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Determination of Some Bread Quality and Grain Yield Characters in Bread Wheat (*Triticum aestivum* L.)

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ABSTRACT

This research was carried out during 1998-1999 and 1999-2000 growing seasons on 10 approved varieties and 10 advanced lines of wheat to determine the bread quality and grain yield characteristics. Grain yields of approved varieties ranged from 3.88 to 6.56 t ha^{-1} and those of advanced lines was between 4.07 and 5.67 t ha^{-1}. Some important quality characters such as wet gluten, sedimentation ratio and flour yield were investigated. ISWYN-14, ISWYN-29, ISWYN-9, IBWSN-42 and IBWSN-62 and Flamura-85, IBWSN-62 and IBWSN-58 and ME-2 (51), IBWSN-62 and IBWSN-58 genotypes had the highest values. In addition, most genotypes had higher test weight and flour yield than the desired standards. Alveograph test values of IBWSN-62, ISWYN-24, ME7HR (274), Prostar, IBWSN-42, Sana, Pehlivan, Flamura-85, Miryana and IBWSN-58 were closest to the required values. Flamura-80, Flamura-85, Bezostaya-I, Kate A-I among the varieties and IBWSN-62, IBWSN-42, ISWYN-14 and IBWSN-58 among the advanced lines performed better in terms of bread quality. It was noted that advanced lines originating from CIMMYT had a great variation for grain yield and quality properties.

Key Words: Advanced lines; Alveograph; Bread wheat; Flour yield; Grain yield; Protein ratio; Wet gluten rate
Abbreviations used: IBWSN = International Bread Wheat Screening Nursery; ISWYN = International Spring Wheat Yield Nursery; ME2 (7) HR = Mega Environment High Rainfall; R/E = Resistance/Elasticity

INTRODUCTION

In human diet, vegetables provide 90% of calories and 77% of daily protein need while these values for cereals and cereal products are 54 and 66%, respectively (Elgün & Ertugay, 1992). Wheat, consumed as 40% of cereals (Hanson *et al*., 1982) is used as a cereal protein source, and is of basic need for 40 countries consisting of 35% of world population. It contributes greater than the any other field crop to world protein production (Harlan & Starks, 1980). Therefore, wheat and wheat products are the main food sources for human.

During the last five years, average world wheat was 550 million tones and Turkey is among the most wheat producing 10 countries. Wheat processing industry of Turkey has a great potential in terms of technology and capacity all over the World, constituting 8% share in world flour trade in 1997. This rate, however, decreased to 4% in 2000. Wheat at present does not satisfy the demand of Turkish flour industry and bakers up to industrial standards. Turkey imports high quality flour, and this import has increased six times in the last few years due to a decrease in wheat quality produced in the country (Anonymous, 2000). The imported flour is mixed with flour from Turkish wheat to improve the bread making quality.

The main reason for this quality decrease in wheat produced in Turkey is the government push to farmers produce wheat cultivars with high yield without considering bread making quality. At the same time, too many new cultivars are introduced each year without properly testing their performance and quality in Turkey. This situation is creating problems for both farmers and industrialists. Therefore, it is imperative to develop promising varieties both for high yield and quality.

The objective of this study was to select appropriate material among the approved varieties and advanced lines, recently introduced from CIMMYT in the northwest region of Turkey, for quality characters and grain yield attributes.

MATERIALS AND METHODS

Pehlivan, Saraybosna, Flamura-80, Flamura-85, Kate A-I, Miryana, Mv-17, Sana, Bezostaya-I and Prostar varieties obtained from Turkey and other countries and 10 advanced lines developed from CIMMYT material were used as experimental material. This research was conducted in the experimental area of the Field Crops Department of Tekirdağ Agricultural Faculty at Trakya University in the growing season of 1998-1999 and 1999-2000, using a random blocks of experimental design with three replications. Each plot was 5 m long and consisted of six rows. Row spacing was 20 cm.

Test weight (Anonymous, 1978), flour yield (Özkaya & Kahveci, 1990), protein ratio (Anonymous, 1980), wet gluten (Anonymous, 1982), gluten index (Anonymous, 1994), sedimentation and retarded sedimentation (Anonymous, 1972) and alveograph test (Anonymous, 1990) were determined for each genotype. Alveograph values of the samples were grouped based on genotypes the scale made by Pomeranz (1987). All quality analyses were made in Form Grain Quality Laboratory of Form Group Company in Istanbul, Turkey.

Variance analysis of data obtained from the experiments was carried out based on randomized complete block design as connected years. LSD test was performed according to method suggested by (Steel & Torrie, 1960) by using MSTAT 3.00/EM computer programme.

RESULTS AND DISCUSSION

Bread wheat with minimum test weights of 78 kg has been accepted as high-quality in Turkish Standard 2974 (Anonymous, 1978). Test weight values of 18 genotypes, except ISWYN-14 and Sana were higher than 78 kg (Table I). Our results regarding test weight are in agreement with the results of Başer *et al*. (2001).

Flour yield in wheat varies depending on physical characters such as grain size, test weight, and thousand kernel weights. Bread wheat, for these purposes, is place into four classes: low (less than 62%), medium (between 62 and 68%), good (between 68 and 72%) and best (more than 72%) (Özkaya & Kahveci, 1990). In our research, ME2HR (51) and IBWSN-62 were regarded as "best", and IBWSN-58, ISWYN-9, ISWYN-14, ISWYN-29, ME7HR (274), Bezostaya-I, ISWYN-24, IBWSN-42, Flamura-80 and IBWSN-69 as "good". Remaining eight varieties/lines were classified as "medium".

Protein content and composition of the wheat grain is the most important character in determination of wheat quality (Olered & Johnson, 1986). Protein content is a character determining the water absorbing ability, stability, resistance and elasticity of flour. In addition, the energy content of flour is also affected by protein content (Elgün & Ertugay, 1992). Protein ratio varies to a large extent based on variations in environmental factors (Zeleny, 1961; Uhlen *et al*., 1998). Protein ratios of wheat genotypes in this study ranged between 10.60 and 12.30% (Table I). In the previous studies, however, this ratio had a wider range, i.e. 7-21% (Obuchowski & Bushuk, 1980; Korkut & Çıtak, 1992; Matuz *et al*., 1993; Tosun *et al*., 1997). The highest protein ratio was noted in Bezostaya-I. IBWSN-42 had a higher protein ratio than Flamura-85. Similar results were reported for wheat from Thrace province (Avcı, 1989).

Gluten proteins promote formation of a strong and visco-elastic dough structure, and this also affects kneading extension and development of dough (Wade, 1970; Finney *et al*., 1978; Boyacıoğlu, 1994). Wet gluten rates of

Table I. Significance groups and averages related evaluated some quality characters and grain yield in investigated genotypes in research

Genotypes	Test weight (kg)	Flour yield (%)	Protein ratio (%)	Wet gluten (%)	Gluten index	Sedimentation (ml)	Retarded Sedimentation (ml)	Energy ($x10^{-4}$ joules)	Resistance (R) (mm)	Resistance/elasticity (R/E) ratio	Swelling index (cm^3)	Grain yield (t/ha)
IBWSN-69	80.05 fgh	68.37 gh	11.01 f-ı	21.93 ı	71.17 h	21.50 ı	21.00 j	91.17 o	55.62 ıj	1.36 bc	16.02 h	4.21 ef
IBWSN-58	81.32 b-f	71.70 abc	10.87 ghı	25.77 b-e	86.00 b	29.17 b	32.00 c	231.67 a	85.90 bc	1.27 bcd	20.02 b	5.55 b
IBWSN-42	82.82 a	69.10 fg	12.00 ab	26.87 abc	82.83 c	23.17 h	28.83 de	173.33 g	68.48 f	0.95 c-f	18.30 e	4.86 b-e
IBWSN-62	80.92 d-g	72.07 ab	11.67 bcd	26.85 abc	79.00 d	29.83 b	33.83 b	134.50 ı	60.33 gh	0.95 c-f	19.18 cd	4.09 ef
ME-2 (51)	81.45 b-e	72.35 a	11.21 d-h	24.70 d-h	82.67 c	24.00 g	28.67 de	182.67 e	72.15 e	1.02 cde	19.12 cd	4.07 ef
ME-7 (274)	79.05 hı	69.50 ef	10.80 hı	24.93 c-h	51.67 n	23.00 h	20.67 j	91.50 o	61.00 g	1.48 b	14.77 ıj	4.47 def
ISWYN-29	82.37 abc	70.03 de	11.22 d-h	27.22 ab	67.33 j	26.67 de	27.17 f	128.08 j	75.50 d	1.54 b	15.25 ı	4.81 b-f
ISWYN-14	81.93 a-d	70.80 cd	11.64 bcd	27.97 a	74.83 g	26.50 de	32.00 c	220.00 b	86.27 bc	1.26 bcd	19.18 cd	5.67 ab
ISWYN-24	78.33 ı	69.12 efg	11.52 cde	23.48 f-ı	60.50 l	23.67 gh	24.33 g	135.00 ı	87.02 bc	2.40 a	13.67 k	4.88 b-e
ISWYN-9	82.63 ab	71.15 bc	10.78 hı	27.33 ab	61.00 l	26.17 e	26.83 f	171.58 g	84.55 c	1.52 b	17.05 fg	5.47 bc
Pehlivan	81.53 a-e	67.48 hı	11.69 bc	25.10 c-g	74.50 g	21.83 ı	22.17 ı	121.75 l	53.32 jk	0.83 ef	19.52 bc	5.53 b
Saraybosna	79.60 ghı	67.25 ıj	10.60 ı	23.02 ghı	78.83 d	27.83 c	29.17 d	183.83 e	88.82 ab	2.18 a	14.13 jk	3.88 f
Flamura-80	81.87 a-d	68.85 fg	10.83 hı	22.90 hı	75.00 g	27.00 d	32.17 c	210.25 c	78.38 d	1.29 bcd	17.13 f	5.25 bcd
Kate A-1	81.02 def	67.05 ıj	10.61 ı	23.92 e-ı	59.33 m	22.17 ı	22.83 hı	142.00 h	70.79 ef	1.59 b	16.40 gh	5.34 bcd
Miryana	79.63 ghı	67.38 ı	10.79 hı	25.30 b-f	69.50 ı	25.33 f	28.17 e	124.08 k	47.92 l	0.58 f	21.17 a	5.32 bcd
Flamura-85	81.20 c-f	66.38 jk	11.75 bc	23.68 e-ı	96.33 a	31.67 a	34.83 a	177.67 f	54.42 ıj	1.26 bcd	21.65 a	5.39 bc
MV-17	80.40 efg	65.63 k	11.36 c-f	22.37 ı	61.17 l	20.50 j	23.00 h	108.00 m	50.60 kl	1.03 cde	18.53 de	5.71 ab
Sana	78.90 hı	66.92 ıj	11.33 c-g	22.40 ı	64.67 k	19.67 k	18.50 k	101.00 n	49.57 l	0.90 def	16.78 fg	6.56 a
Bezostaja-I	82.07 a-d	69.22 efg	12.30 a	26.52 a-d	77.67 e	26.33 de	33.33 b	208.17 d	90.48 a	1.62 b	16.77 fg	4.57 c-f
Prostar	79.67 ghı	67.17 ıj	11.10 e-h	22.97 hı	76.00 f	23.67 gh	26.67 f	125.50 k	57.10 hı	0.93 def	17.30 f	5.30 bcd
Mean	80.84	68.88	11.26	24.77	72.50	24.99	27.31	153.09	68.91	1.29	17.60	5.05
LSD (P<0.05)	1.340	0.919	0.463	2.101	0.976	0.679	0.678	1.883	3.316	0.430	0.690	0.920

Mean sharing same letter differ non-significantly (P>0.05) advanced lines were generally found to be higher than all varieties, but the means of advanced lines were still 30% lower than those suggested by Ünal (1996), who has stated that genotypes are largely affected by environmental factors. The highest wet gluten rates among the genotypes were obtained from ISWYN-14, ISWYN-9, ISWYN-29, IBWSN-42, IBWSN-62 and Bezostaya-I, respectively. Sana, Mv-17 and IBWSN-69 gave the lowest values. Our results were similar to those of Tosun *et al*. (1997), Demir *et al*. (1999) and Genç *et al*. (1999).

It is also necessary to investigate gluten and gluten index and protein quantity (Martin *et al*., 1990). This method taken a short time has been used in variety development and in production of dry gluten for trade purposes. Gluten index is a measure of the flour strength (Elgün *et al*., 1998). Gluten index values of genotypes ranged between 51.67 and 96.33 (Table I). These values are close to 60 and 90 limits; the limits desired for optimum cooking quality (Elgün *et al*., 1998).

Sedimentation test is a simple method used to discriminate wheat genotypes based on their gluten quality and protein quantity (Zeleny *et al.*, 1960; Carter *et al.*, 1999). Average sedimentation values among genotypes ranged between 19.67 and 31.67 mL in the study. The sedimentation value of flours has been placed into four classes (Elgün *et al.*, 1998): weakest (less than 15 mL), weak (between 16 mL and 24 mL), good (between 25 mL and 36 mL) and best (more than 36 mL). Based on these classes, Sana, Mv-17, Kate A-I, Pehlivan, Prostar, ME7HR (274), ME2HR (51), ISWYN-24, IBWSN-42 and IBWSN-69 had weak and those of Bezostaya-I, Flamura-85, Miryana, Flamura-80, Saraybosna, ISWYN-29, IBWSN-62 and IBWSN-58 had good sedimentation properties (Table I).

Alveograph test was made to determine bread cooking quality of wheat genotypes. Energy, resistance/elasticity rate, and swelling index were evaluated as alveograph properties. Findings of this study were compared with those of Pomeranz (1987), who stated that the energy value of standard flour should be around $141x10^{-4}$ joules. The values of genotypes, used here, ranged from 91.17 to $231x10^{-4}$ joules (Table I). This indicated that there is a wide range variation for this character. Kate A-I, ISWYN-24 and IBWSN-62 had values closest to those given by Pomeranz (1987), and Karatoprak and Dinçer (1999).

Resistance/elasticity (R/E) ratio of flour affects dough structure (Ünal, 1996). R/E ratio of the genotypes was found to be between 0.58 and 2.40 (Table I), which has been reported as 0.81 (Anonymous, 1990). The closest values to this were obtained from Pehlivan, Sana, Prostar, IBWSN-62 and IBWSN-42 genotypes. Swelling index of genotypes ranged from 13.67 to 21.65. An average swelling index value should be 20 cm^3 (Pomeranz, 1987). The genotypes IBWSN-58, Pehlivan, IBWSN-62 and ISWYN-14 had this index close to that reported by Pomeranz (1987).

The genotypes indicated significant differences for the flour quality attributes. Among them, Flamura-80, Flamura-85, Bezostaya-I, Kate A-I, IBWSN-62, IBWSN-42 and IBWSN-58 were the top notchers for these characters. Grain yields of the genotypes ranged between 3.88-6.56 t ha^{-1}; the highest being in Sana (6.56 t/ha), Mv-17 (5.71 t ha^{-1}) and ISWYN-14 (5.67 t ha^{-1}). ISWYN-14 having superior flour quality and grain yield can be registered for cultivation in semi-arid regions such as northwest region of Turkey.

CONCLUSION

While Sana, Mv-17 and ISWYN-14 were best in grain yield, Bezostaya, Pehlivan and Miryana varieties and ISWYN-14, ISWYN-29, IBWSN-62, IBWSN-42 and IBWSN-58 lines had the best flour quality. In general, bread quality of these lines had better than other standard varieties. Furthermore, these lines can be used as genetic material in the breeding programs because of their better performance in the semi-arid regions.

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