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VARIETY – THE MAIN FACTOR FOR IMPOVING THE QUALITY OF DURUM WHEAT (*TRITICUM DURUM DESF.*)

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The grain quality of 16 durum wheat varieties with different origin was studied. The following qualitative traits were determined: 1000 kernel weight, test weight, vitreousness, crude protein, wet and dry gluten, yellow pigments, SDS sedimentation value. Bulgarian varieties have better physical characteristics of grain that are a precondition for good semolina yield. The varieties originated from Austria, France, Hungary, Italy and Spain have much higher content of yellow pigment in semolina and SDS sedimentation value. Better protein quality makes the group of these varieties a very good raw material for production of semolina and pasta. The dendrogram of the cluster analysis visualized the hierarchical grouping of the evaluated varieties. At a relatively low level they group in two clusters. The varieties Selyendur (Hungary) and Levante (Italy) were unique with the highest SDS sedimentation value. In this study 70.47 % of the total variation in the estimates of similarity was revealed by the first two components. The traitssuch as crud protein, wet gluten, SDS sedimentation value and yellow pigments had the greatest impact as far as clustering is concerned.

Key words: durum wheat; 1000 kernel weigh; crud protein; SDS sedimentation; wet gluten; yellow pigment

СОРТАТА-ГЛАВЕН ФАКТОР ЗА ПОДОБРУВАЊЕ НА КВАЛИТЕТОТ НА ТВРДАТА ПЧЕНИЦА (*TRITICUM DURUM DESF.*)

Испитуван е квалитетот на зрното на 16 сорти тврда пченица со различно потекло. Следните квалитетни својства се определени: маса на 1000 зрна, хектолитарска маса, стаклавост, сурови протеини, влажен и сув глутен, жолти пигменти и SDS седиментациона вредност. Бугарските сорти имаат подобри физички карактеристики на зрното кои се предуслов за добар принос на крупица. Сортите кои потекнуваатод Австрија, Франција, Унгарија, Италија и Шпанија имаат многу поголема содржина на жолт пигмент во крупицата и SDS седиментациона вредност. Подобриот квалитет на протеините ја прави групата на овие сорти многу добра суровина за производство на крупица и тестенини. Дендограмот на групната анализа го визуализира хиерархиското групирање на оценуваните сорти. На ниско ниво тие се групирани во две групи. Сортите Селиендур (Унгарија) и Леванте (Италија) беа единствени со најголема SDS седиментациона вредност. Во оваа студија 70.47 % од вкупното варирање на определувањата на сличноста беа покажани од првите две компоненти. Својствата: сурови протеини, влажен глутен, SDS седиментационата вредност и жолтите пигменти имаат најголемо влијание доколку се однесуваат на групирањето.

Клучни зборови: тврда пченица; маса на 1000 зрна; сурови протеини; SDS седиментација; влажен глутен; жолт пигмент

INTRODUCTION

Durum wheat is a main raw material for pasta products due to its balanced components that interact during processing, allow receiving products with desired quality. The principal quality objectives of durum wheat variety development – protein content and gluten strength are factors in pasta

cooking quality, and pasta color, as primary market traits. Varieties that combine high yellow pigments (over 7 ppm), protein concentration (over 15-16% dm) and strong gluten give pasta with a bright yellow color and good cooking quality [1]; [2]. One of the most important factors determining processing potential is the variety, which makes it necessary to breed durum wheat with high intrinsic quality that is key to market recognition [3], [4].

The object of the present study was Bulgarian and perspectives of durum wheat varieties with different origin having a complex of valuable economic parameters. This work aims to determine the similarity/diversity of durum wheat varieties based on qualitative traits and to explain the causes of the clustering.

MATERIAL AND METHODS

The grain samples consisted of sixteen durum wheat varietes (*Triticum Durum Desf*.) with different origin for three crop years were studied (2009–2011). Nine accessions originate from Bulgaria, two varieties from France and Italy and each one from Austria, Spain and Hungary (Table 1). The field experiments in the region of South – Central Bulgaria were conducted using a randomized block design with four replications and a harvest plot of 10 m^2.

Table 1

Biochemical and technological quality of durum wheat varieties, (T.durum), average 2009 - 2011

Variety	1000 kernel weight g	Test weight kg/hl	Vitreousness %	Crude protein %	Wet gluten %	Dry gluten %	Yellow pigments ppm d. m.	SDS Sediment. value cm^3
Progress	51.9	80.0	71.0	13.8	26.3	8.9	6.2	23.5
Saturn1	46.0	80.4	75.3	12.9	29.1	9.8	6.1	37.0
Victoria	47.3	79.7	76.0	13.7	24.1	8.0	7.1	18.3
Beloslava	48.6	80.6	80.7	13.6	30.3	10.0	5.2	24.7
Vashod	50.4	80.1	80.7	15.2	33.3	11.2	6.1	34.7
Deiyana	48.7	81.2	79.3	14.4	24.8	7.9	6.0	25.0
Zvesditsa	52.4	80.9	73	13.7	27.0	8.9	5.9	28.3
Predel	49.0	80.1	78.7	14.7	28.6	9.5	7.4	39.3
Zagorka	47.1	83.8	75.0	13.7	29.5	10.0	6.3	28.5
Auradur	44.7	78.4	80.0	16.1	33.2	11.5	9.8	51.3
Karur	43.7	77.6	75.7	13.1	26.7	8.9	9.0	53.0
Selyendur	40.9	80.7	81.3	13.1	32.1	10.3	8.5	79.0
Grecale	43.5	76.0	80.0	14.8	33.7	11.4	7.9	55.7
Pescadou	41.7	78.4	80.7	14.5	27.4	8.6	9.8	46.0
Levante	42.2	79.5	72.3	13.0	25.7	7.8	9.3	68.0
Janeiro	45.3	78.3	75.3	11.8	29.3	9.9	9.9	31.3

The following were determined:

Milling properties of the grain: moisture content, 1000 kernel weight, test weight, vitreousness of grain

Color of semolina: content of yellow pigments

Cooking properties: crude protein, SDS-sedimentation value, wet gluten and dry gluten

After standardization of the data a hierarchical cluster analysis UPGME for average values was performed considering the complex effect of the analyzed traits. The computer software STATISTICA FOR WINDOWS 4.3 was used. The genetic distinction was calculated by determining Euclidean distance between two objects in the multidimensional space, defined by the studied traits,

and was illustrated by a dendrogram. A principal component analysis leading to a respective clustering was made.

RESULTS AND DISCUSSION

Harvested grain was dry and moisture content below the basic value for wheat 10.97–11.46 %. There was not presence of „black points" in the kernel's germ, which could impair culinary and commercial quality wheat semolina.

1000 kernel weight and specific weight in the world collection of durum wheat are in range, 30–62 g and 72–87 kg/hl, respectively. The group of Bulgarian varieties has genetically determined higher 1000 kernel weight, overall average 42.8 g. to 37.3 g. for the rest varieties.

Zvesditsa variety with 52.4 g. is superior to the standard Saturn 1 (46.0 g). Specific weight is also higher for Bulgarian species, the average value 77 kg/hl versus 75.9 kg/hl for a group of foreign varieties. By the analysis of variance it was statistically proven that 1000 kernel weight and specific weight are affected by abiotic environmental factors (F exp = 25.34 > Fcr.) and (F exp = 32.67. > Fcr.) respectively. The links of specific weight and 1000 kernel weight as indicators of the relationship-grain endosperm with milling properties are quite variable by location and year of cultivation. Variability explains preference for one or the other as to the estimated yield of semolina and different power of their relationships with the milling quality. According to Dexter and Marchylo [3], 1996 the specific weight decreases the potential of milled wheat deteriorated due to the combined impact of lower yield of semolina, higher ash content and lower content of yellow pigments in semolina. The 1000 kernel weight according to Irvin is a good indicator of the yield potential meal, as he does not establishe relationship between yield and specific (test) weight. Despite conflicting views, specific weight is a common index for standard classification of durum wheat as a measure of healthy status, as all factors that affect grain fail on specific weight (frost, wilting, sprouting, diseases).

Vitreousness as a standard index reflects the structure of the endosperm because of proven links with yield, particle size of semolina, ash, protein and yellow pigments in semolina. The general vitreous grain as a quite labile indicator (shown by ANOVA in Fexp. = 202.1 > Fcr.) was lowest in the wet 2009 (50.4%) and too high in very favorable agro-meteorological conditions of 2010 and 2011, reaching values of 90.7% and 91.8%, respectively. For the studied period varieties Vashod, Beloslava, Hungarian Selyendur and French Pescadou (Table 1) emerged with the highest vitreousness.

The color potential depends on the amount of natural pigments in grain having yellow and brown tint. Durum wheat contains 2 to 5 times more yellow pigments than bread wheat. Excessive nitrogen fertilization can adversely affect color, because of color-dependent reverse protein content

The content of yellow pigments in semolina in 2009 was 6.9 ppm dm, in 2010 – 8.4 ppm dm, in 2011 – 7.5 ppm dm. It was found that for tree years period the group of foreign varieties (9,2 ppm dm) surpassed the content of yellow pigments domestic wheat (6.25 ppm dm). Varieties Janejro, Pescadou and Auradur had the highest values. By analysis of variance it was found that the color potential was not affected by the changes of growing conditions in the years.

Fexp. = 2.74 < Fcr. Matsou regression analysis showed the amount of protein with SDS-sedimentation including, predictive parameters of culinary quality. The quantity and quality of protein and gluten are key indicators in the programs of breeding and variety testing of wheat worldwide. These traits depend on variety and are strongly influenced by abiotic environmental factors. Modern noodle production requires 14% protein in semolina, corresponding to over 15% in the grain. All studied varieties showed similar values for crude protein (13.7% and 13.9%) as well as wet gluten 27.8% for Bulgarian and 29.7% for foreign ones, but the group of foreign varieties had higher quality of protein and gluten, expressed by the high volume of SDS-sedimentation value. The analysis of variance showed that both traits were influenced by environmental factors, wet gluten significantly greater Fexp. = 3.29 > Fcr., and crude protein less, Fexp. = 4.41 > Fcr.

SDS-sedimentation of semolina was determined by the standard method of ICC . Foreign varieties showed significantly higher volume of SDS-sedimentation value, due to the good quality of gluten-forming proteins, 54.9 cm^3 versus 28.1 cm^3 of Bulgarian wheat [5]. Very good SDS-sedimentation volume was archiewed by Selyendur 79 cm^3 and Levante 68 cm^3 (Table 1). It found that SDS sedimentation value was a stable quality trait, and was not significantly influenced by growing conditions in the three years period , Fexp. = 0.9 < Fcr.

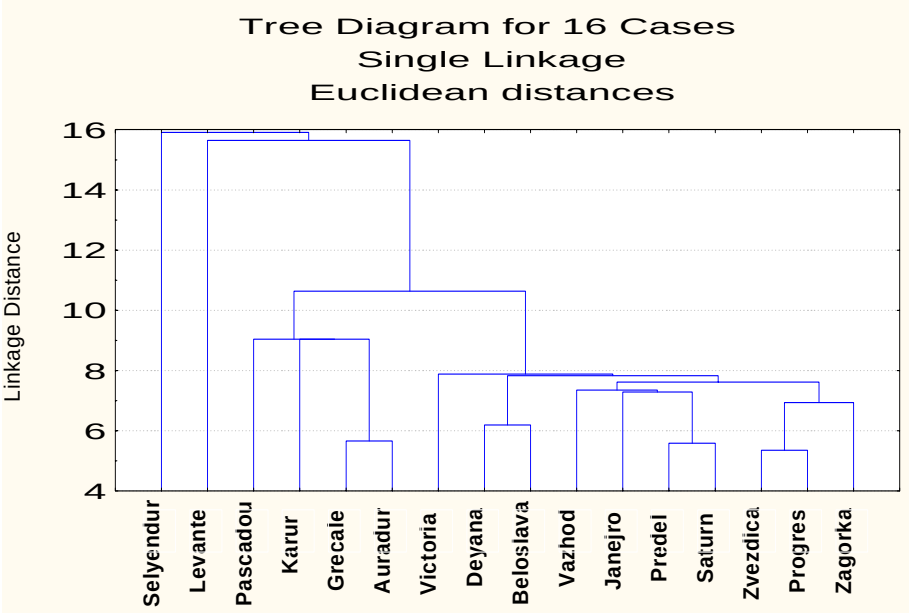

Figure 1. Dendrogram of durum wheat varieties

Dendrogram in Figure 1 illustrates the grouping of durum varieties in two main clusters. It is seen close similarity among the Bulgarian varieties in the cluster 1, grouped according to the 8 studied traits. They were characterized by heavy grain, high test weight and a low yellow pigment concentration according to present standards. Cluster 1 also includes variety Janeiro due to low levels of SDS-sedimentation and crude protein. These differences make it unfit for cluster 2- the group of foreign varieties (Fig. 1).

Cluster 2 consisted of French varieties Karur and Pescadou, Grecale (Italy) and Auradur (Hungary). The unique varieties Levante and Selyendur are form two separate clusters.

The principal component analysis was applied to specify the causes of the separation of the accession(Table 2). In our study 70.469 % of the variation in the estimates of similarity was revealed by the first two components indicated by the suitability of qualitative traits used. In Table 3 it was shown that the traits such as SDS-sedimentation value , wet gluten, dry gluten and yellow pigments, had the greatest impact as far as clustering is concerned.

The relative variation of these traits correlated strongly with the first principal component which explained about 42.07% of the total variation (Tables 2 and 3). Approximately 28.39% of variation was explained by the second component that closely correlated with the relative variation of crud protein and dry gluten content in semolina.

Table 2

Principal component analysis (PCA)

	Total Variance Explained					
	Initial Eigen values			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	**3.366**	**42.070**	**42.070**	**3.366**	**42.070**	**42.070**
2	**2.272**	**28.399**	**70.469**	**2.272**	**28.399**	**70.469**
3	**0.860**	**10.750**	**81.219**	**0.860**	**10.750**	**81.219**

Extraction Method: Principal Component Analysis.

Table 3

Matrix of Components

Components			
	1	2	3
SDS sedimentation	0.753	-0.400	0.242
Wet gluten	0.740	0.562	0.311
1000 kernel weight	-0.717	0.585	-0.137
Dry gluten	0.652	0.625	0.266
Yellow pigments	0.652	-0.625	-0.173
vitreousness	0.639	0.439	-0.137
Test weight	-0.609	0.296	0.489
Crud protein	0.326	0.625	-0.572

Extraction Method: Principal Component Analysis.

3 components extracted.

CONCLUSION

Bulgarian durum wheat varieties in the first cluster have higher values of 1000 kernel weight and test (specific) weight. This fact is a reason for a good yield of semolina in the process of milling the grain [3], [5].

The foreign varieties in the second cluster are described as heaving higher content of yellow pigments and higher SDS-Sedimentation value of semolina. The crud protein and wet gluten of these varieties have very good quality and are better raw material for production of semolina and noodles [2].

SDS-sedimentation value and content of yellow pigments in semolina are stable varietal character. They do not significantly change under the influence of abiotic environmental factors. Selyendur, Grecale and Levante are more specific, combining high protein content with a high quality of gluten. Their genes of adaptively determined the quality diversity therefore are best suited for cultivation in the region of South-Central Bulgaria.

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