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VARIATION OF SOME QUALITATIVE INDICATORS OF WHEAT GENETIC MATERIAL FROM AGRICULTURAL UNIVERSITY OF TIRANA (AUT) COLLECTION

Valentina Arapi[1*], Artiona Laze[1], Vjollca Ibro[1], Fetah Elezi[1], Vlash Mara[1], Aferdita Kasmi[1], Rajmond Meli[1]

[1]Faculty of Food and Biotechnology, Agricultural University of Tirana (AUT), Tirana, Albania
[2]Faculty of Agriculture and Environment, AUT, Tirana, Albania

[*]e-mail: valiarapi@hotmail.com

Abstract

Wheat is one of the most important crop between cereals, mainly, due to the fact that its grains contain protein with unique chemical and physical properties. Gluten protein fractions give to dough viscous and elastic properties and allow it to be use for bread, pasta, etc.

The purpose of this study is to assess the biochemical-chemical-technological indices of some genetic materials of wheat, sown in the experimental plots of Agricultural University of Tirana (AUT), during the years 2011 - 2012. The soft wheat material was analyzed for the: content of proteins, gluten, sedimentation index, bread volume and of the high molecular weight glutenin subunits (HMW) by sodium-dodecyl-sulphat-polyacrylamide-gel electrophoresis (SDS-PAGE). The statistical analysis was performed for all data processed using data analysis of variation and regression - Microsoft Excel, 2007.

Study results for wheat grain showed a high content of protein (13.29 - 16.64%) and gluten (averaging 30.30%) and the good values of sedimentation index (averaging 52.40 mL). The results of correlation analysis between protein and gluten, have shown a statistically significant positive relation (r = 0.74). Protein content, gluten, sedimentation index in flour, vary in high value (averaging 14.30%, 30.90%, and 80.90 mL, respectively) and bread volume in average value (552.5 cm3/100 g flour). Despite the presence of high molecular weight glutenin subunits (HMW - GS), 2 + 12 lines studied showed good chemical and technological properties.

Based on the evaluation of above indicators, it is concluded that the wheat genetic material of the AUT collection is characterized by optimal qualitative indicators.

***Key words**: Gluten, HMW-GS, K-SDS, Protein, SDS-PAGE, Wheat.*

1. Introduction

The study of quality indicators in wheat grain summarizes a number of biochemical-chemical-technological analysis such as: the total protein content, wet gluten, dry gluten, gluten index, sedimentation test, K-SDS, the high molecular weight glutenin subunits (HMW - GS) composition, gliadin components, bread volume, etc. (Pomeranz [14]). The protein content affects the dough properties, and for this reason, protein amount is considered an important parameter for the assessing the quality of the grain (Acquistuci *et al.,* [3]).

Gluten is a plastic-elastic protein fraction of wheat flour responsible for physical dough properties (Curic *et al.,* [5]). The bread-making quality depends mainly on gluten viscoelastic features. The quantity and quality of gluten are considered the most important quality parameters of wheat flour (Pogna *et al.,* [10], and Curic *et al.,* [5]). The unique dough elasticity is mainly connected to polymeric glutenins, while monomeric gliadins define viscous behavior of dough. HMW-GS as polymeric glutenin fractions has the most important role in defining bread-making quality (Horvat *et al.,* [6], and Pogna *et al.,* [10]).

The aim of this study was to assess the quality indicators in wheat genetic material from AUT collection, and the use of their databases by plant breeders in effective programs to improve the quality of wheat.

2. Materials and Methods

Experiments held on the field for the assessment of ten soft wheat lines of the collection took place in the Experimental didactic economy (EDE) of the Agricultural University of Tirana (AUT), during the years 2011 - 2012. Experimental fields are located at latitude

N 41°24'06.35"N, longitude 19°44'09.38"E, at elevation of 40 m. The size plot for each variant was 6 m^2. For the realization of the experiment common practice was implemented as in similar experiments of this nature at all agro-technical levels. During the vegetation phase the following observations as well as biometric measurements were conducted for these indicators: plant height, spikelet's per spike, grain per spike, 1000-kernel weight, life cycle duration, and production realized in ha^{-1} (t) (Sulovari [16]).

Ten soft wheat lines of the collection were collected from EDE of the Agricultural University of Tirana. Dried and cleaned samples, at room temperature were grounded in a mill Perten 3100, and Lab. Mill – I Labor, MIM, CF - 114, with 450 micron sieve.

The moisture content was determined by heating samples in an oven at 130 ^{0}C (Bimbashi and Zeneli [4]). The total nitrogen in wheat samples was determined by Kjeldahl method, where discovered nitrogen was multiplied by a factor (5.7 for wheat), which corresponds to the raw protein in the analyzed wheat sample (Kjeldahl [7]). The wet gluten content and gluten index were defined according to Glutomatic system, Gluten index, Perten, ICC Standard N°155 and N° 158 AACC method N° 38-12 [2]. International gluten index method is faster than the 'manual washing gluten' method and it uses a relatively small amount of flour sample during the analysis (Curic *et al.,* [5]). Sedimentation coefficient (K-SDS) was determined according to Axford *et al.,* [1], and Zeleny [17].

Bread dough was prepared according to the classical technology: flour, salt, water, yeast dough mixture that was left for fermentation and afterwards baked at a temperature 250 - 280 ^{0}C for 50 - 60 min. The bread volume was determined by rapeseed displacement as in the method AACC 10-10 (Pasqualone *et al.*, [15]).

The high molecular weight glutenin subunit (HMW-GS) compositions were fractionated by SDS-PAGE (Laemmlli [8]), running gel was 10% acrylamide solution and 0.3% bis-acrylamide, pH 8.8, whereas stacking gel was 5% acrylamide solution and 0.09% bis-acrylamide, and pH 6.8. The numbering system for soft wheat was determined according to Payne and Lawrence [11], and Payne [12], and quality score according to Pogna [10]. All samples of soft wheat lines were analyzed twice and the data were reported on a dry matter basis. The statistical analysis was performed for all data processed using data analysis of variation and regression - Microsoft Excel, 2007.

3. Results and Discussion

Table 1 presents the data of morpho-physiological and productivity parameters in ten soft wheat lines from the AUT collection.

It is evident from the Table 1, that production in ten soft wheat lines of AUT collection reached from 5.2 to 6.7 ha^{-1} (t) (lines 3,6,4), which were considered high values (Sulovari [14]). The index of 1000-kernel weight in ten soft wheat lines of AUT collection ranged between 38.00 - 47.50 g (lines 6,4), with an average 42.87 g which was considered a satisfactory value. The grain per spike, in ten soft wheat lines of AUT collection reached from 30.00 to 48.80 (lines 3,7), while spikelet's per spike from 15.80 to 21.80 (lines 5,7). Life cycle duration was restricted from 182 to 201 days (lines 3,7), while plant height ranged between 72.40 - 94.80 cm (lines 1,10).

Tables 2 and 3 show some quality indicators in ten soft wheat lines (grain) fom the AUT collection and ten soft wheat lines (flour ray 0.90) of AUT collection.

Table 1. Some morpho-physiological and productivity parameters evaluated in ten soft wheat lines of AUT collection

Nr.	Wheat lines	Plant height, cm	Spikelet's per spike	Grain per spike	1000 kernel weights, g	Life cycle duration, in days	yield, ha-1 (t)
1	V1/12	72.4	21.2	38.0	41.0	189	5.9
2	V2/12	88 .0	18.4	42.0	43.0	192	6.6
3	V3/12	78.6	16.9	30.0	42.4	182	5.2
4	V4/12	76.2	19.0	39.0	47.5	198	6.7
5	V5/12	78.4	15.8	37.0	46.2	198	5.7
6	V6/12	92.0	18.6	44.0	38.0	196	5.2
7	V7/12	84.0	21.8	48.8	42.0	201	6.2
8	V8/12	82.0	17.6	43.2	40.8	196	5.8
9	V9/12	74.6	16.8	40.2	43.2	199	6.1
10	V10/12	94.8	17.2	38.4	44.6	193	6.4

Table 2. Some quality indicators evaluated in ten soft wheat lines (grain) from the AUT collection

Nr.	Wheat line	Moisture %	Protein %	Wet Gluten %	Dry Gluten %	Index Gluten %	K-SDS mL	Ratio K-SDS /protein	Ratio Gluten /Protein
1	V1/12	11.44	13.88	32.80	10.50	49.00	53.00	3.81	2.36
2	V2/12	11.63	14.81	28.60	9.80	11.00	52.00	3.51	1.93
3	V3/12	11.75	16.64	33.10	11.50	14.00	52.00	3.12	1.98
4	V4/12	11.04	15.07	33.00	11.20	13.00	47.00	3.11	2.19
5	V5/12	10.93	13.29	24.90	8.40	17.00	52.00	3.91	1.87
6	V6/12	11.42	15.85	31.40	11.10	19.00	53.00	3.34	1.98
7	V7/12	11.33	15.48	33.20	11.30	7.00	53.00	3.42	2.14
8	V8/12	11.42	13.33	25.00	8.70	17.00	43.00	3.22	1.87
9	V9/12	11.60	15.71	32.10	11.10	18.00	57.00	3.62	2.04
10	V10/12	11.88	14.84	28.90	9.10	37.00	62.00	4.17	1.94

Table 3. Some quality indicators evaluated in ten soft wheat lines (flour ray 0.90) from the AUT collection

Nr.	Wheat line	Moisture %	Protein %	Wet Gluten %	Dry Gluten %	Index Gluten %	K-SDS mL	Ratio K-SDS /prot.	Ratio Gluten /Prot.	Bread Volume cm^3/ 100g flour	Bread Vol. /Gluten
1	V1/12	12.37	13.66	29.80	9.50	19.00	81.00	5.93	2.18	610	20.47
2	V2/12	11.89	14.67	29.70	9.90	10.00	84.00	5.72	2.02	560	18.85
3	V3/12	12.67	14.80	36.80	12.60	2.00	84.00	5.67	2.49	620	16.84
4	V4/12	13.09	14.87	30.20	10.60	2.00	62.00	4.17	2.03	615	20.36
5	V5/12	12.80	11.89	25.70	9.10	47.00	84.00	7.06	2.16	620	24.12
6	V6/12	12.92	15.21	31.90	11.00	2.00	86.00	5.65	2.10	540	16.93
7	V7/12	12.84	14.83	36.10	12.50	1.00	76.00	5.12	2.43	600	16.62
8	V8/12	13.37	12.90	25.10	8.50	4.00	81.00	6.28	1.94	490	19.52
9	V9/12	13.23	15.45	34.10	11.60	3.00	87.00	5.63	2.21	420	12.32
10	V10/12	13.46	14.75	30.00	9.60	65.00	84.00	5.69	2.03	450	15.00

As noticed from Table 2 and 3, the ten soft wheat lines (grain) from AUT collection and the ten soft wheat lines (flour ray 0.90) were characterized by high values of protein content, with an average value of 14.89% and 14.30 %, respectively (Pomeranz [14], and Sulovari [16]).

The moisture content resulted in satisfactory value, averaging 11.44% for the soft wheat lines (grain) and 12.86% for the soft wheat lines (flour ray 0.90).

The wet gluten content ranged from 24.90 to 33.20% (lines 5,7) and from 25.10% to 36.80% (lines 8,3), which are considered minimum to high values, specifically in the soft wheat lines (grain) and the soft wheat lines (flour ray 0.90) from the AUT collection. Eight of the ten lines of soft wheat in grain and flour were distinguished for high value of wet gluten (above 28%) (Sulovari [16]).

While the dry gluten content resulted with an average value of 10.30% and 10.50%, which are considered medium values, specifically in the soft wheat lines (grain) and the soft wheat lines (flour ray 0.90). The report gluten/protein in the soft wheat lines (grain) and the soft wheat lines (flour ray 0.90), resulted with an average value of 2.03 and 2.16, which are considered medium values, respectively Gluten index.

The gluten index values showed significant differences between the studied lines, that were limited from 37.00 to 49.00% (lines 10,1) in the soft wheat lines (grain), and from 1.00% to 65.00% (lines 7,10) in the soft wheat lines (flour ray 0.90), which are considered medium values and from low value to high ones (Curic *et al.,* [5]). The sedimentation coefficient (sedimentation test) is an indicator of the protein quality, which

means that with the increase of the protein content, values of this indicator grows (Preston *et al.,* [13]). The soft wheat lines (flour ray 0.90) were characterized by high values of sedimentation coefficient K-SDS, with an average value of 80.90 mL, while lines of soft wheat (grain) by medium to high values, with an average of 52.40 mL. The specific volume of sediment (report K-SDS\protein) as an expression of the quality of this indicator per unit of protein resulted in medium values, with an average of 5.69 for the soft wheat lines (flour ray 0.90) and at low values, with an average of 3.52 for the soft wheat lines (grain).

The bread volume in the soft wheat lines (flour ray 0.90) resulted in medium values (averaging 552.5 cm^3/100 g flour). As well, the report bread volume/gluten, resulted in medium values (averaging 18.10), respectively.

Data processing showed that grain per spike had a positive correlation with spikelet's per spike (r = 0.54). The correlation analyses showed that life cycle duration had a significant positive correlation with grain per spike (r = 0.74), while the production showed positive correlation with 1000-kernel weight (r = 0.60) for ten soft wheat lines of the AUT collection, respectively. On the other hand, the correlation analyses also showed that protein content was positively correlated with wet gluten (r = 0.74 and r = 0.76) and dry gluten (r = 0.83 and r = 0.70), specifically in the soft wheat lines (grain) and the soft wheat lines (flour ray 0.90). The graphic presentation of protein, wet gluten and K-SDS values in 10 soft wheat lines (grain) and (flour ray 0.90) of AUT collection are shown in Figures 1 - 6.

Table 4 presents the composition of HMW-GS in ten soft wheat lines. SDS-PAGE electrophoregram was shown in Figure 7. The analyzed grain samples were different in HMW-GS. Line 8 contained glutenin subunits 7 + 8 (chromosome 1 B) and 1 (chromosome 1 A) responsible for the good quality of bread flour. Line 2 contained glutenin subunit 7 + 8 (chromosome 1 B), responsible for the good quality of bread flour. All studied lines of the soft wheat, contained glutenin subunits 2 + 12 (chromosome 1 D), responsible for the weak quality of bread flour, as well as glutenin subunits 1 (chromosome1 A) responsible for the good quality of bread flour. In the ten soft wheat lines, qualitative

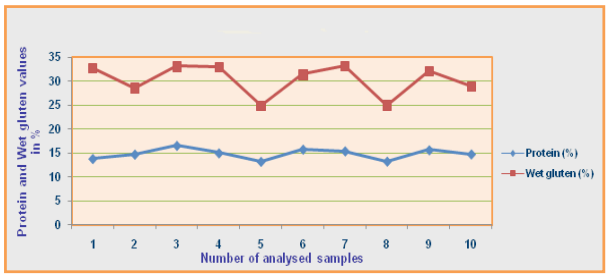

Figure 1. The graphic presentation of protein and wet gluten values in 10 soft wheat lines (grain)

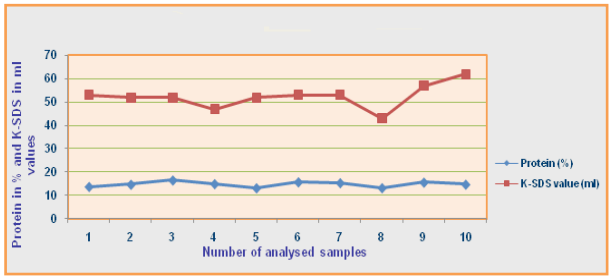

Figure 2. The graphic presentation of protein and K-SDS values in 10 soft wheat lines (grain)

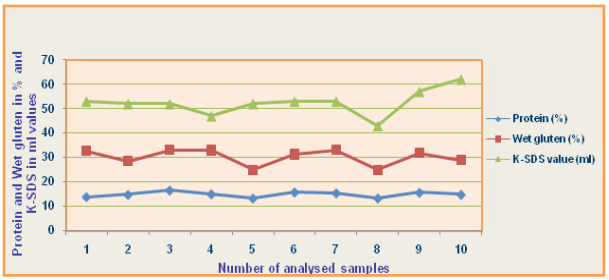

Figure 3. The graphic presentation of protein, wet gluten and K-SDS values in 10 soft wheat lines (grain)

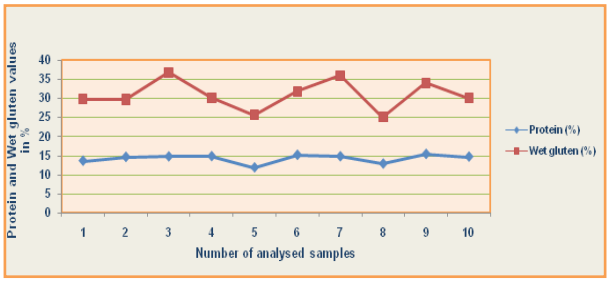

Figure 4. The graphic presentation of protein and wet gluten values in 10 soft wheat lines (flour ray 0.90)

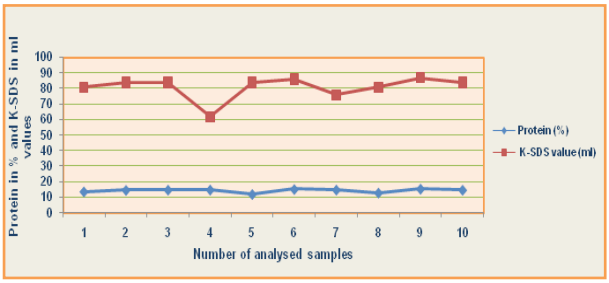

Figure 5. The graphic presentation of protein and K-SDS values in 10 soft wheat lines (flour ray 0.90)

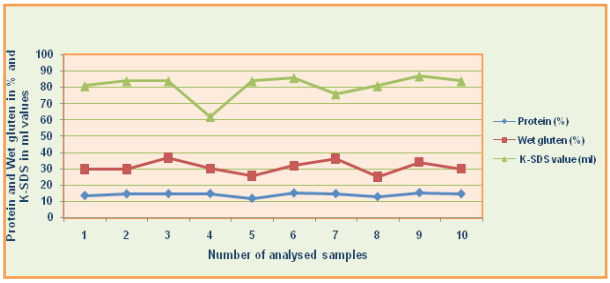

Figure 6. The graphic presentation of protein, wet gluten and K-SDS values in 10 soft wheat lines (flour ray 0.9)

scoring, which is the amount of HMW-GS points to a variety, resulted on average, X = 7.1. Lines 8,2 resulted in high values of quality score (X), 9 (nine) and 8 (eight) respectively (Pogna [10]).

Table 4. Composition of HMW- GS in ten soft wheat lines of the AUT collection

Nr.	Wheat lines	Glutenin subunits of HMW			Valuation with point, X (Pogna), ( )
		1A	1B	1D	
1	V1/12	1	7	2+12	7
2	V2/12	N	7+8	2+12	8
3	V3/12	1	7	2+12	7
4	V4/12	1	7	2+12	7
5	V5/12	1	7	2+12	7
6	V6/12	N	7	2+12	6
7	V7/12	1	7	2+12	7
8	V8/12	1	7+8	2+12	9
9	V9/12	1	7	2+12	7

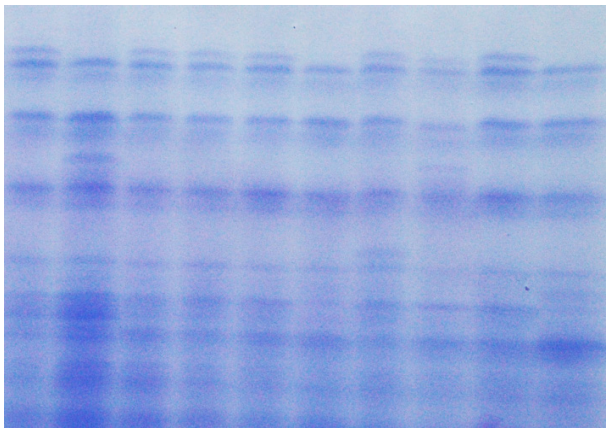

Figure 7. SDS-PAGE electrophoregram (llinesV1/12; V2/12; V3/12; V4/12; V5/12; V16/12; V7/12; V8/12;V9/12; V10/12)

4. Conclusions

- From the study of quality indicators and morpho-physiological and productivity parameters in the soft wheat genetic material from AUT collections the following parameters resulted: high values of protein content, on average high values of wet gluten, medium values of dry gluten, significant differences of gluten index values specifically in the soft wheat lines (grain), and the soft wheat lines (flour ray 0.90). On the other side, the soft wheat lines (flour ray 0.90) resulted in higher values of the sedimentation coefficient, K-SDS and of specific volume in comparison with the soft wheat lines (grain). The bread volume in the soft wheat lines (flour ray 0.90) resulted in medium values. The production in ten soft wheat lines reached high values.

- Correlation analysis showed a significant positive correlation between life cycle duration and grain per spike (r = 0.74), while the protein content was positively correlated to wet gluten (r = 0.74 and r = 0.76), and dry gluten (r = 0.83 and r = 0.70) specifically in the soft wheat lines (grain) and the soft wheat lines (flour ray 0.90). Line 8 contained glutenin subunits 7 + 8 (chromosome 1 B) and subunit 1 (chromosome 1 A) responsible for the good quality of bread flour. Line 2 contained glutenin subunit 7 + 8 (chromosome 1 B) responsible for the good quality of bread flour. Lines 8 and 2 resulted in high values of quality score (X), 9 (nine) and 8 (eight) respectively.

- Based on the evaluation of the above indicators, it is concluded that the wheat genetic material from AUT collection was characterized by optimal qualitative indicators and high production values. The data presented in this study could be used by plant breeders in effective programs, in order to improve the quality of wheat. Line 10 was distinguished for the highest indicators of quality and production. Therefore, we can recommend it to be proven in production conditions with the aim of spreading and involving in the variety structure of wheat.

5. References

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