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THE EFFECTS OF BREAD WHEAT VARIETY ON THE FARINOGRAPH AND COLOR PARAMETERS

Ozcan Caglar[1,*], Gulcin Yildiz[2], Mehmet Murat Karaoglu[3], Ali Ozturk[4], Sancar Bulut[5]

[1]Igdir University, Faculty of Applied Sciences, Department of Organic Farming Business Management, Iğdır, 76000, Turkiye
[2]Igdir University, Faculty of Engineering, Food Engineering Department, Iğdır, 76000, Turkiye
[3]Atatürk University, Faculty of Agriculture, Department of Food Engineering, Erzurum, 25240, Turkiye
[4]Atatürk University, Faculty of Agriculture, Department of Field Crops, Erzurum, 25240, Turkiye
[5]Kayseri University, Safiye Cikrikcioglu Vocational School, Department of Plant and Animal Production, Kayseri, 38280, Turkiye

ABSTRACT

This study was undertaken to evaluate the color, water absorption and farinograph properties (development time, mixing tolerance index (MTI), softening degree and dough stability) of bread wheat (*Triticum aestivum* L.) varieties. The effects of 25 different bread wheat varieties were investigated. It was observed that the wheat variety changed significantly ($p < 0.001$) the farinograph parameters as well as color values. A significant change on L* values was observed by different wheat varieties. The "Alparslan" variety among the bread wheat samples exhibited the highest water absorption (67.8%), while the "Bayraktar 2000" variety showed the lowest water absorption (53.9%) in 2001-2002 season. On the other hand, "Dağdaş 94" variety showed the highest water absorption (68.8%), while the "Yıldız 98" variety showed the lowest water absorption (52.1%) in 2002-2003 season. While the highest softening degree was observed in "Kırkpınar 79" variety (185.0 BU) in 2001-2002 season, it was observed in "Türkmen" variety (140.0 BU) in 2002-2003 season. "Gün 91" variety exhibited the highest dough stability as 19.8 min in both 2001-2002 and 2003-2004 seasons. All in all, bread wheat variety is an important parameter to get a high-quality product with an enhanced water absorption, improved farinograph parameters and color.

KEYWORDS:
Color, bread wheat, farinograph parameters, water absorption, wheat variety

INTRODUCTION

Wheat is an annual plant and is grown in many parts of the World because it does not vary in soil demand and has many varieties that can be grown in all climatic conditions. Wheat is one of the most planted agricultural products in terms of cultivation area in the World and in Turkiye [1]. Both the rapid increase in the world population and the continuous improvement of living standards in many countries creates more and more serious problems in the field of agriculture. For this reason, the concept of soil fertility gains importance and is updated a little more every day as an element that should be considered more seriously. There are other reasons for the prevalence of wheat cultivation all over the world. It is known that this group of plants, which includes many product species, shows a wide variety of species, varieties and ecotypes. For this reason, wheat finds wider adaptation areas compared to other cultivated plants. In addition to wheat types, species and varieties that require high humidity and fertile soil; It is also known that there are wheat species and varieties that can grow in soils with low fertility. In addition, it is known that being easy to grow and suitable for transportation, storage and keeping of the product is important for wheat to find a wide spread area on earth [1].

Wheat, which ranks first in the World in terms of cultivation area and among cultivated plants used in human nutrition, is an indispensable agricultural product in terms of basic energy and protein source. Wheat plant, which is used both in human nutrition and animal nutrition, has an economic and strategic importance in the regions. It has been reported that 90% of the world wheat agriculture is made up of wheat for bread and 10% for durum wheat [2]. The production of wheat is highly sensitive to environmental constraints. Despite utmost importance, a detailed characterization of wheat varieties is still limited in various cereal crops. Therefore, the purpose of the current study was to evaluate the color, water absorption and farinograph properties (development time, mixing tolerance index (MTI), softening degree and dough stability) of bread wheat (*Triticum aestivum* L.) varieties. The effects of 25 different bread wheat varieties were investigated.

MATERIALS AND METHODS

Sample preparation and analyses. Experiments were carried out at the Experimental Farm of Ataturk University in Erzurum (29° 55'N and 41° 16'E with the altitude of 1850 m) under natural pre-

cipitation conditions. As the plant material of the research, 25 bread wheat varieties of which adaptation experiments were performed previously [3] were used in experiments. Soil texture of experimental fields are clay-loam with pH of 7.5-7.8 and organic material content of 1.44-1.90%, available P_2O_5 and K_2O contents of 389-436 and 539-602 kg ha^{-1} respectively. Experiments were performed in randomized block design with 4 replications. Experiments were set up over fallow lands during both crop years. Sowing was performed with pressed plot seeder at a rate of 475 seeds m^{-2} during the winter sowing period recommended for Erzurum region. Plots were basically fertilized with 60 kg ha^{-1} N and 50 kg ha^{-1} P_2O_5. All of the phosphorus and half of the nitrogen were applied at sowing time. Half of N was applied at the beginning of stem elongation. Weed control by chemical method has been made.The quality analyses were determined by using the AACC method with slight modifications and performed at research lab in Food Engineering Department of Ataturk University [4]. Analysis of variance was performed with the MSTAT-C (1991) software package. Duncan's multiple range test was used to determine the differences among the means.

RESULTS AND DISCUSSIONS

Color measurement. The color is one of the major quality specifications in food products, but it might change because of the environmental conditions [5]. The effect of bread wheat variety on color values is demonstrated in Table 1. It was observed that the L* value of bread wheat during 2001-2002 season showed a significant difference according to the wheat variety ($p < 0.001$). The L* values were changed between 92.2 to 96.4. While the lowest L* value was observed for "Demir 2000" variety as 92.2, the highest L* value was observed for "Kutluk 94" variety as 96.4. Similar to 2001-2002 season, a significant difference ($p < 0.001$) was found for the bread wheat samples during 2002-2003 season by different bread wheat variety. While the "Kutluk 94" and "Mizrak" varieties showed the highest L* values (96.3), "Demir 2000" variety showed the lowest L* value (92.2). A significant change ($p < 0.001$) in a* values was observed in samples with different wheat variety. While the highest a* value was determined for "Kate A-1" variety (1.6), the lowest a* value was found in "Bolal 2973" variety (0.5) in 2001-2002 season. Similar to the 2001-2002 season, the highest a* value for "Kate A-1" variety (1.5) and the lowest a* value for "Bolal 2973" variety (0.5) in 2002-2003 season were obtained. The similar trend with L* and a* values were observed for b* values of bread wheat samples both in 2001-2002 and 2002-2003 seasons. While the highest b* values were determined for "Kate A-1" variety in 2001-2002 and 2002-2003 seasons (11.1 and 11.2, respectively), the lowest b* values were found in "Nenehatun" variety (5.6) both in 2001-2002 and 2002-2003 seasons. Compared to the 2002-2003 season in terms of all color values (L*, a*, and b* values), the 2001-2002 season showed higher color values (Table 1). All in all, comparison of color values of different bread wheat varieties did not show any certain patterns. Similarly, it was observed that the different wheat types indicate no clear pattern on color parameters in the work of Punia et al. (2019) [6]. Singh and Singh (2010) figured out that the hunter color parameters (L∗, a∗ and b∗ values) of the wheat in the range from 56.4 to 63.8, 6.9 to 7.8 and 18.4 to 23.2, respectively [7]. As mentioned above, "Kutluk 94" and "Mizrak" varieties showed the highest L* values, indicating the light color as compared to the other bread wheat varieties. "Demir 2000" variety showed the darkest color in appearance with the lowest L* value. Moreover, "Kate A-1" variety demonstrated more yellow color compared to the other bread wheat varieties. The yellowish color of wheat is due to a carotenoid pigment called lutein, which can be oxidized to a colorless form by enzymes present in the grain. The most important carotenoids found in wheat are lutein and lutein-fatty acid esters from xanthophy and ß-carotene from carotenes [8].

Water absorption. The amount of water required to be added to the flour in order to obtain a dough with a certain viscosity is the water absorption value of that flour. The water absorption value of flour is constant and is approximately 2.8 times the amount of dry gluten [9]. Hard wheat flours show high water absorption, resistance, high kneading energy and more elastic structure. Soft wheat flours, on the other hand, have low water absorption, low resistance, low energy and more viscous properties [10]. The water absorption values (WAV) were tabulated in Table 1. Keceli et al. (2017) determined that the average value of farinograph water absorption in bread wheat genotypes varied between 46.6-66.8% [11]. According to Koksel et al. (2000), the moisture content of the flour plays an important role in the water absorption of bread flour [12]. This situation is generally negatively proportional.

Development time. The development time value is the rate at which the dough takes in water to reach the point where kneading is most effective. If the development period is short, it shows that water absorption occurs very quickly. On the other hand, if it is long, it shows that the water is taken up by the flour much slower [13]. The development time values were exhibited in Table 2. "Gün 91" variety showed the highest development time in both 2001-2002 and 2002-2003 seasons (9.3, and 8.5 min.; respectively). On the other hand, it was observed that the lowest development time belongs to "Palandöken 97" variety (Table 2) in both 2001-2002 and 2002-2003 seasons (1.8, and 1.3 min.; respectively). The

development times have been reported as less than 2 minutes for weak flours, 2-3 minutes for medium strength flours, 3-5 minutes for strong flours and 5-12 minutes in very strong flours [14]. A long development time indicates that the kneading time will be long, and it also shows that the amount and quality of the extract is high [15]. It has been stated that the low development time will cause the bread volume to decrease and the pore structure to deteriorate [16]. The length of the development period indicates the length of the kneading period and the high amount and quality of the core [17].

Mixing tolerance index (MTI). Mixing tolerance index is a measure of the decrease in resistance to kneading during dough kneading, 5 minutes after the peak value is reached. MTI value gives an idea about dough stability [18]. While the MTI value for good quality flours is around 20 BU, it is around 100 BU for weak flours [19]. The mixing tolerance index values were exhibited in Table 2. "Yakar 99" variety showed the lowest MTI in both 2001-2002 and 2002-2003 seasons (10.0, and 20.0 BU, respectively). On the other hand, it was observed that the highest MTI belongs to "Kırkpınar 79" variety in both 2001-2002 and 2002-2003 seasons (205.0, and 150.0 BU, respectively). Ozer et al. (2003) revealed in their study that the mixing tolerance index varies between 27 BU and 168 BU [20].

TABLE 1
Effects of experimental variables on color and water absorption

Variables	Color measurements						Water absorption (%)	
	*L**		*a**		*b**			
Years (Y)	2001-02	2002-03	2001-02	2002-03	2001-02	2002-03	2001-02	2002-03
2001-02	94.7	-	1.0	-	7.7	-	60.9	-
2002-03	-	94.6	-	1.0	-	7.7	-	56.8
Wheat varieties (WV)								
Aksel 2000	93.7hij	93.6hij	1.0gh	1.0gh	7.4fg	7.4f	58.9ijkl	57.2fg
Alparslan	94.9cde	94.8cde	0.9i	0.9i	8.3d	8.2e	67.8a	58.0def
Atay 85	94.5efgh	94.6efgh	1.2c	1.1c	10.2b	10.1b	65.1cd	61.7b
Bayraktar 2000	95.8^{ab}	95.3^{ab}	1.0^{h}	1.1^{c}	6.9^{i}	6.8^{g}	53.9^{n}	51.4^{l}
Bolal 2973	94.5efgh	94.7efgh	0.5k	0.5k	5.7kl	5.7i	62.9efg	55.4ijk
Dağdaş 94	92.5^{kl}	92.3^{kl}	1.1efg	1.1^{c}	10.2^{b}	9.6^{d}	67.1^{ab}	68.8^{a}
Demir 2000	92.2l	92.2l	0.7j	0.6j	6.5j	6.5h	66.2bc	61.9b
Doğu 88	95.3^{bcd}	95.3^{bcd}	1.4^{b}	1.4^{b}	10.0^{b}	10.3^{b}	60.1^{hi}	55.5^{ij}
Gerek 79	95.7ab	95.6ab	1.1def	1.0gh	7.9e	7.5f	57.9klm	55.3jk
Gün 91	93.9ghij	94.0ghij	0.9i	1.0gh	7.4fg	7.3f	62.5fg	56.6ghi
Ikizce 96	94.7cdef	94.3cdef	1.0^{h}	1.0^{gh}	7.3fgh	7.4^{f}	65.0^{cd}	56.6^{ghi}
Kate A-1	94.5efgh	95.3efgh	1.6^{a}	1.5^{a}	11.1^{a}	11.2^{a}	63.3^{ef}	57.8defg
Kınacı 97	96.3^{a}	96.3^{a}	1.1efg	1.2^{de}	7.4^{fg}	7.4^{f}	58.3^{jkl}	52.4^{l}
Kırgız 95	95.7ab	95.6ab	1.2de	1.2de	7.4fg	7.3f	58.7ijkl	55.3jk
Kırkpınar 79	95.4bc	95.5bc	1.0h	0.9i	7.2gh	7.0g	58.4jkl	55.9hij
Kutluk 94	96.4a	96.3a	0.7j	0.7j	5.9k	5.8i	56.7m	57.0fgh
Mizrak	96.3a	96.3a	0.9i	0.9i	5.9k	5.8i	56.6m	54.9jk
Nenehatun	92.4kl	92.3kl	0.7j	0.7j	5.6l	5.6i	59.1ijk	57.5efg
Palandöken 97	95.8ab	95.9ab	0.9i	1.0gh	7.0hi	6.9g	57.4lm	52.3l
Pehlivan	94.1fghi	94.3fghi	1.2de	1.2de	9.5c	9.5d	64.3de	60.1c
Sultan 95	94.9^{cde}	94.8^{cde}	0.7^{j}	0.6^{j}	6.3^{j}	6.5^{h}	61.6^{gh}	55.7^{ij}
Türkmen	94.4efghi	94.3efghi	1.2^{de}	1.1^{c}	9.7^{c}	9.8^{c}	61.4^{gh}	58.8^{d}
Uzunyayla	93.1^{jk}	93.3^{jk}	1.0^{h}	1.0^{gh}	7.9^{e}	8.1^{e}	61.8^{fg}	58.6^{de}
Yakar 99	93.7^{ij}	93.6^{ij}	1.1fgh	1.0^{gh}	7.5^{f}	7.3^{f}	59.7^{ij}	54.2^{k}
Yıldız 98	95.8^{ab}	95.7^{ab}	0.9^{i}	1.0^{gh}	6.3^{j}	6.3^{h}	56.5^{m}	52.1^{l}
Sources of variation								
F- values								
Y	0.9528	0.9525	1.1831	1.180				
WV	35.53***	35.50***	160.42***	160.43***	483.0***	559.97***	80.55***	126.83***
Y x WV	0.9528	0.94	1.3885	1.387				
Lsd range								
WV	0.773	0.760	0.067	0.070	0.27	0.25	1.56	1.26
CV (%)	0.54	0.52	4.50	4.51	1.60	1.51	1.17	1.00

[a-n] Means superscript with different letters in the same column alter significantly ($p < 0.001$).

In current study, MTI varied between 10.0 and 205.0 BU, with an average of 90.1 BU in 2001-2002 season. In addition, MTI changed between 20.0 and 150.0 BU, with an average of 90.3 BU in 2002-2003 season. It is desired that the development stability period is long and the mixing tolerance index and softening degree values are low for the flour with high bread quality. The longer the increase time (development time) of the resistance indicates that the mixing time will be long, and it indicates that the amount of extract is high and the quality is high. If the degree of softening is high, it indicates that the flour has less tolerance to processing and the fermentation period should be short [21].

Softening degree. The softening degree is the distance to the 500-consistency line after 12 minutes from the apex of the farinograph graph curve. It is generally known as the time when the dough starts to soften. The softening degree values were exhibited in Table 2. While the highest softening degree was observed in "Kırkpınar 79" variety (185.0 BU) in 2001-2002 season, it was observed in "Türkmen" variety (140.0 BU) in 2002-2003 season. On the other hand, "Doğu 88" variety showed the lowest softening degree (5.0 BU) in 2001-2002 season. For 2002-2003 season, the lowest softening degree was obtained for "Gün 91" variety (25.0 BU). The degree of softening is low in bread flours with high protein amount and quality. A high degree of softening indicates the weakness of gluten proteins, less tolerance to flour processing, low bread quality, and a short fermentation time [21]. It is desired that the degree of softening is low in bread flours and high in biscuit flours [22].

TABLE 2
Effects of experimental variables on development time, MTI, softening degree and dough stability

Variables	Development time **(min)		Mixing tolerance index (MTI)*(BU)		Softening degree *(BU)		Dough stability **(min)	
Years (Y)	2001-02	2002-03	2001-02	2002-03	2001-02	2002-03	2001-02	2002-03
2001-02	3.9	-	90.1	-	79.5	-	15.4	-
2002-03	-	2.6	-	90.3	-	79.8	-	13.2
Wheat varieties (WV)								
Aksel 2000	5.5bc	2.0efg	45.0i	110.0bcde	55.0hij	90.0bcdef	16.5de	13.0efg
Alparslan	4.5de	2.8cde	110.0cde	95.0efghi	115.0bcd	107.7b	14.0ijk	13.0efg
Atay 85	3.0ghi	4.0^{b}	115.0^{cde}	90.0fghij	125.0^{bc}	82.7defg	6.5^{n}	16.0^{b}
Bayraktar 2000	1.8k	1.5fg	55.0hi	107.7bcdef	80.0efgh	85.0cdef	13.3jkl	12.5g
Bolal 2973	4.3def	1.3^{g}	97.7defg	60.0^{kl}	75.0^{fgh}	50.0^{ij}	15.3^{fgh}	12.8^{fg}
Dağdaş 94	4.0ef	2.5de	90.0efg	125.0b	75.0fgh	105.0b	14.5ghi	10.8h
Demir 2000	3.5fgh	3.5bc	150.0b	100.0cdefg	105.0bcde	100.0bcd	7.3n	13.8cde
Doğu 88	5.0^{cd}	2.5^{de}	10.0^{j}	50.0^{l}	5.0^{l}	40.0^{jk}	16.3^{def}	13.5^{def}
Gerek 79	2.8hij	2.5de	125.0bcd	85.0ghij	80.0efgh	75.0fg	14.0ijk	13.5def
Gün 91	9.3^{a}	8.5^{a}	45.0^{i}	30.0^{m}	45.0^{ijk}	25.0^{k}	19.8^{a}	19.8^{a}
Ikizce 96	5.0cd	1.5fg	90.0efg	117.7bc	65.0ghi	97.7bcd	15.5efg	12.8fg
Kate A-1	2.5ijk	2.3ef	130.0bc	75.0jk	70.0ghi	55.0hij	13.0kl	14.0cd
Kınacı 97	4.3def	1.5^{fg}	70.0^{ghi}	100.0cdefg	80.0efgh	95.0bcde	15.0^{ghi}	12.8^{fg}
Kırgız 95	2.0jk	2.3ef	115.0cde	92.7efghij	127.7b	77.7efg	7.5n	13.5def
Kırkpınar 79	1.8^{k}	2.5^{de}	205.0^{a}	150.0^{a}	185.0^{a}	97.7^{bcd}	4.8^{o}	13.3defg
Kutluk 94	3.0ghi	2.3ef	95.0efg	110.0bcde	70.0ghi	102.7bc	14.3hij	9.0i
Mizrak	2.8hij	2.0efg	100.0def	60.0kl	100.0cdef	50.0ij	11.3m	13.0efg
Nenehatun	2.8hij	2.0efg	90.0^{efg}	80.0^{hij}	90.0defg	72.7^{fgh}	12.8^{l}	13.0^{efg}
Palandöken 97	1.8k	1.3g	45.0i	120.0b	35.0jk	95.0bcde	13.0kl	12.8fg
Pehlivan	3.8efg	2.8cde	130.0^{bc}	77.7^{ijk}	102.7^{bcde}	55.0^{hij}	18.2^{c}	14.0^{cd}
Sultan 95	5.5bc	4.0b	90.0efg	110.0bcde	60.0hij	100.0bcd	16.3def	14.5c
Türkmen	3.5fgh	3.3bcd	80.0fgh	80.0hij	67.7ghi	140.0a	14.3hij	9.0i
Uzunyayla	6.0^{b}	1.5^{fg}	70.0^{ghi}	115.0^{bcd}	20.0^{kl}	102.7^{bc}	18.3^{c}	12.8^{fg}
Yakar 99	6.0b	2.5de	10.0j	20.0m	65.0ghi	27.7k	17.3cd	13.5def
Yıldız 98	4.0^{ef}	1.3^{g}	90.0^{efg}	97.7defgh	90.0defg	65.0^{ghi}	15.3^{fgh}	13.0^{efg}
Sources of variation								
F -values								
WV	56.36***	37.83***	31.88***	32.19***	28.68***	29.92***	935.81***	61.99***
Lsd range								
WV	0.87	0.91	28.79	19.97	26.12	19.38	1.20	0.97
CV (%)	10.09	16.16	14.59	10.10	15.00	11.10	3.55	3.36

[a-o] Means superscript with different letters in the same column alter significantly ($p < 0.001$).
*BU:Brabender Unit, **min:Minute

Dough stability. Stability is the value that shows the resistance of the dough to processing. If the stability is short, the processing ability of the dough is reduced and the fermentation time is shortened. The dough stability values were exhibited in Table 2. The highest dough stability value (19.8 min) was observed in "Gün 91" variety in both 2001-2002 and 2002-2003 seasons. On the other hand, "Kırkpınar 79" variety showed the lowest dough stability (4.8 min) in 2001-2002 season. For 2002-2003 season, the lowest dough stability was obtained for "Türkmen" and "Kutluk 94" varieties as 9.0 min. According to D'Appolonia and Kunherth, (1984), a stronger dough is formed as the stability value increases [23]. In the study of Aydogan et al. (2012), the relationships between rheological properties in bread wheat were examined [24]. They found significant correlations between rheological properties. In addition, Sahin et al. (2013) found a high correlation between dough stability value and the amount of protein and wet gluten in their study [25]. According to Aydogan et al. (2012), if the stability value is low, the processing ability of the dough decreases accordingly and the fermentation time becomes shorter [24]. In general, it is desired that the stability value of flours with high bread quality should be long and the degree of softening should be low. The longer the stability period, the greater the elasticity of the dough and its suitability for processing, and the larger volume of bread to be made from these flours.

CONCLUSION

In current study, the impacts of different bread wheat varieties on the color, water absorption and farinograph properties (development time, mixing tolerance index (MTI), softening degree and dough stability) of bread wheat (*Triticum aestivum* L.) varieties were explored. It was concluded that the wheat variety changed significantly the farinograph parameters as well as color values. All in all, bread wheat variety is an important parameter to get a high-quality product with an enhanced water absorption, improved farinograph parameters and color.

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CORRESPONDING AUTHOR

Ozcan Caglar
Igdir University, Faculty of Applied Sciences
Department of Organic Farming Business Management
Igdir – Turkiye

e-mail: ozcan.caglar@igdir.edu.tr