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Characterization of domestic grains based on chemical and Technological indicators

VALENTINA ARAPI[1*], FETAH ELEZI[2], VLADIMIR MALO[3], ARTIONA LAZE[1], VJOLLCA GJINI[3], VJOLLCA IBRO[2], SUZANA KOLA[4]

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

[2]Faculty of Agriculture and Environment, AUT, Tirana, Albania

[3]Agricultural Technology Transfer Center, Tirana, Albania

[4]Institute of Food Safety and Veterinary, Tirana, Albania

*Corresponding author; E-mail: valiarapi@hotmail.com

Abstract

Wheat constitutes the basic food of most of the world's population. Numerous assortments of food are prepared from wheat including bread, pasta, biscuits, cakes, starch, etc. The purpose of this study is to analyze some quality indicators in a number of soft wheat lines of the AUT Genetic Resource Center, planted in the experimental areas of the Agricultural University of Tirana (AUT), during 2012-2013 and 2013-2014. The results of the study for soft wheat lines, evidenced both a high protein content at 12.80 -14.79%, as well as wet gluten, with an average of about 28.35%. Similar high value are confirmed by sedimentation coefficient indicator with an average of about 84.10%, as well as in the gluten index with an average of 77.55%. The examined lines also showed relatively high values of the specific volume of sediment (K-SDS / protein ratio) with an average of about 6.11. Satisfactory values were also reported from the morphological indicators. Statistical results of qualitative and quantitative index values evidenced significant positive correlations between protein and wet gluten, r = 0.83. Significant positive correlations were also observed between K-SDS and proteins, r = 0.76, as well as between K-SDS and wet gluten, r = 0.76. Moreover, a positive correlation with r = 0.61 was observed between the plant height and the wet gluten index. Biometric indicators for each line were calculated as averages of 10 consequential measurements. Descriptive statistics and correlation coefficients are estimated via the statistical package STATA 14. The valuation of the chemical-technological and morphological indicators of the examined lines, resulted in optimal qualitative indicators and satisfactory quantitative ones.

Keywords: protein; gluten; K-SDS; gluten index; line.

1. Introduction

Cereals constitute the largest group of important cultivated plants. Soft wheat (*Triticum aestivum*) is the most widespread among wheat species in the world. Wheat can be stored for a long time under different environmental conditions as well as packaged and transported easily [17, 22]. Wheat is used to produce a large variety of bread and other baking products [17]. Wheat together with oats have the highest protein content in the grain. Referring to literature sources and studies conducted in our country, the protein content in the wheat grain fluctuates between 8-15%, 7-24% [22], 8-17% [17], 14.38-21.07% [4], depending on the genotype and growth environment. The protein content in the oat grain fluctuates between 13.80-17.37% [10], 15.00-20% [11], 9.70-17.30% [19]. Oats are known as a healthy food containing soluble dietary fiber, vitamins, fats, unsaturated fatty acids and minerals [19, 20].

The purpose of this study is to evaluate the chemical-technological indexes of some soft wheat lines of a preliminary test and to recommend those lines which evidence optimal qualitative and quantitative indicators to proceed further in zonal tests of the selection.

2. Material and Methods

Ten soft wheat lines pertaining to a Preliminary sample of the AUT Genetic Resources Center were planted in the experimental areas of the Agricultural University of Tirana (AUT), during 2012-2013 and 2013-2014. The following quantitative indicators were recorded in these lines: plant height, spike length, spikelet's per spike, grain per spike, grain in spikelet, weight of the spike kernel, 100- kernel weight [21]. After the threshing process, samples of soft wheat were left to dry at room temperature. The cleaned and dried samples were grounded in a mill Perten 3100, and Lab. Mill – I LABOR, MIM, CF – 114. The moisture content was determined by the method of drying samples in the thermostat at 110 ° C [7]. The total protein content was determined by the Kjeldahl method [3, 13], according to which the sample was burned with H_2SO_4 in the presence of a catalyst, followed by NaOH addition, where ammonium sulfate is converted to ammonia which is distilled and collected in a beaker with an excessive amount of sulfuric acids. The excess acid was titrated with NaOH. The discovered nitrogen was multiplied by a factor (5.7 for wheat and 6.25 for oats) corresponding to total proteins in analyzed grain and oats samples. The content of wet and dry gluten as well as the gluten index in soft wheat samples, were determined according to Glutomatic System, Gluten Index, Perten, ICC Standard $N^0$155 and N^0 158 AACC (2000) method N^0 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 [8]. Sedimentation coefficient (K-SDS) was determined according to Axford et al., [1]. The bread dough was prepared by mixing whole wheat flour with oat flour in different ratios and by adding water, salt & yeast to it. The dough was left for fermentation and afterwards baked at a temperature of 250 ° to 280 ° C for 50-60 minutes. The bread volume was determined by rapeseed displacement as in the method AACC 10-10 [18]. All samples of soft wheat and oats were analyzed twice and the data were reported in a dry material basis. Biometric indicators for each line were calculated as averages of 10 consequential measurements. Descriptive statistics and correlation coefficients are estimated via the statistical package STATA 14.

3. Results and Discussion

Table 1 presents the results of some bio-morphological parameters in ten soft wheat lines of preliminary sample of the AUT Genetic Resources Center. As noted in the Table, the height of the wheat plant reached between 75.00 to 79.80 cm (lines 1.9), with an average of 78.34 cm. The spike length, in ten soft wheat lines of the preliminary sample reached between 7.30 to 8.50, cm (lines 3,8,9), with an average of 7.94 cm. Whereas, the spikelet's per spike in the ten soft wheat lines were roughly the same, with an average of 18 spikelet's per spike. Also, grains per spike and grain per spikelet in all the soft wheat lines were roughly the same, with an average of 49.71 grains per spike and 3.07 grains per spikelet, respectively. The same results were noted for the spike weight and the 100 kernel weight in all soft wheat lines, with an average of 2.23 and 3.49, respectively.

Table 1. Some bio-morphological parameters in ten soft wheat lines of the preliminary sample

No.	Wheat lines	Plant height, cm	Spike length cm	Spikelet's per spike	Grains per spike	Grains in spikelet	Weight of the spike kernel, g	100 kernel weight, g
1	V1	75.00	7.90	18.20	49.70	3.00	2.24	3.49
2	V2	79 .00	8.30	17.80	49.60	3.30	2.23	3.49
3	V3	78.50	7.30	17.80	50.00	3.20	2.26	3.51
4	V4	78.70	8.10	18.60	49.60	2.80	2.20	3.48
5	V5	79.50	7.80	18.40	49.60	3.10	2.20	3.47
6	V6	78.50	8.30	18.00	50.01	2.90	2.21	3.50
7	V7	77.20	7.70	17.60	49.00	3.00	2.20	3.50
8	V8	77.50	7.30	18..40	50.00	3.20	2.24	3.49
9	V9	79.80	8.50	18.00	49.60	3.00	2.25	3.47
10	V10	79.70	8.20	17.20	49.90	3.20	2.25	3.49

The two-year average values of chemical-technological indicators in ten soft wheat lines of preliminary sample of the AUT Genetic Resource Center are presented in Table 2. Among the chemical

components of wheat grain, the most important indicator of wheat quality for bread and its by-products is the content and composition of proteins [5, 14]. As shown in Table 2, all soft wheat lines of the preliminary sample, were characterized by high protein content values (12.80-14.79%), with an average value of 13.75%, respectively 2016[16, 17, 21]. The moisture content evidenced satisfactory values with an average value of 13.19%.

The wet gluten content in wheat grain depended on the level of nitrogen [9]. The quantity and quality of gluten are considered among the most important qualitative parameters of wheat flour [8, 12]. The wet gluten content ranged between 23.30%-31.20% (lines 2 & 7), with an average value of 28.35%, as observed in the ten soft wheat lines of the preliminary sample. Seven of ten soft wheat lines were distinguished for high value of wet gluten, over 28% [21]. Whereas the dry gluten content resulted in an average value of 9.33, which was considered an average value. In our study, line 2 was characterized by low values of wet and dry gluten (23.30% and 7.70%), while line 7 of high values of these indicators (31.20% and 10.10%). According to literature sources, dry gluten (DG) is directly related to wet gluten (WG), and their variation peculiarities were similar [9]. The gluten / protein ratio in soft wheat lines of the preliminary sample, resulted in an average value of 2.05, respectively. Based on literature sources, flours used in the production of bakery products have the gluten index value from 60 to 90% [8]. The gluten index values in the ten soft wheat lines of the preliminary sample ranged from 57.91 to 97.30% (lines 7 & 10), with an average of 77.55%, which was considered a high value. Nine of the ten soft wheat lines were distinguished for high gluten index values, as the following; lines 10, 3, 2 (over 95%), lines 9, 4 (over 80%), line 6 (over 70%) and lines 5, 8, 1 (over 70%) [8]. SDS-sedimentation test is an indicator of protein quality [15]. All soft wheat lines of the preliminary sample were characterized by high values of SDS-sedimentation volume, with an average value of 84.10 ml. Also, the specific volume of sediment (ratio K-SDS \ protein) resulted in optimal values, with an average value of 6.11, respectively. All soft wheat lines of the preliminary sample were characterized by high values of qualitative indicators with the exception of the values of the wet gluten indicator, which ranged from low (23.30%) to average values (27.90% 27.35), respectively in lines 2, 3, 1.

Table 2. The two-year average values of some chemical-technological indicators in ten soft test lines of the Preliminary sample

No.	Wheat line	Moisture %	Protein Nx5.7 %	Wet Gluten %	Dry Gluten %	Index Gluten %	K-SDS Ml	Ratio K-SDS /protein	Ratio Gluten/Protein
1	V1	13.28	12.98	27.35	9.15	61.96	72.20	5.56	2.10
2	V2	12.68	12.80	23.30	7.70	95.61	74.00	5.78	1.82
3	V3	13.21	14.07	27.90	9.20	96.34	85.80	6.09	1.98
4	V4	13.03	13.67	28.50	9.20	81.24	84.05	6.14	2.08
5	V5	13.38	13.73	28.25	9.45	66.05	85.80	6.24	2.05
6	V6	13.25	13.71	29.25	9.70	74.58	84.10	6.13	2.13
7	V7	13.14	14.79	31.20	10.10	57.91	89.20	6.03	2.10
8	V8	13.35	14.18	29.90	9.80	63.20	89.20	6.29	2.10
9	V9	13.27	13.34	28.45	9.00	81.37	90.05	6.75	2.13
10	V10	13.40	14.28	29.40	10.00	97.30	86.65	6.06	2.05

Table 3 shows the bread production tests and quality indicators for soft wheat cultivars, Progres first generation, Progres elite, and Oats "Kamza", planted in the experimental areas of AUT. The contents of protein, wet gluten and dry gluten in soft wheat cultivars Progres first generation & Progres elite, resulted in average and high values (10.80%, 12.81%), low and minimum (21.30%, 24 , 80%), and minimal (7.50%, 8.00%). Whereas, the gluten index resulted in high values (92.49%, 60.08%) versus the average values of SDS-sedimentation volume (39.80 ml, 46.60 ml), specifically in soft wheat cultivars, Progres first generation and Progres elite. Gluten / protein ratios and K-SDS / protein ratios resulted in low values (1.97, 1.93) and (3.68, 3.63), while moisture content resulted in satisfactory values (12.78%, 12.78%) in soft wheat cultivars Progres first generation, Progres elite. Protein content and SDS-sedimentation volume at Oats "Kamza, resulted in average values (10.79%, 55.10 ml), while moisture content in satisfactory value (10.76%). The bread dough was prepared by blending the whole wheat flours, Progres first generation & Progres elite with the Oats whole flour "Kamza" in various ratios, as well

as by blending only the whole wheat flours, Progres first Generation, Progres elite separately. The volume of prepared bread resulted in low values, with an average of 309.50 cm3 / 100 g flour (Table 3). Meanwhile, it is noticed that the volume of loaves produced by the blend of wheat flour, the first generation Progress, the elite Progress, with oat flour "Kamza", was slightly higher compared to the bread produced only with wheat flour, the first generation Progres and Progress elite.

Table 3. Bread production tests and qualitative indicators for soft wheat cultivars, Progres first generation, Progres elite, and Oats "Kamza"

No.	Sample	Protein Nx5.7 %	Protein Nx6.25 %	Bread Volume Cm^3/ 100g flour	Crust	Crumb
					Colour, Consistency	Colour, Consistency
1	120 g Progres first generation +30g Oats "Kamza"	10.80	10.79	327	pale brown, with small cracks,	beige, friable, with mixed pore, non-elastic
2	120 g Progres elite +30g Oats "Kamza"	12.81	10.79	320	brown, polished, with little cracks	beige, friable, with mixed pore, medium elastic
3	90g g Progres first generation +60g Oats "Kamza"	10.80	10.79	320	pale brown, with small cracks	dark beige, friable, with mixed pore, non-elastic
4	90g Progres elite + 60g Oats "Kamza"	12.81	10.79	323	pale brown, with long cracks	dark beige, friable, with mixed pore, non-elastic
5	Progres first generation	10.80	-	287	pale brown, with slight cracking	beige, medium pore, medium elastic
6	Progres elite	12.81	-	280	brown, with slight cracking	dark beige, medium pore, medium elastic

Statistical results of qualitative and quantitative index values evidenced significant positive correlations between protein and wet gluten, r = 0.83. Significant positive correlations were also observed between K-SDS and proteins, r = 0.76, as well as between K-SDS and wet gluten, r = 0.76. Moreover, a positive correlation with r = 0.61 was observed between the plant height and the gluten index. The correlation analyses also showed that the weight of the spike kernels had a positive correlation with the grains in spikelet (r = 0.56), and the gluten index (r = 0.50). While the gluten index showed negative correlation with wet gluten (r = - 0.50).

The results of two-factor analysis of the variance (ANOVA) without replication for selected quality indicators reveal that there are significant differences for the values of wet gluten across the ten soft wheat lines, and the two observation years. In other words, both the genotype of wheat and the year of observation are important factors in explaining the observed variation in wet gluten. With regards to the gluten index, we find that the difference in the observed values across the wheat lines is not statistically significant, but the year of observation seem to play a significant role in explaining such differences. For the protein indicator, the year of observation does not play a significant role in explaining differences in the observed values for selected wheat lines. Last but

not least, differences across wheat lines play a significant role in explaining differences in K-SDS values but the factor year is not influential [6].

The graphic presentation of protein, wet gluten, K-SDS values and gluten index in ten soft wheat lines of the preliminary sample for years 2012-2013, 2013-2014, are shown in Figures 1-4. While, the graphic presentation of the two-year average values for protein indicators, wet gluten, K-SDS values and gluten index, in ten soft wheat lines, is shown in Figure 5.

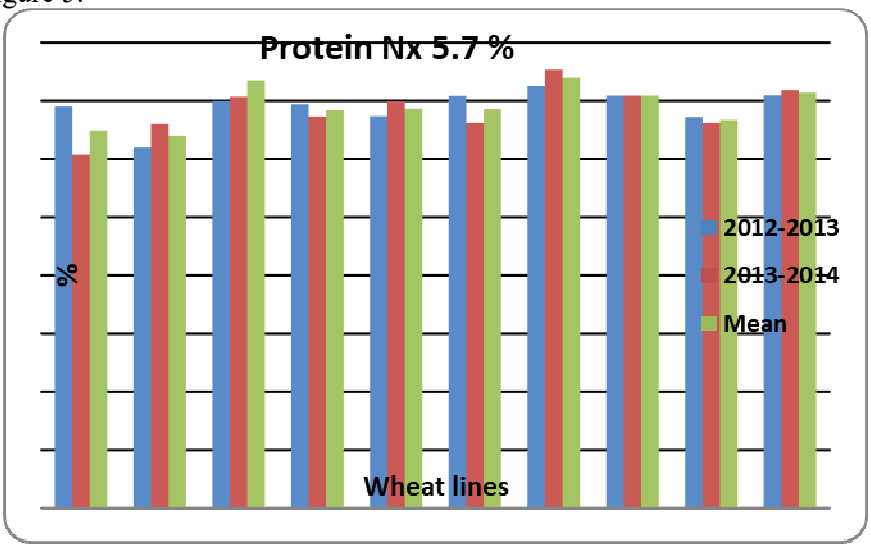

Figure 1. The graphic presentation of Protein values in ten soft wheat lines for two years of study

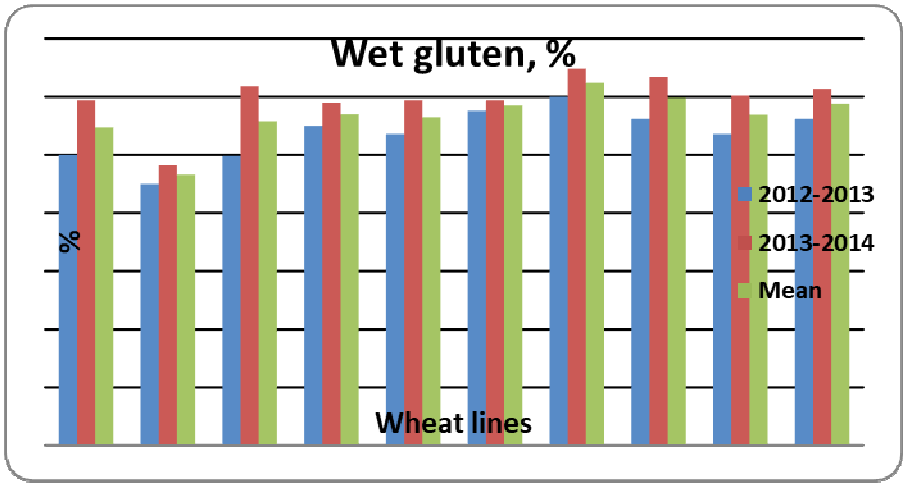

Figure 2. The graphic presentation of wet gluten values in ten soft wheat lines for two years of study

Figure 3. The graphic presentation of gluten index values in ten soft wheat lines for two years of study

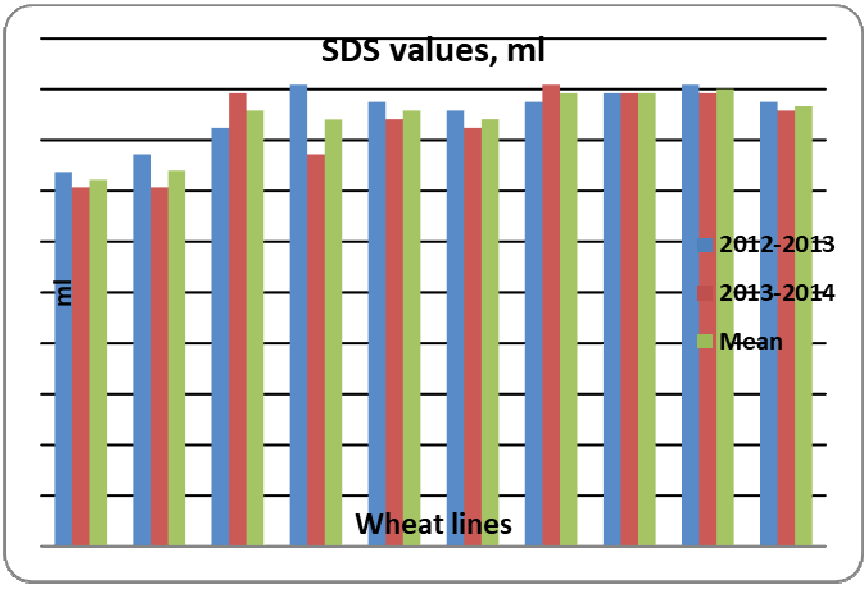

Figure 4. The graphic presentation of K-SDS value in ten soft wheat lines, for two years of study.

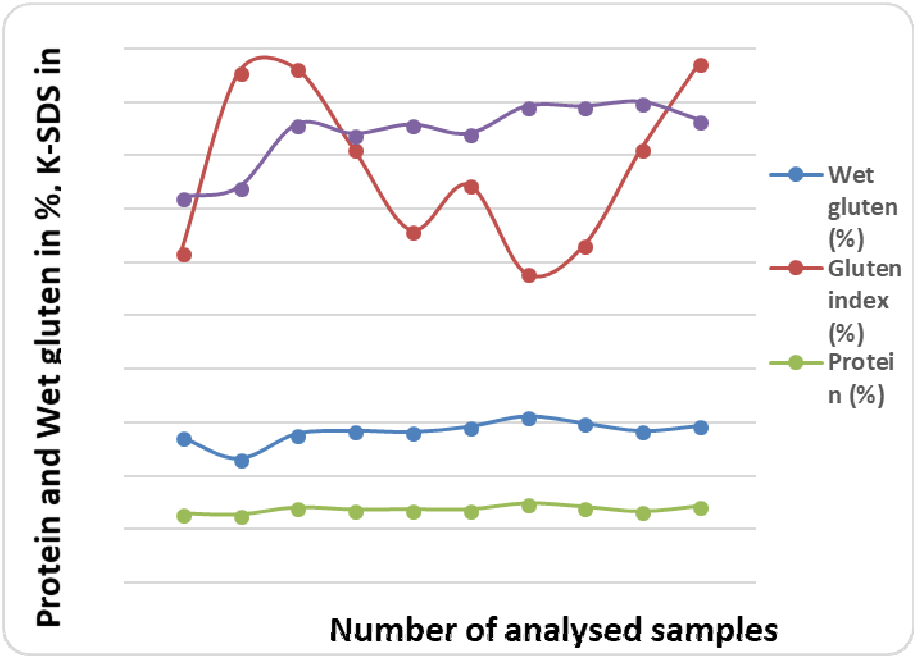

Figure 5. The graphic presentation of the two-year average values of protein, wet gluten, K-SDS values and gluten index, in ten soft wheat lines

4. Conclusions

From the two-year study of chemical-technological indicators and bio-morphological parameters, in ten soft wheat lines of the preliminary sample, the following data were obtained: high values of protein content, gluten index, SDS- sedimentation volume, as well as moderately high levels of wet gluten and dry gluten. Whereas the specific volume of sediment (ratio K-SDS / protein) resulted in optimal values. Statistical results of qualitative and quantitative index values evidenced significant positive correlations between protein and wet gluten, between K-SDS and proteins, as well as between K-SDS and wet gluten. Moreover, a positive correlation was observed between the plant height and the gluten index. The results of two-factor analysis of the variance (ANOVA) without replication for selected quality indicators reveal that there are significant differences for the values of wet gluten across the ten soft wheat lines, and the two observation years. In other words, both the genotype of wheat

and the year of observation are important factors in explaining the observed variation in wet gluten. With regards to the gluten index, we find that the difference in the observed values across the wheat lines is not statistically significant but the year of observation seems to play a significant role in explaining such differences. For the protein indicator, the year of observation does not play a significant role in explaining differences in the observed values for selected wheat lines. Differences across wheat lines play a significant role in explaining differences in K-SDS values but the factor year is not influential. The volume of loaves prepared by blending whole wheat flour, Progres first generation, the Progres elite, with the Oats whole flour "Kamza" in various ratios, as well as only with whole wheat flour, Progres first Generation, Progres elite, separately, resulted in low values. Based on the assessment of the above indicators, it was concluded that the soft wheat lines of the preliminary sample were characterized by optimal qualitative indices and satisfactory quantitative ones. Therefore, we can recommend the inclusion of these lines, in zonal tests of genetic improvement, with the aim of creating new wheat cultivars with optimal qualitative and quantitative indicators.

5. References

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