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Analysis and Influence of Barley Protein Content for Beer Production in Kosovo

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ABSTRACT
Barley is a plant that occupies an important place in the structure of cultivated plants in Europe. The main use of barley is for brewing beer. Even in Kosovo, the main part of barley production is used in the beer industry. The beer industry in Kosovo produces beer prepared from barley; it is liked by the consumer, not only in Kosovo but also in Albania. Our brewing industry mainly uses locally grown barley. Our farmers have planted the traditional cultivars of barley, but recently and in the future, new cultivars are being introduced, preferring those that give high yields but also with good chemical and technological indicators. The introduction of new cultivars has laid the need for their study, both quantitatively, i.e. for the amount of production per unit of surface area, but also for qualitative indicators. Such a study needs to be undertaken not only because of the new cultivars but also because of the fact that in our country, in our cultivation conditions, there has not been any real study in these directions.

Keywords: food, barley, beer, proteins, food safety.

INTRODUCTION

The main characteristics of the production of malt from barley depend on their chemical composition, which have a direct impact on the quality of beer, these characteristics are controlled genetically, that is, by the cultivar, but also by environmental conditions. Kosovo is estimated to have the area of 413,635 hectares, of which over 5,000 hectares are planted with potatoes in the areas with suitable climatic conditions (Dreshaj et al., 2022).

The productive potential for barley cultivars grown in our conditions is over 8000 kg/ha, which means that, on a national scale, this potential is currently used around 30–40%. The proportion of protein in barley is much less than that in wheat, and its quality is very different. The most important source of cadmium in the air is industrial plants. Other sources of anthropogenic origin include phosphate fertilizers (Dreshaj et al., 2021).

Barley starch, like that of wheat, consists mainly of large and small grains, but the diameter of the largest grains is somewhat larger than that of wheat starch grains. Barley contains yellow, pungent, specifiable butyraceous oil. The effect is attributed to the fermentation of insoluble carbohydrates. In barley, the phenolic acids caffeic, p-coumaric and ferulic can be found in small amounts. The main objective of this study was the analysis of the concentration of metal pollutant deposition in the Dukagjini region (Dreshaj et al., 2022).

Barley (*Triticum aestivum* L.) is grown for many purposes, but most of all barley is used for animal feed, human consumption, or brewing. High protein barley is generally valued for food and forage, and starch production. The percentage of organic carbon and concentration of heavy metals (such as Pb, Cd, Cr and Zn) in soil and plant samples analyzed (Table 1) (Dreshaj et al., 2022).

Table 1. The content of mineral elements in unlulled barley

Designation	Content per 100 g
Calcium	29.0 mg
Iron	2.5 mg
Magnesium	79.0 mg
Phosphorus	221 mg
Potassium	280 mg
Zinc	2.1 mg

MATERIALS AND METHODS

Study area

The experimental evidence was raised in two points (Table 2):

a) on the lands of the Agricultural Institute of Kosovo, in Arbnesh, (Dukagjin Plain) 6 km away from Peja, 488 m above sea level;
b) in Pestovo (Kosovo Plain), 560 m above sea level.

The field trials were set up in three replicates and the barley cultivars in the trial were arranged according to the randomized block method. The area of each variant was 10 m^2 (10 × 1 m). Each variant consisted of 6 rows, with a distance of 11 cm between them. Planting was done with a Hege 80 experimental planter, and the seed was planted at a depth of 3 cm. The first crop was corn in the Peja trial and potato in the Pestovo trial. Fertilization of barley plots was carried out based on the state of nutrients in the soil in both experimental plots. On this basis, the amounts of fertilizers that were used in both areas were calculated with the aim of meeting the needs of barley with the three basic nutrients (nitrogen, phosphorus, potash) for a calculated yield of 6 tons·ha^{-1}. Kosovo's roads are overloaded with a high percentage of old vehicles (Dreshaj et al., 2022). The study continues with the determination of sampling in 10 sampling sites in the Drin I Bardh river, where the municipal wastewater discharge has started (Dreshaj et al., 2022).

RESULTS AND DISCUSSION

The protein content in the grain is proven in both field tests. It is interesting that this year there are differences between the cultivars, comparing the two field trials Eff orts were made to ensure the samples collected were as reliable as possible (Dreshaj et al., 2022). Thus, for example, while in the field test in Peja, the cultivars Bingo with 13.40%, Zlatko with 13.2% and Rex with 13.2% stand out for their higher content of protein in the grain, while in Pestovo the highest value is presented by the cultivars Bingo, with 13.9%, and Rex and Vanessa with 13.8% (Tables 3, 4, 5, 6). The protection of this basin from heavy metal pollution also depends on the quality of the soil, the preservation of essential minerals, and the management of soil erosion (Dreshaj et al., 2022).

The differences between the data are confirmed in both field trials, show the unstable character of the cultivars for the protein content in the grain, keeping in mind. Cultivars are divided into two groups with 3 cultivars for each group, but throughout the three years of the study, only the Esterel cultivar has maintained the lowest values of protein content, which means that this cultivar may be more valuable. for the beer industry. Even the cultivar Vanessa presented in both climatic zones a rather low protein content in the grain. Although water is a renewable resource, misuse and mismanagement of the water system can cause the problems in the quality and security of drinking water (Dreshaj al., 2022).

Starch, as the most important indicator for the beer industry, has more interest to be analyzed. Although in the analysis of the protein content so far we have dealt with the behavior of the cultivars towards the environmental conditions (field test and years), behavior that seems to be influenced by the conditions in the majority of the barley cultivars in the study, it is of interest to analyze the very conditions of the field trial sites and years, taking these factors as primary, as they are responsible for protein content and stability for this indicator.

Table 2. The data of the chemical analyzes of the soil in Peja and Pestovo

Location	pH	$CaCO_3$ (%)	Mineral nitrogen (mg/100 g)		Hummus (%)	Nutrient element (mg/100 g)			
			$N{\cdot}NH_4$	$N{\cdot}NO_3$		P_2O_5	K_2O	Ca	Mg
Peja	5.6	5	0.425	0.375	4.0	15.4	26.8	202.7	15.2
Pestovo	5.9	6	0.820	0.315	3.6	13.2	17.6	360.5	42.0

Table 3. Protein content, Peja and Pestovo

No.	Cultivar	Peja				Pestovo			
		Repetition				Repetition			
		I	II	III	Average	I	II	III	Average
1.	Bingo	13.50	13.40	13.30	13.40a	13.95	13.90	13.85	13.90a
2.	Zllatko	13.30	13.20	13.10	13.2a	13.60	13.40	13.20	13.40b
3.	Vanessa	12.80	12.70	12.60	12.70b	13.90	13.80	13.70	13.80a
4.	Esterel	12.95	12.90	12.85	12.90b	13.30	13.20	13.10	13.20b
5.	Rex	13.30	13.20	13.10	13.20a	13.90	13.80	13.70	13.80a

Table 4. Analysis of variance for protein content, Peja

Source of variation	Degree of freedom	Quadratic sum	Mean squared	„F“ values		
				„F“ Factual	“F” Theoretical	
					0.95	0.99
Variants (V)	4	0.92	0.23	462.00**	3.84	7.01
Repetitions (P)	2	0.08	0.04	81.00**	4.46	8.65
Error (E)	8	0.004	0.0005			
Amounts	14	1.009				

Table 5. Analysis of variance for protein content, Pestovo

Source of variation	Degree of freedom	Quadratic sum	Mean squared	„F“ values		
				“F” Factual	“F” Theoretical	
					0.95	0.99
Variants (V)	4	1.10	0.28	92.00**	3.84	7.01
Repetitions (P)	2	0.12	0.06	20.17**	4.46	8.65
Error (E)	8	0.024	0.003			
Amounts	14	1.249				

The data, which are verified for both field tests, position the cultivar Vanessa in first place with 63.60 percent starch in Peja and the cultivars (Tables 7, 8, 9). This year, the highest starch contents were recorded in Pestovo and the lowest in Peja.

In our study, we also analyzed the fat content, but our data on this indicator are not validated for any field test and study year. So all cultivars in the study years and in both field tests are equal in terms of fat content (Table 10). Of interest is also the examination of the fat content in the grain of barley cultivars in the perspective of the influence of the climatic conditions of the year. Our study data, laid out at the level of years of study, are validated. In the analysis of variance analysis of these data, the years of the study differ greatly between them for the level of fat content. The study concludes that people should be careful in preserving water basins as an indicator of agricultural land quality (Dreshaj et al., 2022).

It is already known that plant food products containing fiber are healthy for those who use them, due to very positive impacts on the protection of human health. We don’t know, we currently have no data on the value of this ingredient in industrialized products, especially in beer products. Anyway, let’s analyze our data on the fiber content of the barley grain of the cultivars we studied.

The fiber content data is not validated even in the case of their presentation in the framework of the countries where the field tests were carried out (Table 11). Thus, the field trials are considered the same in terms of grain fiber content, although the cultivars differ between them (Table 12). The

Table 6. Analysis of variance for protein content by study site

Source of variation	Degree of freedom	Quadratic sum	Mean squared	„F“ values		
				“F” Factual	“F” Theoretical	
					0.95	0.99
Variants (V)	1	0.011408333	0.011408333	3.516267	6.61	16.26
Repetitions (P)	5	0.524451852	0.10489037	32.329224**	5.05	11
Error (E)	5	0.016222222	0.003244444			
Amounts	11	0.552082407				

Table 7. Starch content, Peja and Pestovo

No.	Cultivar	Peja				Pestovo			
		Repeating				Repeating			
		I	II	III	Average	I	II	III	Average
1.	Bingo	60.1	60.1	60.1	60.1b	60.2	60.2	60.1	60.2ab
2.	Zllatko	60.0	60.1	60.1	60.1b	60.6	60.4	60.2	60.4a
3.	Vanessa	60.1	60.1	60.0	60.1b	60.2	60.1	60.0	60.1ab
4.	Esterel	60.4	60.3	60.2	60.3a	60.1	60.1	60.0	60.1b
5.	Rex	60.3	60.2	60.1	60.2ab	60.4	60.3	60.2	60.3a
D_{01}		0.18				0.17			
D_{05}		0.13				0.12			

Table 8. Analysis of variance for starch content, Peja

Source of variation	Degree of freedom	Quadratic sum	Mean squared	„F“ values		
				“F” Factual	“F” Theoretical	
					0.95	0.99
Variants (V)	4	0.1	0.0	6.89*	3.84	7.01
Repetitions (P)	2	0.0	0.0	1.9	4.46	8.65
Error (E)	8	0.036	0.0045			
Amounts	14	0.177333333				

Table 9. Analysis of variance for starch content, Pestovo

Source of variation	Degree of freedom	Quadratic sum	Mean squared	„F“ values		
				“F” Factual	“F” Theoretical	
					0.95	0.99
Variants (V)	4	0.2	0.1	14.75**	3.84	7.01
Repetitions (P)	2	0.1	0.1	12.67**	4.46	8.65
Error (E)	8	0.032	0.004			
Amounts	14	0.369333333				

Table 10. Fat content, Peja and Pestovo

No.	Cultivar	Peja				Pestovo			
		Repeating				Repeating			
		I	II	III	Average	I	II	III	Average
1.	Bingo	1.7	1.6	1.8	1.7	1.6	1.6	1.7	1.6
2.	Zllatko	1.7	1.8	1.8	1.8	1.6	1.7	1.5	1.6
3.	Vanessa	1.7	1.8	1.7	1.7	1.6	1.7	1.6	1.6
4.	Esterel	1.7	1.6	1.7	1.7	1.5	1.5	1.6	1.5
5.	Rex	1.6	1.7	1.6	1.6	1.6	1.6	1.7	1.6

Table 11. Fiber content, Peja and Pestovo

No.	Cultivar	Peja				Pestovo			
		Repeating				Repeating			
		I	II	III	Average	I	II	III	Average
1.	Bingo	4.3	4.5	4.1	4.3	4.3	4.2	4.1	4.2
2.	Zllatko	4.5	4.5	4.5	4.5	4.1	4.2	4.1	4.1
3.	Vanessa	4.3	4.3	4.4	4.3	4.2	4.2	4.1	4.2
4.	Esterel	4.2	4.2	4.3	4.2	4.1	4.2	4.2	4.2
5.	Rex	4.3	4.2	4.2	4.2	4.4	4.3	4.2	4.3

Table 12. Fiber content by study site

No.	Location	Cultivar						Average
		Bingo	Zllatko	Vanessa	Esterel	Rex	Barun	
1.	Peja	4.0	4.1	4.0	3.9	4.0	3.8	4.0
2.	Pestovo	4.0	4.1	4.0	3.9	4.1	3.9	4.0

Table 13. The content of the ashes, Peja and Pestovo

No.	Cultivar	Peja				Pestovo			
		Repeating				Repeating			
		I	II	III	Average	I	II	III	Average
1.	Bingo	1.47	1.41	1.44	1.44ab	1.47	1.41	1.44	1.44a
2.	Zllatko	1.45	1.42	1.42	1.43b	1.45	1.42	1.32	1.40ab
3.	Vanessa	1.37	1.36	1.41	1.38c	1.37	1.36	1.31	1.35b
4.	Esterel	1.49	1.47	1.47	1.48a	1.39	1.37	1.37	1.38ab
5.	Rex	1.45	1.41	1.44	1.43ab	1.45	1.41	1.44	1.43a
D_{01}		0.05				0.09			
D_{05}		0.03				0.06			

fiber content data is only valid when it is put in perspective of the years of study. The analysis of variance in this case classifies the years into two groups that are very different from each other.

Ash is an element that remains after burning, but even so, it occupies a part of the dry matter accumulated in the plant. Therefore, the ash is also analyzed to determine the percentage of dry matter (Table 13).

CONCLUSIONS

Based on observations, biometric measurements, chemical analyzes and our scientific evaluations on plant period indicators, production elements, on quantitative and qualitative production indicators obtained on 6 barley cultivars studied in two field trials and three years.

1. For the features, characteristics and quantitative and qualitative indicators of cultivar production, we make the following scientific generalizations:
   - For the absolute weight (weight of 1,000 grains) cultivars Vanessa, Bingo and Barun had the highest value;
   - For the weight of the ear, the Esterel and Rex cultivars had the lowest values, the other four had the highest weight;
   - The cultivars Zlatko, Barun, Vanessa and Bingo stood out for the highest grain yield;
   - Bingo and Rex cultivars were distinguished for the highest protein content in the grain, while Vanessa and Esterel were distinguished for the lowest content;
   - Rex and Vanessa cultivars were distinguished for the highest starch content.

2. Regarding the influence of the environmental conditions, of the areas where the field tests were carried out, we make the following generalizations:
   - The environmental conditions did not affect the indicators of the chemical content. No statistically proven changes were observed for both protein and starch content;
   - Environmental conditions, represented by the place of cultivation, have also influenced the association of traits.

3. We make the following generalizations about the influence of the climatic conditions of the year:
   - The climatic conditions of the year have also affected the chemical content of the grain, obtaining the highest values of the protein content;
   - Even the correlations between different features or indicators are influenced by the climatic conditions of the country.
   - For high yields, it is more suitable to cultivate the Zllatko, Barun, Vanessa and Bingo cultivars, where the Zllatko cultivar stood out more in the area of Peja and Vanessa in that of Pestova.

If the barley production is to be used for consumption as a food product, the most suitable cultivars are Bingo and Rex. Keeping in mind the high production capacity and high protein content, the most suitable cultivar would be Bingo. If barley production were to be used for the brewing industry, the most suitable cultivars would be Rex and Vanessa. Combining high yielding ability and high starch content, the most suitable cultivar would be Vanessa. In future studies on the influence of active temperatures on the behavior of barley varieties in the conditions of Kosovo, we recommend taking into consideration the active temperature calculated on the base T = 5°C.

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