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Relationships between Farinograph Parameters and Bread Volume, Physicochemical Traits in Bread Wheat Flours

Seydi AYDOĞAN Mehmet ŞAHİN Aysun GÖÇMEN AKÇACIK
Sümerya HAMZAOĞLU Seyfi TANER

Bahri Dağdaş Uluslararası Tarımsal Araştırma Enstitüsü Müdürlüğü
seydiaydogan@yahoo.com

Abstract

The aim of this work was to determine relationships between farinograph parameters and bread volume, physicochemical traits in bread wheat flours. In this study, one hundred wheat genotypes (*Triticum aestivum* L.) were grown under rainfed conditions in 2012-2013 growing season in Konya location. Physical, chemical and rheological (farinograph parameters) analyzes of wheat samples were made and the correlation between quality traits were investigated. In this study, it was obtained that the significant correlation between bread volume and protein content (PRT) ($p<0.01$), Zeleny sedimentation (ZLN) ($p<0.01$), dough development time (DDT) ($p<0.01$), water absorbtion capacity(WAC)($p<0.01$), softening 12. minute (SFT12) ($p<0.01$), farinograph quality number (FQN) ($p<0.01$), farinograph stability (STB) ($p<0.05$). The farinograph is a widely used predictive test with which end-use quality of many genotypes can be assessed in a short period of time in bread wheat breeding program.

Keywords: Bread wheat, quality, farinograph, protein

Ekmeklik Buğday Unlarında Farinograf Parametreleri ile Ekmek Hacmi ve Bazı Kalite Özellikleri Arasındaki İlişkiler

Öz

Bu çalışmanın amacı ekmeklik buğday ununda farinograf parametreleri, ekmek hacmi ve fizikokimyasal özellikler arasındaki ilişkilerin belirlenmesidir. Bu çalışmada 100 buğday genotipi (*Triticum aestivum* L.) 2012-2013 yetiştirme döneminde kuru şartlarda Konya merkez lokasyonunda yetiştirilmiştir. Buğday örneklerinin fiziksel, kimyasal ve reolojik (farinograf) analizleri yapılmış ve kalite özellikleri arasındaki korelasyon incelenmiştir. Bu çalışmada ekmek hacmi ile protein oranı (PRT) ($p<0.01$), Zeleny sedimantasyon (ZLN) ($p<0.01$), hamur gelişme süresi (DDT) ($p<0.01$), su absorbsiyon kapasitesi (WAC) ($p<0.01$), yumuşama derecesi 12. Dk (SFT12) ($p<0.01$), farinograf kalite numarası (FQN) ($p<0.01$), farinograf stabilite (STB) ($p<0.05$) arasında önemli korelasyon tespit edilmiştir. Ekmeklik buğday ıslah programlarında genotiplerin son kullanım kalitesinin kısa sürede tespit edilmesinde farinograf testi yaygın olarak kullanılmaktadır.

Anahtar Kelimeler: Ekmeklik buğday, kalite, farinograf, protein

Introduction

Bread-making quality increases linearly with increasing protein content within a cultivar, but for a given protein content, bread-making quality differences among wheat cultivars are largely a function of the qualitative nature of the gluten proteins, which affects their rheological properties (Khatkar et al., 1995). Protein content and quality are important in bread making. The protein content constitutes an important characteristic to consider for further evaluation of flours quality. However, the calculation of the crude protein content does not give any indication about the quality of proteins. DDT, STB, ZLN, WAC analysis gives an idea of the quality of protein. Protein quality is not a simple concept. What constitutes superior protein quality varies depending on the type of end

product being made and the processed to obtain that product. Protein quality is generally considered by processors to be synonymous with dough strength, with baking quality being to ultimate test. Typically, several methods of assessing protein quality are used. Dough strength measurements provide a means of predicting the suitability and performance of flour for particularly end product. Some common predictor of dough strength include gluten index and empirical rheological tests such as farinograph, extensograph and alveograph provide some information on dough extensibility as well as on overall strength (Carson and Edwards, 2009).

The farinograph has been a standart tool of the cereal chemist for many years, giving information concerning absorbtion and mixing characteristic of flours. With the introduction of new short-time baking processes the baker has an increasingly wider range of methods available to him, and the cereal chemist must be able to determine the suitability of a particularly flour for a variety of different processes (Tanaka and Tipples, 1969). Dough development time, used as an indicator of mixing requirements, the farinograph at which the dough reaches maximum consistency. In cereal technology, wheats that have long dough-development times are considered to be strong (Bushuk et al., 1969). The variation in dough rheology and bread making performance between wheat cultivars is largely determined by differences in protein quantity and composition (Pomeranz, 1988; MacRitchie, 1992).

The aim of this work was to determine relationships between farinograph parameters and bread volume, physicochemical traits in bread wheat flours.

Material and Methods

One hundred bread wheat genotypes were grown according to randomized block design with three replication under rainfed conditions in 2012-2013 growing season in Konya location. Grains from each cultivar were milled to an aproximately 65% extraction rate using a Brabender Quadrumat Junior mill after being conditioned to 15% (w/w) moisture level overnight. Protein content of the flour was measured using a Leco FP 528 analyzer (Leco Inc, St Joseph, MI) AOAC 992.23 (Anonymous, 2009). Zeleny sedimentation were determined according to ICC standard number:116 (Anonymous, 1981). Bread making were determined basic straight dough bread baking method according to AACC 10-09 (Anonymous, 2002), Farinograph properties were determined according to AACC approved methods 54-21 (Anonymous, 2002) with 50 g mixing bowl (Brabender AT model 50). DDT: Farinograph development time (min), WAC: Water absorbtion capacity (%), STB: Farinograph stability (min), SFT12: Farinograph softening degree, FQN: Farinograph quality number.

Result and Discussion

Experimental measurements to evaluate the quality of flour in the kneading process were performed using a Brabender farinograph, version AT. This instrument allows classifying the flour tested by measuring not only its gluten strength but also the hydrating power of the flour**.** Farinograph also allows measuring the water absorption capacity of flours. The reological data, Table 1 shows farinograph characteristics, protein contents, Zeleny sedimentations and loaf volumes. The farinograph development time is the amount of time it took to mix the dough to optimum development. The dough development time (peak time) is an indication of protein quality stronger flours normally require a longer development time do weaker flour. In this study, the lowest farinograph development time (min) (DDT) value was 1.35 min., the highest value was 12.17 min., average value 4.22 min. was determined. In this study conducted on bread wheat flours showed significiant

correlations for bread volume (p<0.01)with both farinograph development time. In addition to between DDT protein content, Zeleny sedimentation, STB, FQN positive and significant (p<0.01), SFT negative significant (p<0.01) correlation coefficient were determined.

DDT important parameter has been observed for estimating the quality of the protein. Dough development time (DDT) and stability value are indicators of the flour strength, with higher values suggesting stronger doughs(Wang et al., 2002).

Table 1. Quality characteristics of bread wheat materials

Traits	Sample Number	Mean	Std. Dev	Minimum	Maximum
PRT	100	12.46	1.94	8.43	16.63
ZLN	100	6.64	11.20	20.00	66.00
DDT	100	4.22	1.88	1.35	12.17
WAC	100	61.76	3.94	54.80	68.40
STB	100	6.687	3.55	0.50	16.11
SFT12	100	100.99	55.89	0.000	264.00
FQN	100	86.87	39.12	24.00	200.00
Bread W	100	144.64	4.94	128.60	155.10
Bread V.	100	422.15	62.50	315.00	585.00

PRT: Protein content (%), ZLN: Zeleny sedimantation (ml), DDT: Farinograph development time (min). WAC: Water absorbtion capacity (%), STB: Farinograph stability (min), SFT12: Farinograph softening degree (farinograph unit FU), FQN: Farinograph quality number (mm), Bread W: Bread weight (g), Bread V: Bread volume (cm^3).

Water absorption is the amount of water required by a given weight of flour to yield dough of given consistency. The usually accepted consistency corresponds to a curve that centers on the 500 BU line. Farinograph water absorption is mainly influenced by the properties of flour main components, gluten and starch. Farinograph absorption correlated also with dough stability. High water absorption is desirable. High water absorption, combined with low degree of softening indicates good quality flour, whereas a high water absorption combined with a high degree of softening indicates poor quality flour. The water absorbtion value ranged between 61.76% to 68.40%.

Positive and significant (p<0.01) correlation were determined between WAC and bread volume, bread weight, protein content, Zeleny sedimentation. This was consistent with the results of (Şahin et al., 2011), they reported in their study made with bread wheat the lowest farinograph water absorption value; 52.6, the highest value; 63.1, the average value; 70.8 were found. They determined significant positive correlation between farinograph water absorption and bread volume.

Table 2. Correlation between farinograph parameters and flour charecteristics

Traits	PRT	ZLN	DDT	WAC	STB	SFT12	FQN	Bread W.
ZLN	**0.539****							
DDT	**0.489****	**0.642****						
WAC	**0.720****	**0.238***	**0.290****					
STB	0.188	**0.492****	**0.568****	0.0610				
SFT12	**-0.276****	**-0.527****	**-0.548****	-0.0918	**-0.714****			
FQN	**0.324****	**0.600****	**0.788****	0.1008	**0.830****	**-0.772***		
Bread W.	0.1244	-0.0800	0.0277	**0.362****	-0.0149	0.0181	-0.0382	
Bread V.	**0.560****	**0.407****	**0.400****	**0.374****	**0.240***	**-0.451****	**0.358****	-0.0934

*:p<0.05 **:p<0.01 significant PRT: Protein content (%) ZLN: Zeleny sedimantation (ml), DDT: Farinograph development time (min). WAC: Water absorbtion capacity (%), STB: Farinograph stability (min), SFT12: Farinograph softening degree (Brabender unit BU), FQN: Farinograph quality number (mm), Bread W: Bread weight (g), Bread V: Bread volume (cm^3).

Farinograph stability time (STB) is correlated with flour strength. Long stability times are generally more suited for variety bread production and often require longer mixing times. The farinograph stability value ranged between 0.50 min. to 16.11 min. Avarage farinograph stability time was 6.68 minute. Significant correlations have found that between STB and bread volume ($p<0.05$). STB is an influential parameter in predicting gluten strength. Aydogan et al. (2012), stated that the value of farinograph water absorption; 56.40% to 64.20%, STB; 1.40 min.to 4.65 min., development time; 2:15 min. to 4:25 min. were found in a study. They determined significant relationships between the rheological properties. As shown in Table 1, the mean values of farinograph softening degree (SFT12), farinograph quality number (FQN) were 100.9 BU 86.8 mm respectively. We found a significant negative correlation between SFT12 and PRT(-0.276**); ZLN(-0,527**) bread V (-0.451**). The higher values of stability time 16 min and lower degree of softening 20 BU were given by normal milling of wheat Gemmeiza 11 (El-porai et al., 2013). Bread volume showed significant correlation with all studied features. Most rheological and sensory tests used in industry to assess bread wheat quality are not suitable to screen hundreds of experimental breeding lines at the segregating and the early-advanced stages, due to the limited amount of testing sample and short testing time. Several small-scale parameters used to screen germplasm at early breeding stages are strongly associated with rheological quality and with bread making quality attributes.

The mean value of PRT in our research was 12.46%, lower than that of bread wheat in the worldwide collection (14.5%) (Bordes et al.2008) and of North Dakota wheat in the U.S. (14.7%) (Underdahl et al., 2008), protein content is important quality trait for using bread wheat. Protein content can vary greatly in wheat from as low as 6% up to nearly 20%. The level depends on wheat class, soil fertility of the growing region and enviromental conditions. Wheat protein content is an important consideration in baking and in the production of pasta and noodles. All other factors being equal, higher protein wheat has higher water absorbtion capacity and greater loaf volume potential and is reported to have better quality(Carson and Edwards, 2009). The importance of protein content in evaluating wheat as a commodity derives from the fact that the total protein content can be related to aspects of end use quality (Mills and Bekes, 2009).

The mean value of ZLN in our research was 36.64 ml, The Zeleny sedimantation volume of wheat is a rough measure of gluten strength. It is defined primarily by protein quality and strongly influenced by protein content and by environmental effects. The statistical relationships between the protein content of wheat flour and the Zeleny sedimentation volume were found positive and very strong (with $p<0.01$) (Hruskova and Famera, 2003).

Conclusions

The results of these studies showed that farinograph traits (water absorption, dough development time, farinograph stabilite, farinograph quality number) protein and Zeleny sedimentation were affected bread volume. There was wide variation in dough rheological properties and flour quality traits among 111 bread wheat varieties. Zeleny sedimentation value and farinograph traits was strongly correlated with the bread volume, indicating that it could be used as a primary indicator for dough rheological property evaluation. The dough rheological properties of wheat genetic resources in Turkey have greatly improved from 1980. Therefore flour quality and protein content, has markedly improved. Future studies should be focused on these issues increasing demand for wheat quality.

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