

Physical Characteristics and Chemical Compositions of Local Red Onion Cultivar Grown in Kapıdağ, Turkey

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ABSTRACT

Preserving traditional cultures, promoting local and rural development, protecting small producers and improving product quality, the conservation and sustainable use of all plant genetic resources is essential for food security. The objective of this study was to determine the characteristics of landrace red onion (*Allium cepa* L.) in Southern Marmara Region in Turkey for measures of conservation. Red onions produced in the Kapıdağ Peninsula are called as "Kapıdağ purple onion", "Kapıdağ red onion" or "Kapıdağ fish onion". Red onion is generally produced by small family farmers according to traditional methods. The red onion samples were taken from Doğanlar, Turanlar, Ormanlı, Ballıpınar and Çayağzı villages in Erdek district and investigated for various properties including information about the descriptions of red onions and ecology. In addition, various chemical (titratable acidity, pH and total soluble solid) and physical (weight, width length and color of onion bulbs) analyses were performed in red onion samples. In this study, titratable acidity and pH values of red onion bulbs were found to be between 0.146% - 0.194% and 5.36 – 5.59 respectively. Total soluble solids and total phenol of red onion bulbs were between 9.17% –10.23% and 58.69 mg GAE g dw⁻¹ – 138.37 mg GAE g dw⁻¹ respectively. Bulb weights of red onion were between 83.31-169.06 g. Bulb width (diameter) and length in red onion bulbs were 70.28 – 49.97 mm and 78.29 – 60.31 mm, respectively. Red onion bulbs, Ormanlı, Turan, Ballıpınar and Çayağzı areas had have elliptical shape, while Doğanlar area had have flattened shape. The tunic colors and flesh color of onion bulbs ranged from red to red dark violet. The obtained from our study will support the protection of genetic resources in their agro-ecosystems and development regional community.

Keywords: Agro ecosystems, *Allium cepa* L., Bulb formation, Kapıdağ Peninsula, Quality, Turkey

INTRODUCTION

The onion (*Allium cepa* L.) is a historical crop grown for thousands of years. It is one of the oldest crops cultivated and its origin is West Asia. But it is grown in almost all parts of the world in the suitable ecological conditions. The dry onion production and consumption is common in every country of the world. Total production of all onion species is about 93.2 million tons in the World. Seven leading countries are China, India, USA, Iran, Turkey and Russia (FAOSTAT, 2018). Turkey's grown in many regions of onion, there are many varieties such as yellow, red, white and green, each with their own unique flavor, from very strong to mildly sweet. Red onion is grown widely in Kapıdağ Peninsula. These landraces are supposed to be Protected Geographical Indication (PGI) for red onion grown in the Kapıdağ Peninsula Southern Marmara Region of Turkey, a region with a polyculture agricultural system and autochthonous landraces have been grown for many years. Kapıdağ Peninsula, which includes temperate and Marmara sea climate properties (Anonymous, 2017).

Dry onion is indispensable kitchen vegetables in every home and typically used as an ingredient in many dishes and salads. There are numerous scientific reports suggesting that onions and or its relatives can be used to cure, reduce, or prevent some of the health problems such as cardiovascular diseases, antidiabetic, cancer, asthma, antibiosis and prebiotic effects (Desjardins, 2008). Allicin and Alliin in the onion whet the appetite, facilitate digestion and serve as a regulatory impact on intestines. Onion has vitamins (A, B1, B2, C, nicotinic acid, pantothenic acid) and important substances such as protein, calcium, phosphorus, potassium and traces of Fe, Al, Cu, Zn, Mn and I. Furthermore, it has anti-fungal and anti-bacterial properties and contains an acrid volatile oil with a pungent smell. Its oil is rich in sulfur (Augusti, 1990). Yellow onions have the richest phenolic contents the red onions have higher antioxidant activities than yellow and white onions (Gökçe *et al.*, 2010). In particular,

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Allium cepa L. known as an ancient medicinal plant has rich in phenolic compounds, e.g. phenolic acids and flavonoids which may act as natural antioxidants, anticarcinogens and antimicrobial agents (Griffiths *et al.*, 2002; Hanelt, 1990). Shon *et al.* (2004) have shown antioxidant and antimutagenic activity of onion extracts. Pérez-Gregorio *et al.* (2011) reported that 18 flavonoids were detected in this food, only two quercetin (3,40-O-diglucoside and quercetin 40-O-monoglucoside) were present in significant levels. Red onions have the highest quercetin and kaempferol contents among the other onion types. Therefore, red onion has an important place in world trade.

Quality of dry onion bulbs is related to the external appearance bulb size, color, flavor, firmness and chemical composition (Grangeiro *et al.*, 2018). Unlike other dry onion varieties, red onion skins contain anthocyanin mainly comprising peonidin and cyanidin derivatives (Wu and Prior, 2005). These attributes are defined by factors such as genotype, pre-harvest management, proper harvesting time and post-harvest treatments (Finger and Casali, 2002; Grevsen and Sorensen, 2004). Quality is highly affected by water losses, sprouting and rooting incidence and changes in chemical composition. There are few studies on the red onion in Turkey (Gökçe *et al.*, 2012; Cebec *et al.*, 2015; Koca *et al.*, 2016). Therefore, the aim of this article is to reveal that in Turkey still exist valuable onion genetic resources that need to be officially recognized for their value in supporting food security. Within this context, red onion bulbs belonging to five autochthonous landraces from villages (Doğanlar, Turanlar, Ormanlı, Ballıpınar and Çayağzı) in Southern Marmara Region (Kapıdağ Peninsula) provided by local producers will be described. All landraces will be assessed against the evaluation of their status of conservation in the place of origin. This will also contribute to the preservation of traditional cultures, promoting local and rural development, protecting small producers and improving product quality are examined.

MATERIALS AND METHODS

Study area was represented by Doğanlar village (40° 30' 59" N latitude, 27° 44' 55" E longitude), Turan village (40° 30' 15" N latitude, 27° 46' 47" E longitude), Ormanlı village (40° 30' 31" N latitude, 27° 50' 26" E longitude), Ballıpınar village (40° 30' 18" N latitude, 27° 54' 22" E longitude) and Çayağzı village (40° 29' 20" N latitude, 27° 58' 25" E longitude). Producers grow red onion for more than 50 years and they produce their own red onion seeds. Mature red onion (*Allium cepa* L.) bulb samples were hand-harvested at dark red color in June and July. Fifty bulbs from each area were randomly sampled and used for the analysis. In addition, descriptions, habitats and soil texture (0-30 cm) of red onion growing areas were recorded (Table 1).

Red onion bulbs assessed for bulb weight, bulb size, bulb soluble solids, pH, titretable acidity, total phenol color. Bulb size was evaluated after the removal of dry skin, roots and stems. The average fresh weight was determined at 10 randomly selected bulbs. The width (diameter), the length of bulb and shape index of bulb (diameter/length) (cm) were measured at 10 randomly selected onion bulbs using digital caliper (Figure 1) (Lippert and Legg, 1972). Index value; 1.0 = round, 1.0 - 0.75 elliptical, 0.75 \geq long-elliptical, 1.0 \leq flattened.

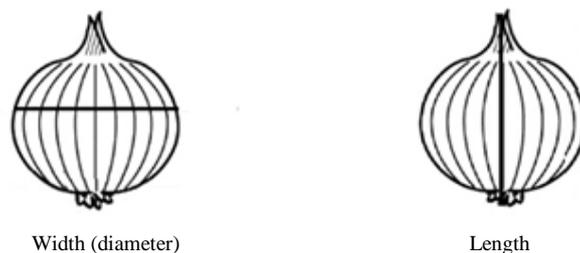


Figure 1. The width (diameter) (mm) and the length (mm) of bulb.

Bulb samples were homogenized before measurements of soluble solids, pH, titretable acidity. Total soluble solid (%) of red onion bulb samples was determined using a refractometer (Mettler Toledo Quick-Brix 60) at room temperature (20 °C). The titratable acidity was determined (citric acid mg/100 ml) using the potentiometric

method (0.1 N NaOH solution up to a pH of 8.1), (Horwitz, 1975, Anonymous 1983, Uylaşer and Başoğlu, 2011) and the pH was determined using a digital pH meter (Hanna Instrument pH 211 microprocessor pH meter) at room temperature (20 °C). The total phenol content in red onion bulbs was determined according to the Folin-Ciocalteu spectrophotometric method (Slinkard and Singleton, 1977). Gallic acid was used as a standard and results were expressed as mg gallic acid equivalent (GAE) g⁻¹ dry weight (DW) basis.

Tunic and flesh color of onions were carried out using a Minolta portable chromameter (Minolta, Model CR-400) which provided CIE L*, a* and b* values. This step was followed by calculating the hue angles [$H_o = \arctan(b^*/a^*)$] and chroma values [$C = [(a^*)^2 + (b^*)^2]^{0.5}$] were converted calculating by Carreño *et al.* (1995). 10 onion bulbs were used in tunic and flesh color measurements in each area.

Statistical analysis

The experiment was conducted in a completely randomized design with three replications. The results were statistically evaluated by one-way analysis of variance (ANOVA) using the JMP software package version 7.0 (SAS Institute Inc. NC, 27513). The significance of the treatments was determined at the 0.05 and 0.01 probability levels by the F-test. The F-protected least significant difference (LSD) was calculated at the 0.05 probability level according to Steel and Torrie (1980).

RESULTS AND DISCUSSION

Observations in the different regions of the Kapıdağ Peninsula showed that *Allium cepa* L. populations were usually located near the sea regions of the Kapıdağ Peninsula at 7-18 m altitude (especially Doğanlar, Turanlar, Ormanlı, Ballıpınar and Çayağzı).

Kapıdağ Peninsula is located on the south shore of Marmara Sea. The color and taste of red onions grown in this region is different from those of red onions grown in other regions of Turkey. Therefore, red onions produced in the Kapıdağ Peninsula are called as “Kapıdağ purple onion”, "Kapıdağ red onion" or "Kapıdağ fish onion". Red onion is a regional product of the Kapıdağ Peninsula. The *Alliums* are of the earliest classified plants. Morphological characteristics such as bulb size, shape, color, and pungency are the first known classification criteria (McCullum, 1971). Physical and chemical properties of soil of Kapıdağ Peninsula (especially Doğanlar, Turanlar, Ormanlı, Ballıpınar and Çayağzı) were given in Table 1. The pH of the soil was ranged from 5.88 to 7.26 and soil texture was clayloam or loam and had organic matter range from 0.43% to 3.63% in the red onion growing areas.

Table 1. Soil texture of Kapıdağ Peninsula.

Areas	Depth (cm)	Texture	Water Saturation (%)	EC ₂₅ (1:2.5) (µmhos cm ⁻¹)	pH (1:2.5)	CaCO ₃ (%)	Organic Matter (%)	Available Phosphorous (mg kg ⁻¹)	Exchangeable Potassium (mg kg ⁻¹)
Ormanlı	0-30	Clayloam	57	616	6.98	0.40	2.15	25	90
Turan	0-30	Clayloam	55	282	7.16	0	3.63	100	453
Doğanlar	0-30	Loam	44	174	7.26	0	0.43	53	73
Ballıpınar	0-30	Loam	44	856	6.20	0	1.61	2	328
Çayağzı	0-30	Loam	48	279	5.88	0.60	2.96	101	298

Red onion harvest begins in Mid-June in Ballıpınar, in July in Çayağzı and Turan and end of July in Doğanlar. Red onion bulbs are sold in the form of bunches. Ecological differences and cultural applications of areas affected the chemical compositions and physical characteristics of red onion bulbs. Some chemical compositions and physical characteristics of Kapıdağ red onion bulbs produced from five different areas (Doğanlar, Turanlar, Ormanlı, Ballıpınar and Çayağzı) are given in Table 2-3.

Table 2. Physical characteristics of harvested red onion bulbs in Kapıdağ Peninsula.

Areas	Bulb weight (g)	Bulb width (diameter) (mm)	Bulb length (mm)	Shape index
Ormanlı	83.31 c*	49.97 b	60.31 c	0.83 b - elliptical
Turan	118.05 b	54.72 b	64.70 bc	0.86 b - elliptical
Doğanlar	147.64 ab	70.28 a	62.92 bc	1.13 a - flattened
Ballıpınar	169.06 a	69.03 a	78.29 a	0.89 b - elliptical
Çayağzı	130.90 ab	65.78 a	71.82 ab	0.92 ab - elliptical
LSD(%5)	31.43	0.16	9.06	0.22

*LSD (Least Significant Difference) values with different letters in the same column indicate significantly different at $p < 0.05$.

Table 3. Chemical compositions of harvested red onion bulbs in Kapıdağ Peninsula.

Areas	Titrateable acidity (g 100 g ⁻¹)	pH	Total soluble solid (Brix)	Total Phenol (mg kg ⁻¹) (mg GAE g dw ⁻¹)
Ormanlı	0.146 b*	5.59 a	9.17 c	77.52 bc
Turan	0.155 b	5.41 d	9.50 bc	98.26 b
Doğanlar	0.148 b	5.49 b	8.63 d	138.37 a
Ballıpınar	0.151 b	5.36 e	10.23 a	58.69 c
Çayağzı	0.194 a	5.44 c	9.73 ab	70.43 bc
LSD (%5)	0.009	0.018	0.56	33.29

*LSD (Least Significant Difference) values with different letters in the same column indicate significantly different at $p < 0.05$.

Physical characteristics of harvested red onion bulbs in Kapıdağ Peninsula were significant. Bulb width (diameter) and length in red onion bulbs were 70.28-49.97 mm and 78.29-60.31 mm, respectively. Weight of red onion bulbs were between 83.31-169.06 g. The weight of bulb was found to be 169.06 g in Ballıpınar followed by Doğanlar (147.64 g), Çayağzı (130.90 g), Turan (118.05 g) and the least was in Ormanlı (83.31 g). Kuroki *et al.* (2017) reported that diameter and weight in onion bulbs ranged from 68.9-101.7 mm and 168.0-384.5 g respectively. According to Fatideh and Asil (2012), onion bulb size and weight are increased with of the amount of nitrogen fertilizer applied. This is in agreement with the findings of Harris *et al.* (2016). Almost a linear relationship between onion bulb weight and macro nutrient content was observed in the present experiment (Sultana *et al.*, 2014). Khan *et al.* (2017) also reported that effect of humic substances on the onion bulbs diameter and weight ranged from 42.3 - 64.3 mm and 83.3 - 117.0 g respectively. Kumar *et al.* (2011) also achieved similar results. Also Kahlon (2017) reported that the grade size of onion bulbs was significantly affected by planting method.

Shape index of red onion bulbs were determined according to areas. Red onion bulbs, Ormanlı, Turan, Ballıpınar and Çayağzı areas had have elliptical shape, while Doğanlar area had have flattened shape.

The titrateable acidity and pH values of red onion bulbs were found between 0.146% - 0.194% and 5.36 - 5.59 respectively. The titrateable acidity was determined the highest on Çayağzı. The amount of titrateable acidity values of red onion bulbs recorded in this study was higher than those of reported by Petropoulos *et al.* (2016). pH values of red onion bulbs fluctuated slightly according to the production areas (5.36 -5.59). The amount of pH values of red onion bulbs recorded in this study confirmed with the previous findings (Petropoulos *et al.*, 2016, Rodrigues *et al.*, 2012). The results of the total soluble solid of red onions are given in Table 3. Total soluble solid of red onions which is an important quality parameter significantly differed among the production areas. Total soluble solid of red onion bulbs were determined between 8.63 – 10.23%. The highest content of total soluble solid was found in bulbs of plants that received from Ballıpınar (10.23 %) and Çayağzı (9.73 %). The findings of Petropoulos *et al.* (2016) and Kahlon (2017) on the total soluble solid of red onions are confirmed. But they are little less than the results of Thangasamy *et al.* (2018) (11.5 - 13.0 %) and Bettoni *et al.* (2016) (14.89 %).

The differences in total phenolic content among the areas were statistically significant (Table 3). Our study revealed a considerable amount of variation among the areas tested. The total phenolic content of areas ranged from 58.69 to 138.37 mg GAE g⁻¹ DW. Our results are in good agreement with earlier reports. Thus Kaur *et al.* (2009) reported a wide variation was observed for total phenolic content of onion bulbs, with a range of 41.74 to 146.90 mg GAE 100 g⁻¹. Also the total phenolic content of the onion samples was reported 44.92 mg

GAE 100 g⁻¹ FW by Siddiq *et al.* (2013). On the contrary Gökçe *et al.* (2010) reported that the total phenolic content of the red onion samples range of 21–24 mg GAE 100 g⁻¹.

Physical characteristics and chemical compositions of onion bulbs can differ according to cultivars (Oancea and Draghici, 2013), climates, growth regulators (Tyagi and Yadav, 2007), long-term storage (Petropoulos *et al.*, 2016, Benkeblia, 2000) and cultural practices (Kahlon, 2017; Khan *et al.*, 2017; Bettoni *et al.*, 2016; Harris *et al.*, 2016; Islam, 2015; Sultana *et al.*, 2014; Fatideh and Asil, 2012; Rodrigues *et al.*, 2012; Kumar *et al.*, 2011).

There were significant differences in terms of lightness (L), hue angle or chroma among the tunic and flesh color measurements of onion among production areas (Table 4). The L* ranged from 17.97 (Ballıpınar) to 22.34 (Turan) of tunic color. Similar pattern was observed for a* but wasn't observed for b*. On the other hand the L* ranged from 17.78 (Doğanlar) to 23.06 (Turan) for flesh color. Similar pattern was observed for a* but wasn't observed for b*. The tunic colors and flesh color of onion bulbs were determined red-dark violet.

Table 4. Tunic and flesh color of onions.

Areas	Tunic Color					Flesh Color				
	L**	a**	b**	Hue°	Chroma	L**	a**	b**	Hue°	Chroma
Ormanlı	20.54 ab*	15.84 ab	2.83	09.92	16.11 ab	19.26 bc	14.80 bc	1.16	5.09 ab	14.84 bc
Turan	22.34 a	20.74 a	3.60	09.49	21.23 b	23.06 a	24.47 a	-2.46	-5.58 b	24.63 a
Doğanlar	18.97 ab	10.78 bc	2.27	11.72	11.03 bc	17.78 c	8.83 c	1.13	7.30 a	8.90 c
Ballıpınar	17.97 b	9.81 b	1.01	5.97	9.87 c	22.32 ab	19.80 ab	0.92	-0.61 ab	20.07 ab
Çayağzı	19.12 ab	16.71 a	1.41	5.40	16.87 ab	20.70 abc	21.22 ab	0.99	-2.78 ab	21.28 ab
LSD (%5)	3.48	5.77	Ns	Ns	5.87	3.71	7.38	Ns	10.98	7.39

*LSD (Least Significant Difference) values with different letters in the same column indicate significantly different at p<0.05.

Ns: Non-significant.

** Chromameter describes color in three coordinates: L, lightness, from 0 (black) to 100 (white); a, from 60 (green) to 60 (red); and b, from 60 (blue) to 60 (yellow).

CONCLUSIONS

The major constraint for our landraces, that are recognized to achieve a relevant recognition for their qualities, is that they are extinct to disappear or to become allochthonous in the country of origin but in different agro-ecosystems. Moreover, there have been some problems in red onion production like the production of autochthonous landraces, the use of these seeds to grow plants by the farmers, using the same material for many years and the failure in rotation and cultural practices. Besides, producers' insufficiency about harvesting, sorting, packing and marketing processes worsened these problems. In order to overcome to these problems, producers should be trained and the new local varieties should be developed by using genetic materials of these landraces. The results of this article are based on original autochthonous landraces provided by local producers belonging to original agro-ecosystems with a long history of cultivating these plant genetic resources.

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