

THE RESPONSE OF SOME BARLEY VARIETIES (*HORDEUM VULGARE* L.) TO THE CURRENT CLIMATE CONTEXT IN DOBROGEA

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Abstract. Barley (*Hordeum vulgare* L.) is one of the oldest cultivated plants. The research carried out focused on the response of some varieties (varieties) of autumn barley, grown in Dobrogea, on the varieties, from the point of view of the quality standards applied to the breweries. The contribution of the variety (variety) to the formation of the harvest and the determination of its quality, as well as the climate and soil conditions, as well as the application of certain variants of cultivation technology, are taken into account. The quality of barley grains used in the brewing process is regulated by Norms issued by the Ministry of Agriculture and the Ministry of Health. The respective norms establish the maximum content of foreign bodies that the barley harvest intended for beer can have, the maximum content of inert, mineral or organic bodies, the maximum content of weed seeds or seeds of other crop species, defects, attacked seeds, sprouted, moldy or undeveloped. Also, the barley grains used in the brewing process must meet sanitary standards and be food safe. The qualitative indicators are established, as well as the microbiological conditions or the content of toxic substances, residues or contaminants that can affect the health of the consumer. The paper presents an analysis of six varieties of barley (*Hordeum vulgare* L.), present in culture in the Dobrogea region, Romania, with reference to the standards necessary to establish the quality of the harvests for industrialized barley (standards applicable to breweries).), as well as identifying the manifestation of their genetic potential, in the current climate context. Also, the correlations between the obtained yield and each harvest quality index, separately, are presented. The research carried out aimed to determine the quality of autumn barley crops, grown in Dobrogea, established in the 2020-2021 agricultural year, by varieties, from the point of view of the quality standards applied to breweries. It is found that, in the climatic conditions of the agricultural year 2020-2021, malting barley had excellent qualities for breweries, with all varieties analyzed falling within the standards.

Keywords: Barley, brewing barley, quality indicators, harvest, climatic conditions

INTRODUCTION

The content of impurities in the varieties of barley and autumn barley grown in the 2020-2021 agricultural year in Dobrogea varied, on average, around 3.17% (2.9% for the Gabriela variety and 3.5% for the Artemis variety) , from the point of view of the content of impurities, the barley from the analyzed varieties fell into the II grading class, according to SR 13477 - Barley for malt.

The hectoliter weight of the analyzed barley varieties varied, on average, at approximately 69.32 kg/hl (68 kg/hl for the Emerald variety and 71 kg/hl for the Artemis variety). Analyzing the data presented in table 6, corroborated with the data presented in table 3, it follows that, from the point of view of the hectoliter mass, the analyzed varieties fell into grade 1, according to SR 13477 - Barley for malt. However, taking into account the fact that, from the point of view of the results obtained for the "impurities" parameter, it can be assigned Grade I only if it is subjected to conditioning operations.

MATERIAL AND METHODS

In the 2020-2021 agricultural year, observations were made on the climatic conditions as well as determinations on the production and quality of the fall common barley and barley harvest, from crops established in Tulcea County and within the Constanța County. The following varieties of barley and fall barley crops were harvested:

- Amethyst – fall barley
- Symbol – fall barley
- Emerald – fall barley
- Artemis – fall common barley
- Diana – fall common barley
- Gabriela – fall barley

Table 1

Average annual temperatures and average annual precipitation recorded at the Constanța weather station, in the 1961-2021 period (according to meteoromania)

Month	Average Temperature °C	Average precipitation mm
September	18.7	36.4
October	13.5	37.6
November	8.2	42.0
December	3.2	39.2
January	1.0	33.6
February	2.2	28.1
March	5.4	32.3
April	10.4	31.1
May	16.1	41.7
June	20.7	41.0
July	22.9	35.8
		Total precipitation during the barley vegetation period 398.8 mm

In barley and fall common barley, the following quality parameters were monitored:

- Impurity content
- Weight of 1000 grains
- Hectoliter weight
- Starch content

- Protein content
- Moisture content
- Obtained productions

Table 2

Average annual temperatures and average annual precipitation recorded at the Constanța weather station, between September 2019 and July 2021 (processing according to the statistical yearbook of Constanța county)

Month	Average Temperature °C	Average precipitation mm
September 2019	20.6	66.6
October 2019	15.1	39.0
November 2019	12.9	8.7
December 2019	7.0	18.6
January 2020	3.2	1.7
February 2020	6.4	28.9
March 2020	8.9	15.6
April 2020	10.7	3.8
May 2020	16.0	15.3
June 2020	21.1	55.5
July 2020	24.6	28.9
		Total precipitation during the barley vegetation period 282.6 liters/m ²

The quality determinations were carried out both in the field and in the Agrochemistry laboratory within the Faculty of Natural and Agricultural Sciences. Regarding the sum of the temperature degrees required for barley to reach maturity, for the conditions in Romania, it varies between 1300 - 1800 ° C for spring barley and between 1700 – 2100 °C for fall barley. For the analyzed period, the weather data are presented in table 1 and table 2.

Table 3

Physical and chemical properties of beer barley

Properties	ELIGIBILITY CONDITIONS
Foreign Bodies, % Maximum	4
Humidity, % Maximum	14
Grains Larger Than 2.5, % Minimum	82
Germination Energy (After 72 Hours), % Minimum	92
Viability, % Minimum	95
Protein Substances, % Maximum	12
Pest Infestation	Inadmissible
Deposits (Live Examples)	
Variety Purity, % Minimum	90

RESULTS AND DISCUSSIONS

The following results were obtained for the analyzed barley and common barley varieties:

Results obtained regarding the content of impurities in the varieties of barley and fall barley grown in the 2020-2021 agricultural year

Table 4

The impurities content in the barley and fall barley varieties grown in the 2020-2021 agricultural year

Variety	Impurities content (%)
Amethyst	3
Symbol	3.1
Emerald	3.3
Artemis	3.5
Diana	3.2
Gabriela	2.9
Average	3.17

The impurities content in the of barley and fall barley varieties grown in the 2020-2021 agricultural year in Dobrogea varied, on average, around 3.17% (2.9% for the Gabriela

variety and 3.5% for the Artemis variety). Analyzing the data presented in Table 4, corroborated with the data presented in table 3, it results that, from the point of view of the content of impurities, barley and fall barley from crops established in the agricultural year 2020-2021 in Dobrogea fell into Grade II grading, according to SR 13477 – Barley for malt.

Results obtained regarding the weight of 1000 grains in the barley and fall barley varieties grown in the 2020-2021 agricultural year

Table 5

Mass of 1000 grains
of barley and fall barley varieties in the 2020-2021 agricultural year

Variety	Mass of 1000 grains g
Amethyst	53.6
Symbol	49.5
Emerald	47.5
Artemis	52.0
Diana	51.6
Gabriela	51.8
Average	51

The mass of 1000 grains of barley and fall spelt grown in the 2020-2021 agricultural year in Dobrogea varied, on average, to around 51 grams (47.5 g for the Emerald variety and 53.6 for the Amethyst variety). Analyzing the data presented in table 5, corroborated with the data presented in table 3, it follows that, from the point of view of the mass of 1000 grains, the barley and fall barley from crops established in the agricultural year 2020-2021 in Dobrogea fell into the category "large, healthy grains, thin shell", according to the grading manual, and according to SR 13477 - Barley for malt.

Results obtained regarding the hectoliter mass of barley and fall barley varieties cultivated in the 2020-2021 agricultural year

The hectoliter mass of barley and fall barley varieties grown in the 2020-2021 agricultural year in Dobrogea varied, on average, to around 69.32 kg/hl (68 kg/hl for the Emerald variety and 71 kg/hl for the Artemis variety). Analyzing the data presented in table 6, corroborated with the data presented in table 3, it results that, from the point of view of hectoliter mass, barley and fall barley from crops established in the 2020-2021 agricultural year in Dobrogea fell into Grade I , according to SR 13477 – Barley for malt. However, taking into account the fact that,

from the point of view of the results obtained for the "impurities" parameter, it can be assigned to Grade I only if it is subjected to conditioning operations.

Table 6

Hectoliter mass
of barley and fall barley varieties cultivated in the 2020-2021 agricultural year

<i>Variety</i>	<i>Hectoliter mass (Kg/hl)</i>
Amethyst	68.1
Symbol	69
Emerald	68
Artemis	71
Diana	70
Gabriela	69.8
Average	69.32

Table 7

Starch content
of barley and fall barley varieties grown in the 2020-2021 agricultural year

Variety	Starch content %
Amethyst	62.4
Symbol	63.1
Emerald	64.2
Artemis	60.1
Diana	60.0
Gabriela	60.2
Average	61.67

Results obtained regarding the starch content of barley and fall barley varieties grown in the 2020-2021 agricultural year

The starch content of the barley and fall barley varieties grown in the 2020-2021 agricultural year in Dobrogea varied, on average, to around 61.67% (60.0% for the Diana variety and

64.2% for the Emerald variety). Analyzing the data presented in table 7, corroborated with the data presented in table 3, it results that, from the point of view of starch content, in barley and fall barley from crops established in the 2020-2021 agricultural year in Dobrogea, the starch content was, at all analyzed varieties, over 60%, according to standards.

Results obtained regarding the protein content of barley and fall sorghum varieties grown in the 2020-2021 agricultural year

Table 8

Protein content
of barley and fall sorghum varieties grown in the 2020-2021 agricultural year

Variety	Protein content %
Amethyst	11.8
Symbol	9.6
Emerald	9.5
Artemis	11.9
Diana	11.6
Gabriela	11.8
Average	11.03

The protein content of the autumn barley and fall barley varieties grown in the 2020-2021 agricultural year in Dobrogea varied, on average, to around 11.03% (9.5% for the Emerald variety and 11.9% for the Artemis lasso). Analyzing the data presented in table 8, corroborated with the data presented in table 3, it follows that, from the point of view of protein content, barley and fall barely from crops established in the 2020-2021 agricultural year in Dobrogea are suitable for beer production, according to SR 13477 - Barley for malt - which stipulates that the protein in the grain must be below 12% (9.5-11.5% for quality malts).

Results obtained regarding the moisture content of barley and fall barley varieties grown in the 2020-2021 agricultural year

The moisture content of barley and fall varieties grown in the 2020-2021 agricultural year in Dobrogea varied, on average, around 11.52% (11.3% for Emerald and Gabriela varieties and 11.8% for the Amethyst variety). Analyzing the data presented in table 9, corroborated with the data presented in table 3, it follows that, from the point of view of moisture content, barley and fall barley from crops established in the 2020-2021 agricultural year in Dobrogea are suitable for beer production, according to SR 13477 – Barley for malt (moisture content must be below 14%).

Table 9

Moisture content
of barley and fall barley varieties grown in the 2020-2021 agricultural year

Variety	Moisture content %
Amethyst	11.6
Symbol	11.8
Emerald	11.3
Artemis	11.6
Diana	11.5
Gabriela	11.3
Average	11.52

Table 10

Productions obtained from the varieties of barley and autumn barley grown
in the 2020-2021 agricultural year

Variety	Productions (Kg/ha)
Amethyst	4250
Symbol	4050
Emerald	4300
Artemis	3800
Diana	3700
Gabriela	3750
Average	3975

Results obtained regarding the productions obtained from the varieties of barley and autumn barley grown in the 2020-2021 agricultural year

The productions obtained from the autumn barley and fall barely varieties cultivated in the 2020-2021 agricultural year in Dobrogea varied, on average, to around 3950 kg/ha (3700 kg/ha for the Diana variety and 4800 kg/ha for the Emerald variety). Analyzing the data presented in table 10, it is found that the productions of barley and fall barley obtained from crops established in the 2020-2021 agricultural year in Dobrogea are higher than the average in the

Constanța and Tulcea counties. We note that the samples for analysis came from agricultural companies that apply modern technologies, and the administrators have specialized studies. For analysis, three samples were collected for each variety, and tables 4-10 show the averages resulting from the analysis of the three samples, for each variety.

Table 11

Synthesis of the results obtained for the barley and fall barley varieties analyzed from the harvest of the 2020-2021 agricultural year in Dobrogea

Variety	Impurities content (%)	Mass of 1000 grains	Hectoliter mass Kg/hl	Starch content %	Protein content %	Moisture content %	Productions
Amethyst	3	53.6	68.1	62.4	11.8	11.6	4250
Symbol	3.1	49.5	69	63.1	9.6	11.8	4050
Emerald	3.3	47.5	68	64.2	9.5	11.3	4300
Artemis	3.5	52.0	71	60.1	11.9	11.6	3800
Diana	3.2	51.6	70	60.0	11.6	11.5	3700
Gabriela	2.9	51.8	69.8	60.2	11.8	11.3	3750
Average	3.17	51	69.32	61.67	11.03	11.52	3975

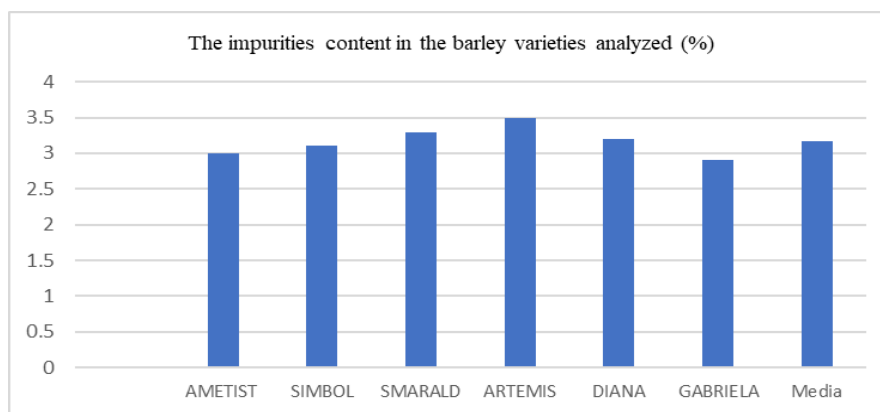


Figure 1. The impurities content in the barley varieties analyzed (%)

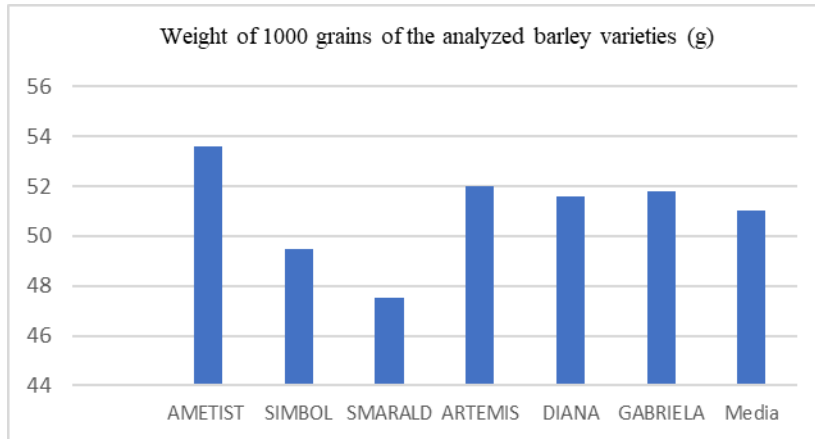


Figure 2. Weight of 1000 grains of the analyzed barley varieties (g)

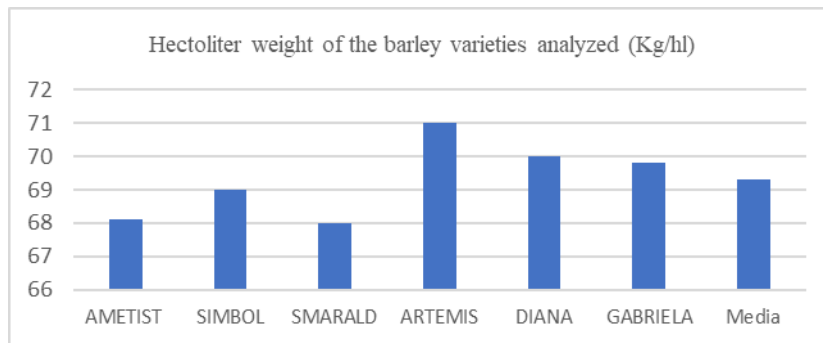


Figure 3. Hectoliter weight of the barley varieties analyzed (Kg/hl)

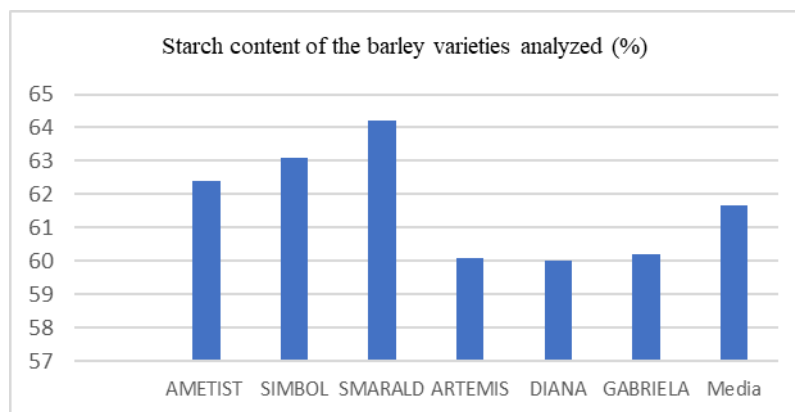


Figure 4. Starch content of the barley varieties analyzed (%)

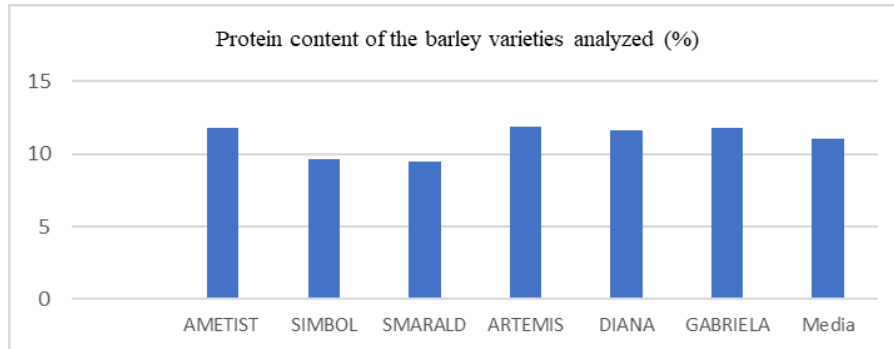


Figure 5. Protein content of the barley varieties analyzed (%)

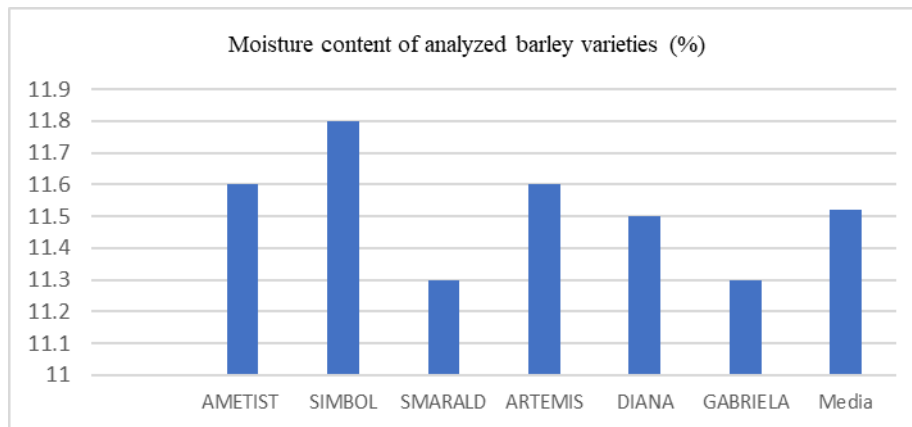


Figure 6. Moisture content of analyzed barley varieties (%)

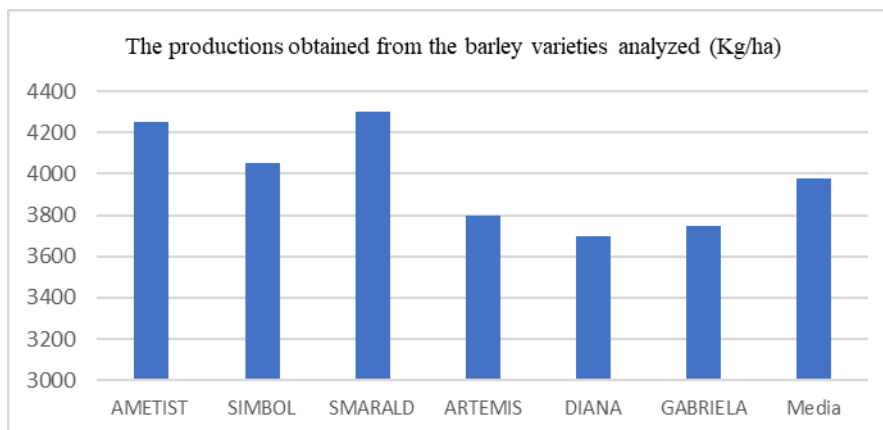


Figure 7. The productions obtained from the barley varieties analyzed (Kg/ha)

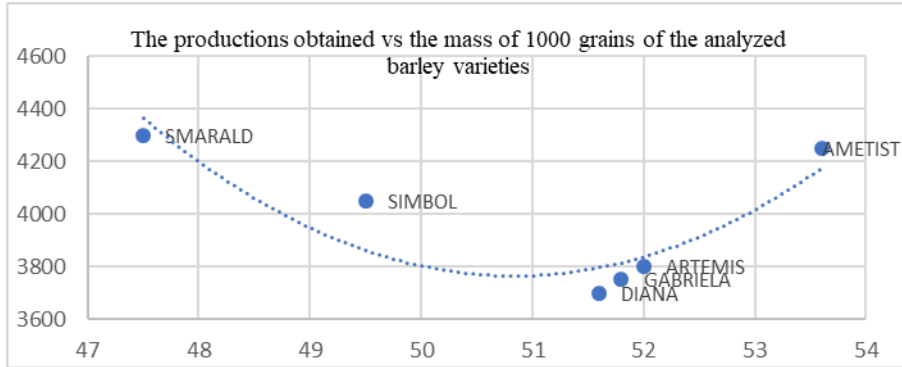


Figure 8. The productions obtained vs the mass of 1000 grains of the analyzed barley varieties

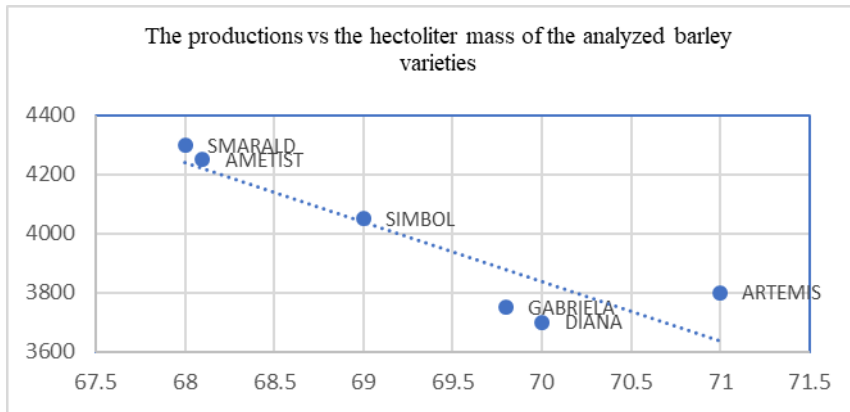


Figure 9. The productions vs the hectoliter mass of the analyzed barley varieties

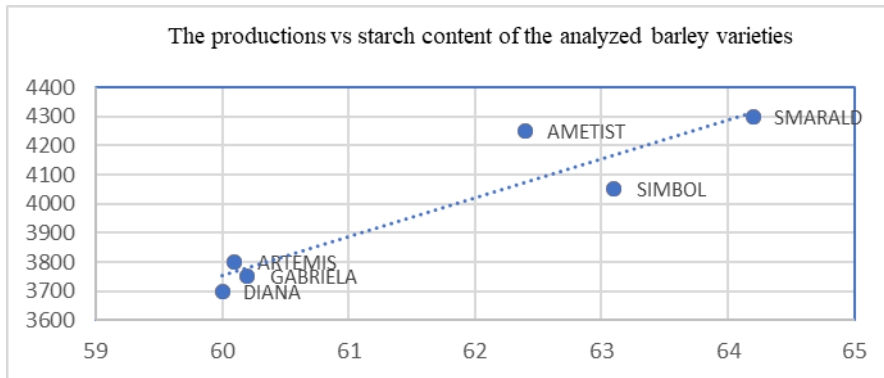


Figure 10. The productions vs starch content of the analyzed barley varieties

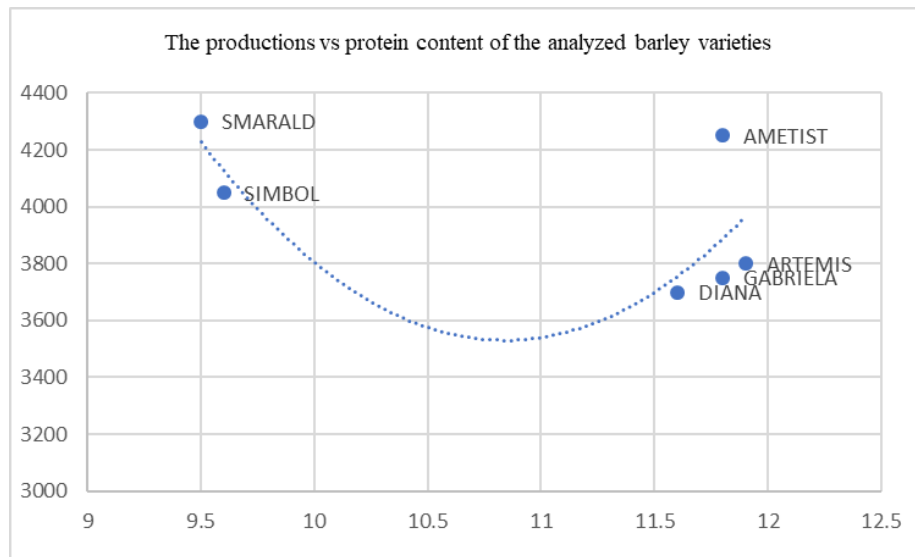


Figure 11. The productions vs protein content of the analyzed barley varieties

CONCLUSIONS

The quality of barley grains used in the brewing process is regulated by Norms issued by the Ministry of Agriculture and the Ministry of Health. The respective norms establish the maximum content of foreign bodies that the barley harvest intended for brewing beer can have, the maximum content of inert, mineral or organic bodies, the maximum content of weed seeds or seeds of other crop species, defective, attacked seeds, sprouted, moldy or undeveloped.

Also, the barley grains used in the brewing process must meet sanitary standards and be food safe. Qualitative indicators are established, as well as microbiological conditions or content of toxic substances, residues or contaminants that may affect consumer health.

The paper presents the standards required for establishing the quality of barley harvests intended for industrialization, with reference to the standards applicable to breweries, as well as determinations of quality indices for some varieties of barley and fall barley in Dobrogea. The research carried out was aimed at determining the quality of the autumn barley and sorghum crops, grown in Dobrogea, established in the 2020-2021 agricultural year, by variety, from the point of view of the quality standards applied to the breweries.

It is found that, in the climatic conditions of the agricultural year 2020-2021, malting barley had excellent qualities for breweries, with all varieties analyzed falling within standards.

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