STUDY OF CHEMICAL AND TECNOLOGICAL PARAMETERS OF SEVERAL COMMON WHEAT (*Triticum aestivum* L) CULTIVARS UNDER KORÇA'S REGION CLIMATE CONDITIONS

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Abstract

The study of chemical and technological parameters of several common or bread wheat (*Triticum aestivum* L.) cultivars was conducted during three consecutive years, 2010-2012, at the Agricultural Technology Transfer Center of Korça. The experimental plot was situated in a uniform flat land with a sloping gradient of 5-6%, 850 m above sea level, on latitude 40°27'- 40°57'N and longitude 21°4'- 20°19'E. A randomized complete block design (RCBD) with 18 common wheat cultivars, introduced from regions with similar climate conditions with Korça or breaded by Albanian researchers, and four replications, with a plot size of 20 m^2 for variant in each replication was used. There was performed a common farmer's agro-technological practice of wheat cultivation, except cultivar. Results showed that all tested cultivars seemed to be suitable for bakery industry, because they contained over 12% protein and 26% gluten, but there were observed significant differences between cultivars for both parameters. Mean crude protein content varied from 12.25% (ATTC 6/1) to 13.07% (I. V. Tabozo), while gluten content varied form 26.03% (ATTC 6) to 28.26% (I. V. Tabozo). Although protein content and gluten content are parameters with high genetic heritability, in 2012, there was observed a higher protein and gluten content for all cultivars under study, compared to other two years (2010-2011), which means that the environmental conditions affected somehow differences for both parameters. There was observed a strong correlation relationship between the 1000 seeds weight (absolute weight - g) and hectoliter weight (kg 100 $liters^{-1}$ volume) for Dajti, Sylvia and Soisons cultivars, as well as for the other cultivars.

Key words: common or bread wheat, cultivar, gluten content, protein content.

INTRODUCTION

Wheat (*Triticum spp*.) is a cereal grain, originally from the Levant region of the Near East and Ethiopian Highlands, cultivated worldwide (Bonjean and Angus, 2001; Belderok *et al.*, 2000; Zohary and Hopf, 2000). In 2010, world production of wheat was 651 million tons, making it the third most-produced cereal, after maize (844 million tons) and rice (672 million tons) (Farmers Weekly, 2013). Wheat is one of the first cereals known to have been domesticated, and wheat's ability to self-pollinate greatly facilitated the selection of many distinct domesticated varieties. Wheat is grown on more than 216 million ha (FAO, 2013), larger than for any other crop. Wheat is the world's major diet component because of the wheat plant's agronomic adaptability with the ability to grow from near arctic regions to equator, from sea level to plains of Tibet, approximately 4000 m above sea level. Common wheat, winter wheat or bread wheat (*Triticum aestivum* L.) is an allohexaploid species (with six sets of chromosomes, two sets from each of three different species) that is the most widely cultivated in the world (Caligari and Brandham, 2001). It was first domesticated in Western Asia during the early Holocene, and spread from there to North Africa, Europe and East Asia in the prehistoric period. The cultivation of common wheat have been dated to between 8600 (at Cayonu) and 8400 BCE (Abu Hureyra), that is, in the Neolithic Period (Ozkan *et al.*, 2002), by 6500 BCE in Greece, Cyprus and India, after 6000 BCE in Egypt, and by 5000 BCE in Germany and Spain (Diamond, 1997). Bread wheat is the most important wheat for human bread. Nutritional value per 100 g grains is 66-71.5 g (or 66-71.5%) carbohydrates, 0.41 g sugars, 12.2 g dietary fibers, 11-14 g proteins, 1.5 g fatty acids, 0.383 mg thiamine (vitamin B1), 0.115 mg riboflavin (vitamin B2), 5464 mg niacin (vitamin B3), 0.954 mg pantothenic acid (vitamin B5), 0.3 mg vitamin B6, 38 µg/100 g vitamin B9(acid folic), 1.01 mg vitamin E, 1.9 µg vitamin K, 29 mg calcium, 3.19 mg iron, 126 mg magnesium, 3985 mg manganese, etc (Belderok *et al.*, 2000). Wheat is widely cultivated as a cash crop because it produces a good yield per unit area, grows well in a temperate climate even with a moderately short growing season, and yields high-quality flour that is widely used in baking (Belderok *et al.*, 2000). In traditional agricultural systems wheat populations often consist of landraces, informal farmer-maintained populations that often maintain high levels of morphological diversity. Although landraces of wheat are no longer grown in Europe and North America, they continue to be important elsewhere. The origins of formal wheat breeding lie in the nineteenth century, when single line varieties were created through selection of seed from a single plant noted to have desired properties. Modern wheat breeding developed in the first years of the twentieth century and was closely linked to the development of Mendelian genetics. The standard method of breeding inbred wheat cultivars is by crossing two lines using hand emasculation, then selfing or inbreeding the progeny. Selections are identified (shown to have the genes responsible for the varietal differences) ten or more generations before release as a variety or cultivar (Bajaj, 1990).

The major breeding objectives of common wheat include high grain yield, good quality, disease and insect resistance and tolerance to abiotic stresses include mineral, moisture and heat tolerance (Heyne, 1987). The major diseases in temperate environments include the following, arranged in a rough order of their significance from cooler to warmer climates: eyespot, *Stagonospora nodorum blotch*, (also known as glume blotch), yellow or stripe rust, Powdery mildew, *Septoria tritici* (known as leaf blotch), brown or leaf rust, *Fusarium head blight*, tan spot, stem rust, and *Helminthosporium leaf blight*. Quality traits, in general, are polygenic traits which, in general, are not environmental dependent. In the bakery technology, gluten is one of the most important flour and bread quality. Wheat proteins contain albumins, globulins, gliadins and glutenins, these four basic proteins depending on their varied solubility in different slovents. Gluten generally contains 75-80% protein which are mostly composed of two proteins, gliadins and glutenins. Gluten gives elasticity to dough, helping it rise and keeps its shape. Wheat gluten has some properties specific to baking quality due to its special amino acid composition and structure. There is one important difference between gliadins and glutenins, that is, gliadins have intra-molecular disulfide linkage while glutenins have both inter- and intra-molecular disulfide linkages. Gliadins are compact and in globular shape, while glutenins are linear. There are four gliadin groups, named α-gliadins, β-gliadins, γ-gliadins and ω-gliadins. Breads, pastas and other grain products are important dietary sources of B vitamins, fiber, iron and other nutrients in the American diet, avoidance of them may increase risk for various nutrient deficiencies (Collins, 2013). Wheat seed storage proteins are made up of about 100 different protein components (Shewry, 2009).

MATERIAL AND METHODS

The study of chemical and technological parameters of several common or bread wheat (*Triticum aestivum* L.) cultivars was conducted during three consecutive years, 2010-2012, at the Agricultural Technology Transfer Center of Korça. The experimental plot was situated in

a uniform flat land with a sloping gradient of 5-6%, 850 m above sea level, on latitude 40°27'-40°57'N and longitude 21°4'- 20°19'E. A randomized complete block design (RCBD) with 18 common wheat cultivars, introduced from regions with similar climate conditions with Korça or breaded by Albanian researchers, and four replications, with a plot size of 20 m2 for variant in each replication was used. There was performed a common farmer's agro-technological practice of wheat cultivation, except cultivar.
During the land preparation, there was used 90 kg ha-1 active matter phosphorus (P_2O_5) and 130 kg ha-1 active matter potassium (K_2O), while, during the vegetative period, was 120 kg ha-1 active matter nitrogen (N).
For each variant and replication, there were weighted the 1000 seeds weight (1000 SW - g) and hectoliter weight (HW - kg 100 liters^{-1} volume). Each variant (cultivar) on each replication was harvested separately and a mean sample of four replications was used for preparing a sample of 1000 g grain for protein and gluten content analysis. Grain analysis for protein content and gluten content were carried out at the Microbiology Lab of the Agriculture Faculty at the University "Fan S. Noli" Korçë.
Absolute weight (1000 seeds weight) (g) was determined by manual counting and weighting using an analytical balance, weighting 100 seeds for 8 replicates, separately.
Hectoliter weight (kg seeds 100 liters-1) was determined by manual weighting of eight grain samples of 1 liter volume and the mean weight was multiplied by 100. Crude (total) protein content was determined on milled wheat samples using international standards (IACST, 2011a). The organic matter of the sample is oxidized with concentrated sulfuric acid in the presence of a catalyst: the product of the reaction $(NH_4)_2SO_4$ is treated by alkali; free ammonia is distilled and titrated.
Gluten content was determined using international standards with a hand-washing method, according to AACC International (AACC International, 2011a; AACC International, 2011b) and IACST (IACST, 2011b; IACST, 2011c). Dough was prepared from a flour sample by adding a buffered sodium chloride solution; the wet gluten was isolated by washing this dough with sodium chloride solution. The residual water adherent to the gluten was removed by centrifugation and the remainder was weighed. Each analysis was done in duplicate.
Differences between cultivars/genotypes and years were confirmed using LSD test and relationship between different characters was tested using correlation coefficient (Papakroni, 2001).

RESULTS AND DISCUSSION

Crude Protein Content (CPC - %)

Observed results showed that all cultivars/genotypes seemed to be suitable for bakery industry, because they contained over 12% protein and 26% gluten. Different cultivars/genotypes differed significantly between each other for crude protein content (CPC - %) and gluten content (GC - %), and differences were also significant from year-to-year, for the same cultivar. Mean values of crude protein content varied from 11.76% (ATTC № 6/1, year 2010) up to 13.81% (I. V. Tabozo, year 2012). Cultivar I. V. Tabozo showed the highest three year mean value for crude protein (13.07%), while ATTC № 6/1 showed the lowest CPC (12.25%). For ATTC № 6/1, a new cultivar/genotype breeded from ATTC Korçë researchers, was observed the lowest difference on crude protein content from year-to-year (Table 1). The data were similar to several previous authors. Kramer (1979) has reported that there exists a considerable variation of protein content of wheat kernels and this variation may be induced by environmental factors, but can also be attributed to genetic differences. *The National Wheat Improvement Committee* (2013), Tokatlidis *et al*., (2004), Kramer (1979), Halloran (1975) have reported that protein content in wheat varies by wheat class, individual variety, fertility levels of the soil and from year-to-year, based on the weather conditions. Casagrande *et al.* (2009) have reported that grain protein content varied by the cultivar, crop nitrogen status, weed density at flowering (showing a positive correlation between grain protein content and both crop nitrogen status and weed density) and climatic factors. A lower water stress increased grain protein content, whereas an increase in the photothermal quotient and daily temperature over 25°C reduced grain protein content. In south-eastern France, grain protein content of organic winter wheat could be increased by improving fertilization management, using an improved baking quality grade cultivar, choosing a legume fodder crop as preceding crop, or by avoiding late sowing dates (Casagrande *et al.*, 2009).

Table 1. Crude protein content (CPC - %) for all cultivars during three years of the study (mean values, different lower superscript letters show significant differences between years for the same cultivar, while the upper superscript letters show significant differences between cultivars for three years mean at $p \leq 0.05$).

№	Cultivar/Genotype	Crude Protein Content (CPC) (%)			3 years mean (µ)
		2010	2011	2102	
1	Dajti	12.22 ^{b}	12.35 ^{b}	13.1 ^{a}	12.56 ^{BC}
2	Sylvia	12.37 ^{b}	12.45 ^{b}	13.4 ^{a}	12.74 ^{B}
3	Rysia	12.45 ^{b}	12.98 ^{a}	13.06 ^{a}	12.83 ^{AB}
4	Soisons	12.21 ^{b}	12.46 ^{b}	13.5 ^{a}	12.72 ^{AB}
5	ATTC № 6	12.29 ^{b}	12.67 ^{a}	12.81 ^{a}	12.59 ^{B}
6	ATTC № 11	12.23 ^{b}	12.39 ^{b}	12.64 ^{a}	12.42 ^{C}
7	ATTC № 15	12.31 ^{b}	12.62 ^{ab}	12.96 ^{a}	12.63 ^{B}
8	ATTC № 16	12.37 ^{b}	12.84 ^{ab}	12.93 ^{a}	12.71 ^{B}
9	ATTC № 22	12.27 ^{b}	12.74 ^{ab}	12.98 ^{a}	12.66 ^{B}
10	ATTC № 23	12.21 ^{b}	12.68 ^{ab}	12.95 ^{a}	12.61 ^{BC}
11	I.V. Tabozo	12.45 ^{c}	12.95 ^{b}	13.81 ^{a}	**13.07 ^{A}**
12	Ajesh x Calves	11.96 ^{c}	12.27 ^{b}	12.65 ^{a}	12.29 ^{D}
13	Virginia 186/2	12.47 ^{c}	12.86 ^{b}	13.05 ^{a}	12.79 ^{AB}
14	ATTC № 5	12.51 ^{c}	12.92 ^{b}	13.06 ^{a}	12.83 ^{AB}
15	ATTC № 6/1	11.76 ^{c}	12.28 ^{b}	12.71 ^{a}	**12.25 ^{D}**
16	ATTC № 9	11.83 ^{c}	12.54 ^{b}	12.87 ^{a}	12.41 ^{C}
17	ATTC № 13	11.92 ^{c}	12.54 ^{b}	12.92 ^{a}	12.46 ^{C}
18	ATTC № 21	12.01 ^{c}	12.57 ^{b}	12.95 ^{a}	12.51 ^{C}
	Mean	12.21	12.62	13.02	12.62 ^{BC}

Different cultivars/genotypes differed significantly between each other for gluten content (GC - %), and differences were also significant from year-to-year, for the same cultivar.
Mean values of gluten content varied from 25.47% (Ajesh x Calves, year 2010) up to 30.1% (I. V. Tabozo, year 2012). Cultivar I. V. Tabozo showed the highest three year mean value for gluten content (28.26%), while ATTC № 6 showed the lowest GC (26.03%), followed by ATTC № 6/1 (26.09%). There was in interesting fact that several newly breeded cultivars/genotypes by researchers of ATTC Korçë showed the lowest difference of gluten content form year-to-year, which mens that these genotypes were very well adapted under climatic conditions of Korça (Table 2).

Table 2. Gluten content (GC - %) for all cultivars during three years of the study (mean values, different lower superscript letters show significant differences between years for the same cultivar, while the upper superscript letters show significant differences between cultivars for three years mean at $p \leq 0.05$).

№	Cultivar/Genotype	Gluten Content (GC) %			3 years mean (μ)
		2010	2011	2102	
1	Dajti	25.93^{c}	27.45^{b}	28.61^{a}	27.33^{AB}
2	Sylvia	26.13^{c}	27.65^{b}	29.05^{a}	27.61^{AB}
3	Rysia	25.56^{c}	26.65^{b}	28.43^{a}	26.88^{B}
4	Soisons	25.86^{c}	27.63^{b}	28.71^{a}	27.40^{AB}
5	ATTC № 6	25.59^{b}	26.07^{a}	26.43^{a}	**26.03^{C}**
6	ATTC № 11	25.72^{b}	26.48^{b}	27.42^{a}	26.54^{BC}
7	ATTC № 15	25.86^{b}	26.79^{b}	29.85^{a}	27.5^{AB}
8	ATTC № 16	26.03^{c}	27.73^{b}	29.64^{a}	27.80^{A}
9	ATTC № 22	25.92^{c}	27.65^{b}	29.71^{a}	27.76^{A}
10	ATTC № 23	25.79^{c}	27.48^{b}	29.32^{a}	27.53^{AB}
11	I.V. Tabozo	26.32^{c}	28.45^{b}	**30.01^{a}**	**28.26^{A}**
12	Ajesh x Calves	**25.47^{c}**	26.89^{b}	28.55^{a}	26.97^{B}
13	Virginia 186/2	25.64^{c}	27.56^{b}	29.69^{a}	27.63^{A}
14	ATTC № 5	25.73^{c}	27.85^{b}	29.61^{a}	27.73^{A}
15	ATTC № 6/1	25.56^{b}	26.04^{a}	26.67^{a}	26.09^{C}
16	ATTC № 9	25.69^{c}	26.89^{b}	28.24^{a}	26.94^{B}
17	ATTC № 13	25.76^{c}	27.58^{b}	28.74^{a}	27.36^{AB}
18	ATTC № 21	25.71^{b}	26.84^{ab}	27.58^{a}	26.71^{BC}
	Mean	25.79	27.20	28.68	27.23

Correlation analysis showed that between crude protein content (%) and gluten content (%) existed a strong positive relationship (r = 0.797), between crude protein content (%) and 1000 seeds weight (g) existed a very strong positive relationship (r = 0.987), and between gluten content (%) and 1000 seeds weight (g) exist a medium strong positive relationship (r = 0.694); while between hectoliter weight (kg 100 liters^{-1}) and 1000 seeds weight (g) and crude protein content and gluten content existed a strong to very strong negative relationship (r = - 0.999, r = -0.992, r = -0.718, respectively) (Table 3).

Table 3. Relationship between the main characters of cultivars/genotypes under study

Characters	*CPC %*	*GC %*	*1000 SW g*	*HW – kg 100 liters^{-1}*
CPC %	1			
GC %	0.797017	1		
1000 SW g	0.987964	0.694003	1	
HW – kg 100 liters^{-1}	-0.99278	-0.71881	-0.99939	1

The observed data were similar to Casagrande *et al.* (2009), Kramer (1979), Johnson and Mattern (1978), Johnson (1976) who have reported that, within a genotype, the correlation between grain yield and grain protein content can be either close to 0, positive or negative, depending on the fertility level, while, between genotypes, this correlation is strongly negative because of the high-harvest index of high yielding varieties.

CONCLUSIONS

All the genotypes under study seemed to be suitable for bakery industry, because they contained over 12% protein and 26% gluten.

Crude protein content (%) and gluten content (%) differed significantly between cultivars and for the same cultivar from year-to-year. Cultivar Tabozo showed the highest three year mean value for crude protein content and for gluten content, by 28.26% and 13.07%, respectively. In 2012, there was observed a higher protein and gluten content for all cultivars under study, compared to other two years (2010-2011), which means that the environmental conditions affected differences for both parameters. There were observed very strong to strong negatively and positively relationship between grain characters for the cultivars/genotypes under study. Several newly breeded cultivars/genotypes by researchers of ATTC Korçë showed the lowest differences of crude protein content and gluten content form year-to-year, which mens that these genotypes were very well adapted under climatic conditions of Korça.

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