

# Investigation of the Effects of Different Environmental Conditions on Zeleny Sedimentation and Bread Properties in Wheat

## Farklı Çevre Koşullarının Buğdayda Zeleny Sedimentasyon ve Ekmek Özelliklerine Etkisinin İncelenmesi

### ABSTRACT

This study was carried out in Bahri Dağdaş International Agricultural Research Institute in the growing period of 2014-2015 with 14 different bread wheat varieties in rainfed and irrigated growing conditions according to a Randomized Block Trial Design with 2 replications. In the study, Zeleny sedimentation values and bread weight and bread volume traits of bread wheat varieties were investigated. Differences between varieties grown in irrigated and rainfed conditions were evaluated statistically. Zeleny sedimentation values were changed between 26.00-39.50 ml, bread weight was between 140.20-146.5 g, bread volume was between 340-475 cm<sup>3</sup> and specific volume was between 2.36-3.37 cm<sup>3</sup>/g in rainfed conditions, while Zeleny sedimentation values were between 31-51 ml, bread weight was between 141.61-149.47 g, bread volume was 367.50-485.00 cm<sup>3</sup> and specific volume 2.48-3.38 cm<sup>3</sup>/g in irrigated conditions. It has been determined that the varieties grown in irrigated conditions gave better values than in rainfed conditions in terms of the examined quality parameters.

**Keywords:** Bread wheat, rainfed, irrigated, bread traits, sedimentation,

### ÖZET

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ekmeklik buğday çeşidi ile yağışa ve sulamaya dayalı yetiştirme koşullarda tesadüf blokları deneme desenine göre 2 tekerrürlü olarak yürütülmüştür. Ekmeklik buğday çeşitlerinin Zeleny sedimentasyon değerleri, ekmek ağırlığı ve ekmek hacmi özellikleri araştırılmıştır. Sulamaya ve yağışa dayalı koşullarda yetiştirilen çeşitler arasındaki farklılıklar istatistiksel olarak değerlendirilmiştir. Yağışa dayalı koşullarda Zeleny sedimentasyon değerleri 26.00-39.50 ml, ekmek ağırlığı 140.20-146.5 g, ekmek hacmi 340-475 cm<sup>3</sup>, spesifik hacim ise 2.36-3.37 cm<sup>3</sup>/g arasında bulunurken sulamaya dayalı koşullarda ise Zeleny sedimentasyon değerleri 31-51 ml, ekmek ağırlığı 141.61-149.47 g, ekmek hacmi 367.50-485.00 cm<sup>3</sup>, spesifik hacim ise 2.48-3.38 cm<sup>3</sup>/g arasında bulunmuştur. İncelenen kalite parametreleri açısından sulu koşullarda yetiştirilen çeşitlerin yağmurlu koşullarda yetiştirilenlere göre daha iyi kalite değerleri verdiği tespit edilmiştir.

**Anahtar kelimeler:** Ekmeklik buğday, kuru, sulu, ekmek özellikleri, sedimentasyon

## INTRODUCTION

Bread wheat (*Triticum aestivum*) has an important place in the consumption of agricultural products in many countries due to its wide adaptability, easy cultivation, economical storage and transportation, high nutritional value and the nutritional habits of societies (Bonfil et al., 2012; Dizlek et al., 2013). Wheat, which is an important cultivated plant for Türkiye and its region, has an important place in grains in terms of total cultivation area and production amount. Türkiye is one of the ten largest producers of wheat production worldwide. Since Türkiye's wheat has a high potential in terms of industrial use quality, it is one of the most important actors of world flour export. The quality of the end product depends upon the quality of the wheat grain. The wheat convenient for one particular use may have certain traits that are completely unsatisfactory for other use (Anjum et al., 2008). Many factors determine the wheat quality, and quality traits change importantly based on the producer, industry and consumer demands. Quality traits are as important as the yield in wheat. In bread wheat, protein content, sedimentation and gluten content are significant quality traits for the milling industry (Mut et

al., 2017). Genotype, environmental conditions, and their interaction play an important role in grain yielding and grain quality traits (Rozbicki et al., 2015). Although wheat quality changes depending on wheat genetics it also shows significant changes in the same year depending on climatic conditions such as precipitation, precipitation distribution and temperature. A large part of the wheat grown in Türkiye is grown in areas dependent on rainfall, and the majority is in Central Anatolia and the passage regions around it. For this reason, increasing wheat production of Türkiye's depends on increasing the yield per unit area, and it will be possible by breeding the varieties with high yield and high-quality characteristics and growing them using appropriate cultural techniques. The main purpose of bread wheat breeding studies is to have good bread volume, bread weight, and texture characteristics. In Türkiye, 65-70% of daily calories are obtained from grain products. After excluding bulgur, pasta, biscuits, and other bakery products, it is reported that approximately 80% of the food made from wheat grain is the bread, and the daily bread consumption per person is around 400-500 g (Özkaya, 1992). While determining the suitability for bread making in the bread wheat trade, it is evaluated in terms of characteristics such as dough rheology and bread volume. Bread volume and texture are dependent on protein amount and quality, and the different performance of two flours with the same protein content in making bread under the same conditions is due to the difference in protein quality. There are many types of bread with different formulations, so the quality of wheat flour should be defined according to the final product (Carson and Edwards, 2009).

In this study, the trial was established by sowing 14 different bread wheat varieties under irrigated and rainfed conditions. Zeleny sedimentation, bread weight, and volume were examined in the varieties included in the trial, and the effects of growing conditions on the examined quality parameters were tried to be determined.

## MATERIAL AND METHOD

This study was carried out in the trial areas of Bahri Dağdaş International Agricultural Research Institute according to the randomized block design with 2

replications under rainfed and irrigated growing conditions with 14 different bread wheat varieties during the 2014-2015 growing period. Wheat samples analyzed in the laboratory were annealed according to American Association of Cereal Chemists (AACC) method (26-95) (14.5% humidity), ground in Brabender Junior mill according to AACC method (26-50), Zeleny sedimentation values were determined according to AACC method 56-70 (Anonymous, 2000). For bread making, 100 grams of flour was weighed, and yeast (3%), salt (1.5%), and water, calculated according to farinograph water absorption, was added. The obtained doughs were ventilated and fermented for 30+30+55 minutes, 115 minutes in total at 30 °C, and 75% air humidity, and they were baked for 25 minutes in an oven at 220 °C (Anonymous, 2000). Bread weight and bread volume values were determined. The specific volume of bread was expressed as cm<sup>3</sup>/g by dividing the determined volume value by the bread weight (Elgün et al., 2002). The data obtained from the experiment were evaluated in the Jump statistical analysis program using the anova analysis method (Anonymous, 2014).

**Table 1: Bread wheat varieties used in the trial**

Varieties	Environment	Varieties	Environment
Tosunbey	Irrigated	Bayraktar-2000	Rainfed
Ahmetağa	Irrigated	Gerek-79	Rainfed
Konya-2002	Irrigated	Bozkır	Rainfed
Yunus	Irrigated	Karahan-99	Rainfed
Pehlivan	Irrigated	Bezostaya-1	Rainfed
Gün-91	Rainfed	Eraybey	Rainfed
Sönmez-2001	Rainfed	Demir-2000	Rainfed

## RESULTS AND DISCUSSION

The variance analysis of Zeleny sedimentation results of 14 different bread wheat varieties in irrigated and rainfed

conditions are given in Table 2, and the difference between variety ( $p < 0.01$ ) and variety x environment interaction ( $p < 0.01$ ) were found to be statistically significant.

**Table 2.** Combined variance analysis results of Zeleny sedimentation means

Variation Source	Degree of Independence	Total squares	F Value
Variyety	13	798.21429**	22.5994
Environment	1	434.57143**	159.9494
Recurrence	1	0.64286	0.2366
VariyetyxEnvironment	13	546.92857**	15.4849
Error	27	73.5571	-

\*\* ( $p < 0.01$ )

**Table 3.** Values of Zeleny sedimentation in rainfed and irrigated conditions

**Zeleny Sedimentation (ml)**

Varieties	Rainfed	Irrigated	Mean	Difference of environment
Ahmetağa	36.0 <sup>bc</sup>	43.0 <sup>bc</sup>	39.5 <sup>abc</sup>	7
Bayraktar-2000	26.0 <sup>h</sup>	31.0 <sup>h</sup>	28.5 <sup>f</sup>	5
Bezostaya-1	37.5 <sup>ab</sup>	46.0 <sup>b</sup>	41.7 <sup>a</sup>	8.5
Bozkır	37.5 <sup>ab</sup>	31.5 <sup>gh</sup>	34.5 <sup>cde</sup>	6
Demir-2000	34.5 <sup>cd</sup>	44.5 <sup>bc</sup>	39.5 <sup>abc</sup>	10
Eraybey	39.5 <sup>a</sup>	36.0 <sup>ef</sup>	37.7 <sup>abcd</sup>	3.5
Gerek-79	26.0 <sup>h</sup>	33.5 <sup>fgh</sup>	29.7 <sup>ef</sup>	7.5
Gün-91	31.0 <sup>efg</sup>	51.0 <sup>a</sup>	41.0 <sup>ab</sup>	20
Karahan-99	34.0 <sup>cd</sup>	41.0 <sup>cd</sup>	37.5 <sup>abcd</sup>	7
Konya-2002	35.0 <sup>bcd</sup>	33.0 <sup>fgh</sup>	34.0 <sup>cdef</sup>	2
Pehlivan	30.0 <sup>g</sup>	40.5 <sup>cd</sup>	35.2 <sup>cde</sup>	10.5
Sönmez-2001	30.5 <sup>fg</sup>	35.5 <sup>efg</sup>	33.0 <sup>def</sup>	5
Tosunbey	33.0 <sup>def</sup>	38.5 <sup>de</sup>	35.7 <sup>bcd</sup>	5.5
Yunus	33.5 <sup>cde</sup>	37.0 <sup>def</sup>	35.2 <sup>cde</sup>	3.5
General mean	33.1	38.7	35.9	5.57
CV <sub>(%)</sub>	3.87	5.28	4.48	
LSD <sub>(0.05)</sub>	2.28	4.41	2.5	

Determination of end-use quality of wheat flour are a routine process in a high-quality wheat breeding program. Bread is the most consumed food in the world. The bread baking test is important to make a final assessment of bread quality. Bread-making quality is influenced by both protein quantity and quality. Zeleny sedimentation is an indicator of protein quality in bread flour and is a quality trait widely used by industrialists. Peighambardoust et al. (2011) reported that Zeleny sedimentation showed a significant correlation between loaf volume and bread height. Abugalieva and Peña (2010) indicated that the basic principles of quality improvement are understanding the effects of genotype × environment interactions on the quality traits, genetic control, and diversity associated with quality traits.

In the study, the Zeleny sedimentation value of the varieties varied between 26.0 and 39.5 ml in rainfed conditions; the trial mean was 33.10 ml, the highest value was obtained from the variety Eraybey, and the lowest values was obtained from variety Bayraktar-2000 and variety Gerek-79. When examined on the basis of varieties, it was determined that varieties Bozkır, Bezostaya-1, Ahmetağa, and Konya-2002 had high mean Zeleny sedimentation values than trial mean (Table 3). Ozturk and Aydın (2004) found the sedimentation values to be 32.2 ml in irrigating conditions, 35.7 ml in rainfed conditions, 34.0 ml in early water stress conditions, 35.0 ml in late water stress conditions and 37.5 ml in continuous water stress conditions. Zeleny sedimentation value is mainly influenced by the genotype and environmental effects (Grausgruber et al., 2000).

Mut et al. (2010) determined that some quality characteristics of 25 bread wheat genotypes such as thousand kernel weight, hectoliter weight, grain protein ratio and Zeleny sedimentation volume were affected by different environmental conditions.

Sezer et al. (2021), indicated that significant differences were observed in the Zeleny sedimentation values at the different irrigation, water table depth, and groundwater salinity treatments ( $p \leq 0.01$ ). The sedimentation value was measured as 26.2 ml in the irrigated treatments and as 25.4 ml in the rainfed treatments. İlgün and Soylu (2019) reported that Zeleny sedimentation values ranged between 21.5-34.7 ml in a study they carried out with bread wheat genotypes in irrigated conditions under ecological conditions of Çumra and Altınekin counties in Konya province. Zeleny sedimentation is considered an indicator of protein quality and high values are desired in bread wheat (Şahin et al, 2017; Aydoğan and Soylu, 2017).

The Zeleny sedimentation value of the varieties grown under irrigated conditions varied between 31.00 and 51.00 ml; the mean value of the trial was 38.7 ml, the highest Zeleny sedimentation value was obtained in the variety Gün-91, and the lowest value was obtained in the variety

Bayraktar-2000 (Table 3). On the basis of varieties, Zeleny sedimentation was obtained above the mean value of trial in varieties Bezostaya-1, Demir-2000 and Ahmetağa. When the Zeleny sedimentation of varieties were compared in terms of environments, the Zeleny sedimentation of irrigated conditions (5.57 ml) was higher than rainfed conditions (Table 3). In a similar study, Şahin et al. (2019), reported in a similar study that Zeleny sedimentation values were affected due to the years, growing conditions, and varieties. They found that the mean value of Zeleny sedimentation was 48.03 ml in rainfed conditions, the mean value of Zeleny sedimentation was 37.79 ml in irrigated conditions. High Zeleny sedimentation value is accepted as an indicator that protein ratio and bread volume will also be high. It is thought that it is high in irrigated conditions due to the excess nitrogen fertilizer thrown into the trial.

### Bread weight

The variance analysis results of the bread weight of 14 bread wheat varieties in irrigated and rainfed conditions were shown in Table 4; the difference between the varieties ( $p<0.01$ ) and variety x environment ( $p<0.01$ ) were found to be statistically significant.

**Table 4.** Combined analysis of variance for bread weight

Variation Source	Degree of Independence	Total squares	F Value
Cultivar	13	179.71424**	73.1410
Environment	1	32.13315**	170.0102
Recurrence	1	0.11161	0.5905
CultivarxEnvironment	13	36.98015**	15.0504
Error	27	5.1031	-

\*\* ( $p<0.01$ )

**Table 5.** Bread weights values determined in rainfed and irrigated conditions

Varieties	Bread weight (g)			Difference of environment
	Rainfed	Irrigated	Mean	
Ahmetağa	144.01 <sup>b</sup>	144.23 <sup>e</sup>	144.12 <sup>ef</sup>	0.22
Bayraktar-2000	143.71 <sup>bc</sup>	141.61 <sup>g</sup>	142.66 <sup>fg</sup>	2.1
Bezostaya-1	144.65 <sup>b</sup>	146.46 <sup>d</sup>	145.55 <sup>cde</sup>	1.81
Bozkır	146.51 <sup>a</sup>	147.48 <sup>c</sup>	146.99 <sup>abc</sup>	0.97
Demir-2000	146.24 <sup>a</sup>	149.47 <sup>a</sup>	147.85 <sup>a</sup>	3.23
Eraybey	142.70 <sup>c</sup>	143.38 <sup>f</sup>	143.04 <sup>fg</sup>	0.68
Gerek-79	144.39 <sup>b</sup>	146.75 <sup>cd</sup>	145.57 <sup>cde</sup>	2.36
Gün-91	142.79 <sup>c</sup>	143.71 <sup>ef</sup>	143.25 <sup>fg</sup>	0.92
Karahan-99	140.20 <sup>d</sup>	144.31 <sup>e</sup>	142.25 <sup>g</sup>	4.11
Konya-2002	146.58 <sup>a</sup>	148.59 <sup>b</sup>	147.58 <sup>ab</sup>	2.01
Pehlivan	144.31 <sup>b</sup>	148.54 <sup>b</sup>	146.42 <sup>abcd</sup>	4.23
Sönmez-2001	146.05 <sup>a</sup>	146.28 <sup>d</sup>	146.16 <sup>bcd</sup>	0.23
Tosunbey	144.41 <sup>b</sup>	146.38 <sup>d</sup>	145.39 <sup>de</sup>	1.97
Yunus	146.14 <sup>a</sup>	146.72 <sup>cd</sup>	146.43 <sup>abcd</sup>	0.58
General mean	144.48	145.99	145.23	1.51
CV <sub>(%)</sub>	3.34	2.48	0.29	
LSD <sub>(0.05)</sub>	0.95	0.77	0.6	

The use of high-quality bread wheat varieties for both industrial and commercial purposes increases the end product values. In this research, the bread weight of the varieties varied between 140.20 and 146.58 g in rainfed conditions; the trial mean was 144.48 g, the highest bread weight was obtained from variety Konya-2002, and the lowest value was obtained from Karahan-99 varieties. When the varieties were examined in general, it was determined that the bread weight values of varieties Bozkır, Demir-2000, Yunus, Sönmez-2001, Bezostaya-1 were above the mean value of the trial. In a similar study Şahin et al. (2013) determined that the bread weight of the genotypes was 146.20 and 140.51 g in rainfed and irrigated conditions, respectively, in 2011-2012. In another study, Şahin et al. (2019), determined the mean value of bread weight of bread wheat varieties as 137.7 g

in rainfed conditions and 139 g in irrigated conditions. Aydogan et al. (2013) found that the bread weight of 21 bread wheat varieties varied between 122.9-153.3 g in rainfed conditions, and the highest values were obtained in varieties Müfitbey, Bezostaya-1, Dağdaş-94, Demir-2000, and Süzen-97. It was determined in this trial that the bread weights of the varieties varied between 141.61 - 149.47 g under irrigated conditions, and the mean value of the trial was 145.99 g. The highest weight was obtained from variety Demir-2000, and the lowest value was obtained from variety Bayraktar-2000. When evaluated in general, it was determined that the bread weight of varieties Konya-2002, Pehlivan, Bozkır, Yunus, and Bezostaya-1 were above the mean of the trial.

The mean value of bread weight of the varieties in irrigated and rainfed conditions was 145.23 g, and the

highest value was obtained from the Demir-2000 cultivar in both conditions. The bread weight difference was 1.51 g higher in irrigated conditions than in rainfed conditions, the highest difference was obtained in Pehlivan and the lowest difference was obtained in the Ahmetağa variety (Table 5).

### Bread volume

The variance analysis results of bread volume of bread wheat varieties are shown in Table 6. The difference between varieties ( $p<0.01$ ) and variety x environment ( $p<0.01$ ) was found to be statistically significant.

**Table 6.** Combined analysis of variance for bread volume

Variation Source	Degree of Independence	Total squares	F Value
Variety	13	59495.089**	267.4294
Environment	1	4375.446**	255.6783
Recurrence	1	1350.446**	78.9130
VarietyxEnvironment	13	4330.804**	19.4669
Error	27	462.054	-

\*\* ( $p<0.01$ )

**Table 7.** Values of bread volumes in irrigated and rainfed conditions

Varieties	Bread Volume (cm <sup>3</sup> )			
	Rainfed	Irrigated	Mean	Difference of environment
Ahmetağa	445.0 <sup>cd</sup>	467.5 <sup>cd</sup>	456.2 <sup>bcd</sup>	22.5
Bayraktar-2000	340.0 <sup>g</sup>	367.5 <sup>j</sup>	353.7 <sup>g</sup>	27.5
Bezostaya-1	440.0 <sup>cd</sup>	472.5 <sup>bc</sup>	456.2 <sup>bcd</sup>	32.5
Bozkır	397.5 <sup>e</sup>	410.0 <sup>i</sup>	403.7 <sup>f</sup>	12.5
Demir-2000	437.5 <sup>d</sup>	447.5 <sup>f</sup>	442.5 <sup>de</sup>	10
Eraybey	475.0 <sup>a</sup>	485.0 <sup>a</sup>	480.0 <sup>a</sup>	10
Gerek-79	380.0 <sup>f</sup>	430.0 <sup>h</sup>	405.0 <sup>f</sup>	50
Gün-91	437.5 <sup>d</sup>	477.5 <sup>b</sup>	457.5 <sup>bcd</sup>	40
Karahan-99	472.5 <sup>a</sup>	485.0 <sup>a</sup>	478.7 <sup>a</sup>	12.5
Konya-2002	440.0 <sup>bc</sup>	450.0 <sup>g</sup>	445.0 <sup>cde</sup>	10
Pehlivan	437.5 <sup>d</sup>	465.0 <sup>d</sup>	451.2 <sup>bcd</sup>	27.5
Sönmez-2001	457.5 <sup>c</sup>	460.0 <sup>cd</sup>	458.7 <sup>bc</sup>	2.5
Tosunbey	447.5 <sup>cd</sup>	475.0 <sup>b</sup>	461.2 <sup>b</sup>	27.5
Yunus	440.0 <sup>bc</sup>	440.0 <sup>f</sup>	433.7 <sup>e</sup>	12.5
General mean	431.96	452.3	441.7	17.68
CV <sub>(%)</sub>	4.15	5.2	0.93	
LSD <sub>(0.05)</sub>	5	6.9	5.84	

Bread volume is the most important criteria used for the determination and assessment of bread quality. The flour protein content, the Zeleny sedimentation, the flour falling number, and dough strength were the main factors affecting the textural properties of the bread crumb alone and with the bread loaf volume (Rózyło and Laskowski, 2011). A good quality bread should have sufficient and balanced developed volume. In this research, the bread volume of the varieties varied between 340 and 475 cm<sup>3</sup> in rainfed conditions, and the mean value of trial was 431.96 cm<sup>3</sup>. The highest value was obtained in the variety Eraybey and the lowest value was obtained in the variety Bayraktar-2000. When evaluated in general, it was determined that the bread volume of varieties Karahan-99, Sönmez-2001, Konya-2002, Tosunbey, Ahmetağa and Yunus were above the mean value of trial in rainfed conditions. Rozbicki et al. (2015) has reported that the baking score and bread volume varied largely between years. In their study, a strong effect of the location on the dough development and protein content was observed and determined that increase of the protein content and sedimentation value caused an increase in the rheological traits. Aydoğan et al. (2013) found that the bread volumes of 21 bread wheat varieties varied between 350-550 cm<sup>3</sup> in rainfed conditions, and the highest values were obtained from varieties Harmankaya-99 (550 cm<sup>3</sup>), Gün-91 (520

cm<sup>3</sup>) and Eraybey (515 cm<sup>3</sup>) varieties.

The bread volume of the varieties grown under irrigated conditions varied between 367.5-485.0 cm<sup>3</sup>, and the mean value of the trial was 452.3 cm<sup>3</sup>. The highest values were obtained from varieties Eraybey and Karahan-99, and the lowest value was obtained from variety Bayraktar-2000. Şahin et al. (2013) determined that the mean bread volume was 473.3 cm<sup>3</sup> in genotypes grown in rainfed conditions and 470.6 cm<sup>3</sup> in genotypes grown in irrigated conditions. In the general evaluation made under irrigated conditions, it was determined that the bread volume of varieties Karahan-99, Gün-91, Bezostaya-1, Ahmetağa and Pehlivan was above the trial mean. Mean values of bread volume for both conditions was 441.7 cm<sup>3</sup>, and the highest bread volume was obtained from the variety Eraybey in both conditions. In both conditions, the highest difference in bread volume was obtained from variety Gün-91 and the lowest was obtained from the Sönmez-2001 (Table 7).

### Specific Volume

The variance analysis results of the specific volume of bread wheat varieties are given in Table 8. The difference between varieties ( $p < 0.01$ ) and variety x environment ( $p < 0.01$ ) was found to be statistically significant.

**Table 8.** Combined analysis of variance for specific volume

Variation Source	Degree of Independence	Total squares	F Value
Variety	13	0.11207**	128.10640
Environment	1	0.11207**	121.20650
Recurrence	1	0.06735**	76.98770
VarietyxEnvironment	13	0.21393**	18.81160
Error	27	0.02362	-

\*\* ( $p < 0.01$ )

**Table 9.** Values of specific volumes in irrigated and rainfed conditions

Varieties	Specific volume (cm <sup>3</sup> /g)			
	Rainfed	Irrigated	Mean	Difference of environment
Ahmetağa	3.09 <sup>bc</sup>	3.24 <sup>bc</sup>	3.17	0.15
Bayraktar-2000	2.36 <sup>e</sup>	2.59 <sup>g</sup>	2.48	0.23
Bezostaya-1	3.04 <sup>bc</sup>	3.22 <sup>bcd</sup>	3.13	0.18
Bozkır	2.71 <sup>d</sup>	2.78 <sup>f</sup>	2.75	0.07
Demir-2000	2.99 <sup>c</sup>	2.98 <sup>e</sup>	2.99	0.01
Eraybey	3.32 <sup>a</sup>	3.38 <sup>a</sup>	3.36	0.05
Gerek-79	2.63 <sup>d</sup>	2.93 <sup>e</sup>	2.78	0.30
Gün-91	3.06 <sup>bc</sup>	3.32 <sup>ab</sup>	3.19	0.26
Karahan-99	3.37 <sup>a</sup>	3.36 <sup>a</sup>	3.37	0.01
Konya-2002	3.07 <sup>bc</sup>	2.96 <sup>e</sup>	3.02	0.11
Pehlivan	3.03 <sup>bc</sup>	3.13 <sup>cd</sup>	3.08	0.10
Sönmez-2001	3.14 <sup>b</sup>	3.12 <sup>d</sup>	3.14	0.02
Tosunbey	3.09 <sup>bc</sup>	3.24 <sup>b</sup>	3.17	0.15
Yunus	3.01 <sup>c</sup>	2.91 <sup>e</sup>	2.96	0.10
General mean	3.00	3.09	3.04	0.12
CV <sub>(%)</sub>	5.24	4.95		
LSD <sub>(0.05)</sub>	0.12	0.10		

The specific volume value, which includes bread volume and bread weight parameters, is an important parameter for analyzing bread quality (Mudgil et al., 2016). Specific volume, which is the ratio of the two properties, namely, bread volume to bread weight, has been generally accepted in the literature as a more reliable measure of bread size (Shittu et al., 2007).

In this research, the specific volume of the varieties changed between 2.36 and 3.37 cm<sup>3</sup>/g in rainfed conditions; the mean of the trial was 3.00 cm<sup>3</sup>/g. The highest value was obtained in the variety Karahan-99 and the lowest value was obtained in the variety Bayraktar-2000 (Table 9). The

specific volume of the varieties grown in irrigated conditions varied between 2.59 and 3.38 cm<sup>3</sup>/g, and the mean of trial was 3.09 cm<sup>3</sup>/g. The highest value was obtained from variety Eraybey and the lowest value was obtained from Bayraktar-2000 in irrigated conditions. When irrigated and rainfed conditions were evaluated together, the mean of specific volume value of the varieties was 3.04 cm<sup>3</sup>/g, and the highest specific volume was obtained in varieties Eraybey and Karahan-99 under both conditions. In both conditions, the highest difference in specific volume was obtained in the variety Gerek-79 and the lowest value in varieties Demir-2000 and Karahan-99 (Table 9).

## CONCLUSION

In this study, the Zeleny sedimentation value and bread traits of 14 different bread wheat varieties under irrigated and rainfed conditions were determined and the effects of different growing conditions and the performances of the varieties were examined. The conclusion of the study showed that rainfed and irrigated growing conditions have affect on Zeleny sedimentation, bread weight and volume directly and indirectly. As a result of the analysis of variance, the differences between the examined traits and varieties were found to be statistically significant.

Considering the mean values in rainfed conditions, the variety Eraybey stood out in terms of Zeleny sedimentation, varieties Konya-2002, Bozkır and Demir-2000 in terms of bread weight, and varieties Eraybey, Karahan-99 and Tosunbey in terms of bread volume. In irrigated conditions, variety Gün-91 was the best in terms of Zeleny sedimentation, varieties Demir-2000, Konya-2002 in terms of bread weight, varieties Eraybey, Karahan-99, Gün-91 and Tosunbey in terms of bread volume. Considering the mean values of both environments; the highest values were obtained from, varieties Bozkır and Gün-91 in terms of Zeleny sedimentation, varieties Demir-2002 and Konya-2002 in terms of bread weight, from Eraybey, Konya-2002 and Tosunbey varieties in terms of bread volume.

The conclusion showed that varieties Gün-91, Bozkır, Konya-2002, Tosunbey and Eraybey had good results in terms of the Zeleny sedimentation and bread traits in both growing conditions in Konya region. Evaluation under different conditions in the development of varieties with high-quality characteristics is of great importance in order to determine the quality results more accurately. Therefore, high yielding and quality new varieties should be improved and among the existing varieties, those that are superior in this regard should be determined and recommended to the producers.

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