Bozok
Tarım ve Doğa Bilimleri Dergisi
(Bozok Journal of Agriculture and Natural Sciences)
https://dergipark.org.tr/en/pub/bojans
e-ISSN: 2822-4604

Araştırma Makalesi

Ekmeklik Buğday Genotiplerinde Farklı Protein Oranlarının Diğer Kalite Parametreleri Üzerine Etkisi

Seydi AYDOĞAN[1]*, Mehmet ŞAHİN[2], Aysun GÖÇMEN AKÇACIK[3], Berat DEMİR[4], Sümeyra HAMZAOĞLU[5], Çiğdem MECİTOĞLU GÜÇBİLMEZ[6], Sadi GÜR[7], Enes YAKIŞIR[8]

[1]Bahri Dağdaş Uluslararası Tarımsal Araştırma Enstitüsü, Konya, Türkiye

*[1]https://orcid.org/0000-0003-0472-1211 [2]https://orcid.org/0000-0003-2446-5227 [3]https://orcid.org/0000-0002-8209-0796 [4]https://orcid.org/0000-0001-6102-2527 [5]https://orcid.org/0000-0002-0572-3801 [6]https://orcid.org/0000-0003-0670-4546 [7]https://orcid.org/0000-0002-1857-8359 [8]https://orcid.org/0000-0002-0161-9206

*Sorumlu Yazar e-mail: seydiaydogan@yahoo.com

Makale Bilgileri

Geliş: 26.12.2023
Kabul: 26.06.2024
DOI: 10.59128/bojans.1410099

Anahtar Kelimeler

Buğday ekmeği
Protein oranı
Reoloji

Öz: Bu çalışma, 2019-2020 yetiştirme sezonunda yağmurla beslenen koşullarda farklı protein oranlarına sahip ekmeklik buğday genotiplerinin kalite özelliklerinde meydana gelen değişiklikleri belirlemek amacıyla yürütülmüştür. Denemede yer alan 24 buğday genotipi protein oranlarına göre gruplandırılmıştır (12.00-12.49, 12.50-12.99, 13.00.13.49, 13.50-13.99, 14.00-14.49 ve 14.50-14.99). Genotiplerin bin tane ağırlığı, Zeleny sedimentasyonu, tane sertliği (SKCS), alveograf parametreleri (P, L, enerji, P/L), farinograf gelişme süresi, su emme ve 10. dakika yumuşama değerleri araştırılmıştır. Protein oranı %12.00-12.49 arasında olan genotiplerin Zeleny sedimantasyon ve alveograf enerji değerleri düşük bulunmuştur. Protein oranı %14.00-14.49 arasında olan genotiplerde tane ağırlığı, Zeleny sedimentasyonu, alveograf P değeri ve enerji değeri açısından yüksek değerler elde edilirken, farinograf 10. dakika yumuşama değeri açısından düşük değerler elde edilmiştir. Tanenin fiziksel özellikleri, protein oranı ve kalitesinin yanı sıra hamurun reolojisini de etkilemiştir.

Atıf Künyesi: Aydoğan S., Şahin M., Göçmen Akçacık A., Demir B., Hamzaoğlu S., Mecitoğlu Güçbilmez Ç., Gür S. ve Yakışır E. (2024). *Ekmeklik Buğday Genotiplerinde Farklı Protein Oranlarının Diğer Kalite Parametreleri Üzerine Etkisi, Bozok Tarım ve Doğa Bilimleri Dergisi,* 3(1), 27-36. **How To Cite:** Aydoğan S., Şahin M., Göçmen Akçacık A., Demir B., Hamzaoğlu S., Mecitoğlu Güçbilmez Ç., Gür S. and Yakışır E. (2024). *The Effect of Protein Ratio on Other Quality Parameters in Bread Wheat Genotypes, Bozok Journal of Agriculture and Natural Sciences,* 3(1), 27-36.

The Effect of Protein Ratio on Other Quality Parameters in Bread Wheat Genotypes

Article Info

Received: 26.12.2023
Accepted: 26.06.2024
DOI: 10.59128/bojans.1410099

Abstract: This study was carried out to determine the changes in quality characteristics of bread wheat genotypes with different protein ratios in rainfed conditions in 2019-2020 growing season. The 24 wheat genotypes in the experiment were grouped according to their protein ratios (12.00-12.49, 12.50-12.99, 13.00.13.49, 13.50-13.99, 14.00-14.49 and 14.50-14.99). Thousand kernel weight, Zeleny sedimentation, grain hardness

Keywords

Bread wheat
Protein ratio
Rheology

(SKCS), alveograph parameters (P, L, energy, P/L), farinograph development time, water absorption and 10th minute softening values of genotypes were investigated. The Zeleny sedimentation and alveograph energy values of the genotypes with protein ratio between 12.00-12.49% were low. In genotypes with protein ratio between 14.00-14.49%, high values were obtained in terms of grain weight, Zeleny sedimentation, alveograph P value and energy value, while low values were obtained in terms of farinograph 10th minute softening value. The physical properties of the grain affected the protein ratio and quality as well as the dough rheology.

1. Introduction

Wheat contributes significantly to the human diet and is grown in a variety of environments around the world (Kiszonas and Morris, 2018). Wheat is one of the main important cereal in the world, and its quality consists mainly of processing and nutritional quality. The term "wheat quality" generally refers to the processing quality, which is mainly dependent on the content and properties of storage proteins in the wheat grains and directly determines the end-use value of the wheat (Ma et al., 2019). Wheat takes the first place as a basic nutrient and strategic product in the world and in our country, and it is seen that this importance will continue in the next years. In wheat breeding programs, it is aimed to develop genotypes with high grain yield and quality characteristics and at the same time stable performance. The food industry uses grains as raw materials and is offered to consumers in modern markets in the form of thousands of different products. The raw material demand of the food industry against grains is increasing every year. Wheat quality includes different standards changing from the farmer to the company, the market and the consumer. Bread wheat breeding lines are evaluated for quality parameters to determine the overall best end-use products. For instance, hard grain with high protein content and strong, extensible gluten is used for making bread, whereas soft grain with low protein content and weak, extensible gluten is best fitting for making cookies, cakes, and pastries (Pena, 2002). In general, for a good bread wheat, it is desired that the protein ratio be above 12%, the bread quality of bread wheat varieties with high protein content is also high (Kara et al., 2009). Although the qualitative composition of the wheat grain is genetically determined, the quantitative composition (i.e., the ratio between the different protein fractions) is remarkably modified by growing conditions, and there are significant environment × genotype interactions (Graybosch et al., 1996; Zhu and Khan, 2001). However temperature, water and N deficiency have different effects on the ratio and duration of accumulation of the different protein fractions, the process of N partitioning is not significantly affected by environmental conditions and at maturity the protein fraction composition depends mostly on the total quantity of N per grain (Triboï et al., 2003). The amount and quality of protein contained in wheat is one of the most considered quality characteristics in the production of products by processing (Erekul et al., 2016). The protein quality of wheat endosperm is the most important factor determining the baking quality of bread, and flours obtained from wheat grains with the same total protein can give very different results during baking due to the quality differences in gluten proteins (Annett et al., 2007). The thousand kernel weight, which is considered in the evaluation of the grain in agricultural and commercial terms; It is an important feature in determining the quality of seed and it is one of the important features that also affects grain yield in cereals (Gençtan and Sağlam, 1987). In determining the bread quality of wheat, the protein amount is generally kept in the foreground, but it is important to evaluate quality parameters such as protein quality and sedimentation as well as protein ratio (Goding et al., 2003). When the dough is made, wheat flour forms a viscoelastic form with the ability to hold gas, which is necessary for the production of bakery products. The gluten protein, which is responsible for dough formation, has an effect on the rheological properties of dough in fermentation and mixing processes. Estimation and measurement of rheological properties such as elasticity, viscosity, extensibility are important for the bread industry (Hruskova and Smejda, 2003). Understanding the contribution of protein quality and gluten structure to dough properties is important for improving wheat grain quality (Zheng et al., 2020). Quality is the expression of a product's suitability for different uses rather than

being within certain standards, and it is essential to develop high quality varieties for the purpose with breeding studies and to offer them to the service of farmers. In this study, it was aimed to determine the change rates of physical, chemical and rheological properties of bread wheat genotypes with different protein ratios.

2. Material and Method

In this study, in the 2019-2020 growing season, the quality analyzes of the materials in the central location of Konya were made according to the randomized blocks trial design with 2 replications. In rainfed conditions (550 units^{-1} m^2) seeds were sown and 3.5 kg N da^{-1} and 6.9 kg P_2O_5 da^{-1} as base fertilizer and 4 kg N da-1 as top fertilizer (7.5 kg N da^{-1} in total) were given and A total of 398.70 mm of precipitation was received during the period. In the study, 24 genotypes were grouped according to different protein ratios (12.00-12.49, 12.50-12.99, 13.00.13.49, 13.50-13.99, 14.00-14.49 and 14.50-14.99). Some quality traits (Thousand kernel weight, protein ratio, Zeleny sedimentation, grain hardness, alveograph P, L, Energy, P/L ratios, farinograph development time, water absorption and 10th minute softening) values of the genotypes were investigated. Wheat samples analyzed in the laboratory were annealed according to AACC method 26-95 (14.5% humidity) and ground in Brabender Quadrumat Junior mill according to AACC method 26-50 (Anonymous, 2000).

The thousand kernel weight analyzed according to the AACC (55-10) method (Anonymous, 2000), the protein ratio was determined by the AOAC 992.23 method with Leco FP 528 device (Anonymous, 2009), the hardness (SKCS) by the Near Infra-red Reflectance spectroscopy device (FOSS NIR 2500F) and it was analyzed according to the AACC (39-70A) method (Anonymous, 2000). Farinograph analyzes were performed using the Farinograf-AT Brabender Germany device using the AACC 54-21 method (Anonymous, 2000). Alveograph energy value (AW) was determined by Chopin Alveo PC (Chopin, France) device according to AACC (54-30) method (Anonymous, 2000). The data obtained from the trials were subjected to analysis of variance according to the randomized blocks trial design in the JMP 11 statistical program, and the differences between the mean values obtained were compared at the 5% significance level using the student multiple comparison test (Anonymous, 2014).

3. Result and Discussion

Protein content is an important parameter in determining wheat grain quality. The bread-making potential of wheat is largely due to the content and quality of protein it contains. While the content of protein is affected by environmental factors, the quality of the protein is determined genetically (Hruskova and Famera, 2003). In general, the protein content in wheat grains ranges from 10% to 18% (Liu et al., 2018). Wheat processing quality is represented by the physical and chemical properties of the dough, which make it possible to process wheat into a variety of food products (Zhang et al., 2021). The usage area of wheat flour is determined according to its protein ratio and quality, and high and low rates are used in the food industry to obtain different products. Bread wheat genotypes were grouped according to protein ratios (12.00-12.49, 12.50-12.99, 13.00-13.49, 13.50-13.99, 14.00-14.49).

3.1. Protein ratio between (12.00 and 12.49%)

The thousand kernel weight of the material with protein between 12.00-12.49% changed between 33.35 and 38.68 g. Thousand kernel weight is important in terms of giving an idea about the size, fullness, thinness of the wheat grain and flour yield (Elgün et al., 2012). In the industry, different protein ratios are required according to the purpose of use. In the biscuit sector it is desired that the protein ratio be between 8 and 10%, and in the bread industry, it is desired that this ratio be above 12%. In the study, Zeleny sedimentation values varied between 30.25-47.25 ml. Zeleny sedimentation value is a feature that gives important information about gluten quality. The highest Zeleny sedimentation values were obtained in genotypes with a protein ratio of 12.37% to 12.48%. The protein ratio of the genotype with thousand kernel weight of 38.68 g was 12.24% and accordingly the Zeleny sedimentation value was 30.25 ml. There were changes in the protein ratios of the varieties according to the grain size, and as the grain size increased, the protein ratios decreased. Protein ratios

can be high when the thousand kernel weight is around 30 g or less, which should not mean that the dough processing properties will be good. The hardness value changed between 37.12 and 73.70 when the protein ratio was between 12.37 and 12.48% and the thousand kernel weight was between 33 and 37 g the hardness values of the genotypes increased. It has been determined that if the thousand kernel weight is 38.68 g and above, there is a decrease in the hardness value and the material is in the soft group. While hard grain structure is desired for bread quality, material with soft endosperm is preferred in biscuit production (Karaduman et al., 2017). In many studies, it has been determined that hardness values are affected by climatic and environmental conditions as well as being genotypic properties. Zheng et al. (2020), stated that the content of grain protein were significantly positively correlated with hardness value. The quantity and quality of protein are very important for bread making and can significantly affect the dough strength properties of wheat flours (Pena, 2002).

Alveograph energy value (W) has been an important parameter in the evaluation of wheat quality in breeding studies. The alveograph energy value varied between 83 and 247 W. Alveograph energy values (W) are classified as very weak for 0-50 J, weak for 50-100 J, medium for 100-200 J, medium strong for 200-300 J, strong for 300-400 J and very strong for over 400 J (Williams et al., 1988). There were changes in the energy value of the alveograph depending on the increase and decrease in the thousand kernel weight and protein ratios. In addition to the alveograph energy value, there were changes in the other parameters examined according to the protein ratio and thousand kernel weight, an increase in the alveograph P value resistance and a decrease in the L elasticity value of the genotypes with high protein content occurred. In genotypes with high protein content, there was an increase in the hardness values from grain properties and differences in alveograph parameters occurred. Marconi and Carcea (2001), suggest that the differences in grain hardness and the different types of products produced from wheat (bread, biscuits, pasta, etc.) are due to the gluten content of the grain. Increases in protein contents are associated with grain size. In genotypes with low thousand kernel weight, protein content may increase, but protein quality decreases. It was determined that farinograph development time, farinograph water absorption values increased and 10th minute softening values decreased in genotypes with high protein content and quality. When evaluated in general, it was determined that the protein ratio was significantly affected depending on the grain size. (Table 1).

Table 1. The variation of examined quality parameters in genotypes with protein ratios between 12.00 and 12.49%

Ratios	Thousand kernel weight (g)	Protein Ratio (%)	Zeleny Sedimentation (ml)	SKCS Hardness (%)	P (mm)	L (mm)	W (10^{-4} Joule)	P/L	DDT (mim)	WAC (%)	DS10 (BU)
	33.35	12.46	47.25	73.70	140.00	42.50	247	3.26	19.00	63.15	36.50
12.00-12.49	35.53	12.48	42.25	65.73	80.50	49.50	159	1.62	18.39	61.15	2.75
	37.66	12.37	46.50	67.77	117.00	36.50	192	3.10	6.91	62.25	2.00
	38.68	12.24	30.25	37.12	36.00	96.00	83	0.42	5.04	55.40	64.00
Mean	36.30	12.38	41.56	61.08	93.38	56.13	170	2.10	12.33	60.49	26.31
$CV_{(\%)}$	2.35	1.52	1.43	1.61	1.73	1.63	1.77	3.78	3.99	1.18	2.29
$LSD_{(0.05)}$	2.72	0.59	2.56	5.87	12.15	11.20	16.60	0.25	357	2.84	21.92

Std. Standards CV: Coefficient of variation, LSD: Least significant differences, P: Alveograph Peak, L: Alveograph Length, W: Alveograph Energy, P/L: Alveograph (P/L), DDT: Farinograph development time, WAC: Farinograph water absorption, DS10: farinograph softening degree in 10th minute.

3.2. Protein ratio between (12.50-12.99%)

The thousand kernel weight of the genotypes with protein ratio between 12.50-12.99% varied between 30.84 and 41.77 g. The thousand kernel weight of the genotype with a protein ratio of 12.83% was determined as 36.21 g, and the genotype with a protein ratio of 12.53% was determined as 41.77 g. Increases in starch ratio depending on grain size affected protein ratio and reological properties. Aydoğan et al. (2014), in a study they conducted with grain sizes, they found that as the grain size increases, there is a decrease in the protein content, and as the size decreases, there is an increase in the protein content. Zeleny sedimentation value ranged from 26.25 to 61.75 ml. The sedimentation value of the genotype with a protein ratio of 12.53% was 26.25 ml, while the sedimentation value of the genotype with a protein ratio of 12.83% was 46.00 ml. Hruskova and Svec (2009) reported that there is a strong relationship between flour protein content and Zeleny sedimentation values. The

hardness value ranged between 39.37 and 67.49%. The hardness value of the genotype with a protein ratio of 12.53% was 39.37 %, and the hardness value of the genotype with a protein ratio of 12.83% was 67.49%. It was determined that the protein content, Zeleny sedimentation and grain hardness values of the genotype with a thousand kernel weight of 41.77 g decreased depending on the increase in grain weight. In terms of rheological properties the ratio of starch and protein in the grain should be in balance in order to obtain a good dough.

The changes of the alveograph parameters according to the protein ratio were examined and when the protein ratio was 12.80%, the alveograph P value was 84.50 mm, the L value was 72.50 mm, the energy value was 220 (W), and the P/L ratio was 1.16. When the protein ratio was 12.53%, the alveograph energy value was 102.50, the P value was 35.50 mm, and the L value was 80.50 mm. When the protein ratio was 12.53, the highest values were obtained with thousand kernel weight 41.77 g, Zeleny sedimentation 26.25 ml, alveograph energy value 102.50, farinograph development time 5.36 min and water absorption 52.15%. Şahin et al. (2017), in a 3-year study, determined the average Zeleny sedimentation value of the varieties as 37.72 ml, thousand grain weight as 33.12 g, protein ratio as 12.68%, hardness (PSI) as 45.60, farinograph development time (DDT) as 6.00 min, farinograph water holding capacity (WAC) as 60.21%, farinograph 10th minute softening degree (DS10) as 53.46 BU, farinograph quality number (FQN) as 124.90. Statistically significant correlation was found between Zeleny sedimentation value and thousand grain weight (-0,2645), protein content (0,4373), hardness (-0,3072), farinograph development time (0,3933), farinograph water absorption (0,3565), farinograph softening value (-0,3435) and farinograph quality number (0,4854) at 1% level ($p<0,01$).

Table 2. The variation of quality parameters examined in genotypes with protein ratios between 12.50% and 12.99%.

Ratios	Thousand kernel weight(g)	Protein Ratio(%)	Zeleny Sedimentation(ml)	SKCS Hardness(%)	P (mm)	L (mm)	W(10^{-4} Joule)	P/L	DDT (mim)	WAC (%)	DS10 (BU)
12.50-12.99	30.84	12.71	45.50	65.59	120.50	47.50	253	2.51	6.05	61.75	10.50
	33.29	12.80	61.75	61.75	84.50	72.50	220	1.16	7.01	61.15	11.50
	41.77	12.53	26.25	39.37	35.50	80.50	102	0.44	5.36	52.15	13.50
	36.21	12.83	46.00	67.49	104.00	44.50	210	2.32	19.43	62.00	17.50
Mean	35.53	12.72	44.88	58.55	86.13	61.25	196	1.60	9.46	59.26	13.25
$CV_{(\%)}$	2.34	2.10	3.02	3.69	2.41	3.25	3.34	2.38	4.31	3.10	4.74
$LSD_{(0.05)}$	3.51	0.41	3.45	7.88	11.12	13.14	23.15	0.91	1.23	2.34	1.15

Std. Standards CV: Coefficient of variation, LSD: Least significant differences, P: Alveograph Peak, L: Alveograph Length, W: Alveograph Energy, P/L: Alveograph (P/L), DDT: Farinograph development time, WAC: Farinograph water absorption, DS10: farinograph softening degree in 10th minute.

3.3. Protein ratio between (13.00-13.49%)

The thousand kernel weight of the genotypes with protein ratios between 13.00 and 13.49% varied between 32.49 and 39.82 g. The genotype with the protein ratio of 13.45% had thousand kernel weight of 33.33 g, a protein ratio of 13.01% and thousand kernel weight of 36.82 g. Differences in grain weight caused changes in protein ratio. The wheat processing industry requires a certain size and protein ratio of wheat. The Zeleny sedimentation value ranged between 43.25 and 52.25 ml, and the highest sedimentation value was obtained from the genotype with a protein ratio of 13.45%. There were no extreme changes in the Zeleny sedimentation value in genotypes with protein ratio between 13.00 and 13.49%. The hardness value varied between 59.85 and 73.67. The grain hardness of the genotype with a protein ratio of 13.10% and thousand kernel weight of 32.49 g was 73.67 and it was in the hard group with. The grain hardness of the genotype, which has a protein ratio of 13.01% and thousand kernel weight of 36.82 g, is 60.60% and is in the medium soft group. The hardness value is an important parameter that should be evaluated in breeding programs. Grain hardness value showed a significant correlation with flour, milling, gluten quality and starch properties (Karaduman and Ercan, 2014). Although the hardness value is a property dependent on the variety, it is also affected by environmental conditions. One of the important traits affecting the bread quality is the alveograph energy value. High alveograph energy values (W) are characteristic for strong flours. When the changes of alveograph parameters according to protein ratio were examined, it was determined that the energy value of the genotype with thousand kernel weight 36.82 g and protein ratio 13.01 % was 226, P/L ratios was 1 that determining the resistance and elasticity value. The energy value of the genotype was 278 W with thousand kernel weight 32.49 g, protein ratio 13.10% and grain hardness value 73.67. It

was determined that the P value of the same genotype was 136.5 mm, the L value was 48.5 mm, and the P/L ratio was 2.79. Differences in thousand kernel weight also affect protein ratio, grain hardness values and rheological properties. When the farinograph examined the water absorption, the Zeleny sedimentation value of the genotype with thousand kernel weight of 36.82 g and protein ratio of 13.01% was determined as 46.75 ml, the alveograph energy value was 226 W, the P/L ratio was 1, the development time of the farinograph was 15.56 minutes, and the water absorption was 61.15%. Differences occur in the Alveograph P/L ratio in the genotype with the highest protein content, which causes difficulties in dough processing (Table 3).

Table 3. The variation of the quality parameters examined in genotypes with protein ratios between 13.00% and 13.49%

Ratios	Thousand kernel weight(g)	Protein Ratio(%)	Zeleny Sedimentation(ml)	SKCS Hardness(%)	P (mm)	L (mm)	W(10^{-4} Joule)	P/L	DDT (mim)	WAC (%)	DS10 (BU)
13.00-13.49	36.82	13.01	46.75	60.60	73.50	73.50	226	1.00	15.56	61.15	22.50
	35.05	13.29	43.25	59.85	91.50	50.50	169	1.79	4.24	63.75	30.50
	33.33	13.45	52.25	65.34	107.50	54.50	253	1.96	8.06	61.55	3.50
	32.49	13.10	45.25	73.67	136.50	48.50	278	2.79	8.05	63.70	7.50
Mean	34.42	13.18	46.88	64.86	102.25	56.75	232	1.88	8.97	62.54	16.00
$CV_{(\%)}$	3.72	2.69	3.16	2.65	3.10	4.40	3.09	2.18	3.51	2.98	2.79
$LSD_{(0.05)}$	0.51	0.45	3.50	4.12	11.22	10.98	20.70	0.30	2.11	0.30	7.23

Std. Standards CV: Coefficient of variation, LSD: Least significant differences, P: Alveograph Peak, L: Alveograph Length, W: Alveograph Energy, P/L: Alveograph (P/L), DDT: Farinograph development time, WAC: Farinograph water absorption, DS10: farinograph softening degree in 10th minute.

3.4. Protein ratio between (13.50-13.99%)

The thousand kernel weight of the material with protein ratios between 13.50-13.99% changed between 33.26 and 35.89 g, and the thousand-grain weight of the genotype with the highest protein ratio was 34.46 g. Zeleny sedimentation value ranged between 41.50 and 57.25 ml, the highest Zeleny sedimentation value was obtained from the genotype with protein ratio of 13.89%. There were no extreme changes in Zeleny sedimentation and grain hardness values in genotypes with protein content between 13.50% and 13.99%. Aydoğan et al. (2014), in a study they conducted, found that Zeleny sedimentation value decreased when the grain size was 2.2% above sieve, while Zeleny sedimentation value increased due to the increase in coarseness when it was 2.5% over sieve. In the genotype group with protein ratio between 13.50-13.99%, the hardness value varied between 62.17 and 67.42, and the genotypes were in the medium hard group. It was observed that the hardness value changed according to the protein ratio and grain weight. When the changes of alveograph parameters according to protein ratio were examined, it was determined that the energy value of the genotype with a thousand grain weight of 35.89 g and protein ratio of 13.48% was 265 W, and the P/L ratio was 1. The thousand grain weight of the genotype with 13.89% protein content was 34.46 g, the grain hardness value was 67.42 and the energy value was 283 W. The P value of the same genotype was 116, the L value was 55, and the P/L ratio was 2.08, and the changes in grain weight and protein ratio were effective. Farinograph water absorption (WAC) ranged between 59.55% and 65.15 %, and the highest absorption value was obtained from the genotype with a protein ratio of 13.84%. The main factor affecting dough rheology is protein. Farinograph water absorption is amount of water required by a given weight of flour to yield dough of given consistency. Water absorption is mainly influenced by traits of flour main components, gluten and starch. Aydoğan et al. (2015), determined that positive and significant ($p<0.01$) correlation between WAC and protein ratio. In another study with parallel results, Punia et al. (2019) stated that wheat varieties with high protein content showed higher ($p<0.05$) functional properties such as water holding capacity when compared to varieties with low protein content. A good quality flour for bread making should have high water absorption, medium-medium-long mixing requirement, satisfactory mixing tolerance and bread volume potential (considering protein content). Bread making is greatly affected by the quantity and quality of its protein (Abdelaleem and Al-azab 2020). The lowest 10th minute softening value (DS10) was determined in the genotype with a protein ratio of 13.84%, which indicates that the dough resistance to kneading is good (Table 4).

Table 4. The variation of quality parameters examined in genotypes with protein ratios between 13.50% and 13.99%.

Ratios	Thousand kernel weight(g)	Protein Ratio(%)	Zeleny Sedimentation(ml)	SKCS Hardness(%)	P (mm)	L (mm)	W(10^{-4} Joule)	P/L	DDT (mim)	WAC (%)	DS10 (BU)
13.50-13.99	34.46	13.89	57.25	67.42	116	55	283	2.08	18.13	65.15	25.50
	35.89	13.48	41.50	64.21	80	77	265	1.03	19.25	62.60	6.50
	33.88	13.83	43.50	62.17	60	84	176	0.71	11.57	59.55	24.50
	33.26	13.84	53.25	66.47	84	75	244	1.12	8.31	64.05	3.50
Mean	34.37	13.76	48.87	65.07	85	72.75	242	1.23	14.31	62.84	15.00
$CV_{(\%)}$	3.16	2.29	4.13	3.26	3.46	3.99	2.78	3.12	2.45	3.91	4.10
$LSD_{(0.05)}$	2.11	0.31	4.75	2.15	10.20	8.14	15.25	0.30	2.30	2.14	8.15

Std. Standards CV: Coefficient of variation, LSD: Least significant differences, P: Alveograph Peak, L: Alveograph Length, W: Alveograph Energy, P/L: Alveograph (P/L), DDT: Farinograph development time, WAC: Farinograph water absorption, DS10: farinograph softening degree in 10th minute.

3.5. Protein ratio between (14.00-14.49%)

Thousand kernel weight change of the material with protein ratios between 14.00-14.49% was between 35.23 and 41.32 g the thousand grain weight of the genotype with the highest protein ratio of 14.42% was 35.93 g. The Zeleny sedimentation value ranged between 49.50 and 61.25 ml, and the highest sedimentation value was obtained from the genotype with protein ratio of 14.42%. When examined the hardness value, there were changes between 53.91 and 76.51 % and the genotypes were in the medium hardness group. Erekul et al. (2016) reported in a study that wheat grains with high protein content are generally harder and this situation positively affects other quality characteristics that are directly affected by protein content. When the changes of the alveograph parameters according to the protein ratio were examined, it was determined that the energy value of the genotype, which had a grain weight of 35.93 g and a protein ratio of 14.42%, was 260 w, and the P/L ratio determining the resistance and elasticity value were 1.09. Grain hardness value was 65.82, energy value was 282 w, P value was 163 mm, L value was 37 mm and P/L ratio was 4.27 for the genotype with a thousand grain weight of 35.57 g and protein ratio of 14.34%. When examined the Farinograph water absorption (WAC), it was determined that it varied between 61.00 and 63.15%, and the highest absorption value was found in the genotype with the protein ratio of 14.22% (Table 5). Many baking properties of wheat flour are associated with protein (Moradi et al. 2016).Higher protein ratio will improve the bread making quality as it will have more gluten protein (Kumar et al., 2018).

Table 5. The variation of quality parameters examined in genotypes with protein ratios between 14.00% and 14.49%

Ratios	Thousand kernel weight(g)	Protein Ratio(%)	Zeleny Sedimentation(ml)	SKCS Hardness(%)	P (mm)	L (mm)	W(10-4 Joule)	P/L	DDT (mim)	WAC (%)	DS10 (BU)
14.00-14.49	35.57	14.34	52.25	65.82	163.50	37.50	282.50	2.27	5.38	63.05	9.50
	35.93	14.42	61.25	53.91	85.50	78.00	260.50	1.09	7.04	61.00	8.50
	41.32	14.22	50.75	76.51	118.00	60.50	278.50	1.90	5.21	63.15	10.50
	35.23	14.02	49.50	63.34	76.50	99.00	282.00	0.76	19.53	61.25	3.50
Mean	37.01	14.25	53.44	64.90	110.88	68.75	275.88	2.00	9.29	62.11	8.00
$CV_{(\%)}$	2.50	3.10	4.31	4.55	2.18	3.10	3.69	3.50	3.60	2.91	3.89
$LSD_{(0.05)}$	2.52	0.31	5.75	6.16	21.14	13.15	15.39	1.25	2.35	1.25	2.41

Std. Standards CV: Coefficient of variation, LSD: Least significant differences, P: Alveograph Peak, L: Alveograph Length, W: Alveograph Energy, P/L: Alveograph (P/L), DDT: Farinograph development time, WAC: Farinograph water absorption, DS10: farinograph softening degree in 10th minute.

3.6. Protein ratio between (14.50-14.99%)

The thousand kernel weight of the material with protein ratios between 14.50-14.99% varied between 30.72 and 35.68 g, and the thousand kernel weight of the genotype with the highest protein ratio of 14.91% was 30.72 g Zeleny sedimentation value ranged between 42.00 and 59.75 ml, the highest sedimentation value was obtained from the genotype with 14.64% protein. Similar results obtained from a study by Olgun et al. (2014), in which they examined quality parameters in bread wheat, a positive and 1% significant relationship was determined between protein content and sedimentation value. The hardness value varied between 28.37 and 67.65, and the genotypes were in the medium hard group. It was observed that the hardness value changed according to the protein content and grain weight. As the grain size increased, the thousand grain weight increased, while the protein ratio decreased. Since the endosperm is small in small-grained genotypes, the protein ratio is high and accordingly the hardness of the wheat grain has increased. The hardness value of the genotype with thousand kernel weight of 30.72 g and protein ratio of 14.91% was the lowest with

28.37, and it was in the soft group due to the variety trait. The alveograph P value was 46.37 mm, L 106 mm and the energy value was 143 W. Due to the low grain hardness value of this genotype, the P resistance value was low and the elasticity value was high, and accordingly, there were decreases in the energy value. It was determined that there were changes in the farinograph parameters of the genotype with low grain weight and high protein content. The alveograph and farinograph parameters of the genotype with a thousand grain weight of 35.11 g and a protein ratio of 14.50% were compatible with each other (Table 6).

Table 6. The variation of quality parameters examined in genotypes with protein ratios between 14.50% and 14.99%.

Ratios	Thousand kernel weight(g)	Protein Ratio(%)	Zeleny Sedimentation(ml)	SKCS Hardness(%)	P (mm)	L (mm)	W(10^{-4} Joule)	P/L	DDT (mim)	WAC (%)	DS10 (BU)
	33.58	14.64	59.75	67.65	96.50	60.50	227.50	1.57	6.16	66.35	32.50
14.50-14.99	35.11	14.50	47.75	51.08	62.00	62.50	164.50	1.00	7.14	59.70	22.50
	35.68	14.83	43.50	37.88	77.50	76.50	232.50	1.01	10.44	58.05	22.50
	30.72	14.91	42.00	28.37	46.50	106.00	143.50	0.45	3.37	58.30	39.50
Mean	33.77	14.72	48.25	46.24	70.63	76.38	192.00	1.01	6.78	60.60	29.25
$CV_{(\%)}$	3.14	2.15	3.74	4.41	2.87	3.96	4.89	2.74	3.75	2.85	4.14
$LSD_{(0.05)}$	2.14	0.25	3.14	6.25	14.36	18.14	25.52	0.31	2.41	0.36	3.41

Std. Standards CV: Coefficient of variation, LSD: Least significant differences, P: Alveograph Peak, L: Alveograph Length, W: Alveograph Energy, P/L: Alveograph (P/L), DDT: Farinograph development time, WAC: Farinograph water absorption, DS10: farinograph softening degree in 10th minute.

The variations of traits of the material with protein ratios between 12.00 and 14.99% are shown in table 7. The mean value of protein ratio was 12.32% in the genotypes between 12.00 and 12.49%, the Zeleny sedimentation value was 41.56 and they were in the medium hard group. The alveograph energy value of the same genotype was 170 W and the farinograph softening value was 26.31. When evaluated in general, genotypes with protein ratio between 13.00 and 14.50% have good Zeleny sedimentation, medium hard, alveograph resistance and elasticity ratios are balanced. Hruskova and Famera (2003), reported that the statistical relationships between the protein content of wheat and flour and the Zeleny sedimentation volume were found positive and very strong (with $P < 0.01$). Studies have shown that there is a significant positive relationship between protein amount and Zeleny sedimentation value (Egesel et al., 2009). The energy values are 250 W, the development time of farinograph is over 10 minutes, the water absorption and softening values are good (Table 7). It is significantly and positively related to several quality traits, including protein content, dough rheology, loaf volume in breads, and overall baking quality of wheat (Blandino et al., 2015).

Table 7. Mean values of quality analyzes examined according to protein ratios

Ratios	Thousand kernel weight(g)	Protein Ratio(%)	Zeleny Sedimentation(ml)	SKCS Hardness(%)	P (mm)	L (mm)	W(10^{-4} Joule)	P/L	DDT (mim)	WAC (%)	DS10 (BU)
12.00-12.49	36.30	12.32	41.56	56.08	93.38	56.13	170.63	2.10	12.33	60.49	26.31
12.50-12.99	35.53	12.72	44.88	53.55	86.13	61.25	196.63	1.60	9.46	59.26	13.25
13.00-13.49	34.42	13.18	46.88	64.86	102.25	56.75	232.00	1.88	9.98	62.54	16.00
13.50-13.99	34.37	13.76	46.25	65.07	85.38	73.13	242.50	1.23	14.31	62.84	15.00
14.00-14.49	37.01	14.25	53.44	64.90	110.88	68.75	275.88	2.00	9.29	62.11	8.00
14.50-14.99	33.77	14.72	48.25	46.24	70.63	76.38	192.00	1.01	6.78	60.60	29.25
$CV_{(\%)}$	4.15	3.74	4.74	3.96	4.01	3.25	3.73	2.15	2.56	3.46	3.85
$LSD_{(0.05)}$	2.15	0.56	4.56	4.78	14.52	8.25	24.96	0.89	3.56	0.98	5.87

Std. Standards CV: coefficient of variation, LSD: least significant differences, P: Alveograph Peak, L: Alveograph Length, W: Alveograph Energy, P/L: Alveograph (P/L), DDT: Farinograph development time, WAC: Farinograph water absorption, DS10: farinograph softening degree in 10th minute.

4. Conclusion

Wheat quality is very important because it indicates the purpose for which the product will be used. Both low grain weight varieties and high grain weight varieties can have different protein ratio and quality with the effect of various environmental factors during the grain filling period. Depending on the developing technology in the food sector, there are rapid developments in the world and in our country, and the industrialist needs a certain standard product in order to respond to the developing sector. In grain breeding studies, varieties with certain standard quality characteristics are desired as well as high yield. Grouping was made according to the different protein ratios of the 24 genotypes in the trial (12.00-12.49, 12.50-12.99, 13.00.13.49, 13.50-13.99, 14.00-14.49 and 14.50-14.99). Genotypes with protein ratio of 12.00-12.49% were in the medium soft group, alveograph energy value

was low, P/L ratio and farinograph 10th minute softening value were high. In the genotypes with protein ratio between 14.00-14.49%, the thousand kernel weight was 37.01 g, the Zeleny sedimentation was 53.44 ml, the grain hardness was 64.90 and the alveograph energy value was 275 W. The highest alveograph energy value was determined in this group. When evaluated in general, each increase in protein ratio may vary depending on the thousand kernel weight properties. There were increases in Zeleny sedimentation, grain hardness, alveographic energy value, farinograph water absorption values of genotypes with protein ratio between 12.50% and 14.50%. Decreases in protein ratios occurred in genotypes with high grain weight, resulting in decreases in zeleny sedimentation, grain hardness and alveograph energy value, and increases in P/L ratio and farinograph softening value. In genotypes with high protein content, the hardness value increases and accordingly the alvrograph P value increases and the L value decreases. Farinograph development time and softening value also vary depending on protein quality. At low protein content, Farinograph development time and stability decreased. It has been determined that the changes in the quality parameters examined vary depending on the grain physical properties and environmental factors, and environmental factors are effective even though the protein ratio and quality are genetic characteristics. It was determined that environmental factors and genetic factors were effective on the grain hardness, and alveograph energy value and farinograph parameters changed depending on protein quality. As a result, the increase and decrease in protein ratio does not mean anything by itself, but there are changes in quality parameters according to the physical characteristics of wheat grain and the characteristics of the genotype.

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