

EXPERIMENTAL RESULTS ON COMMON WHEAT GRAINS QUALITY PRODUCED IN ORGANIC FARMING

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Abstract

Consumer demand for the quality of agricultural products has grown constant in recent decades, representing a set of particularities: hygiene (or sanitary), nutritional and dietetic, organoleptic, use (ease of preparation and preservation), regulatory (compliance with the rules in force), commercial. The quality of an organic product must meet all these requirements and is subject to strict regulations regarding the conditions of production, processing and marketing. In this context, the present paper presents the results of the quality analyses performed on the common wheat produced in organic farming in Romania, regarding: the content in pesticide residues, nitrates and nitrites, mycotoxins, as well as the nutritional quality (content in carbohydrates, proteins, lipids, ash, fibres, energy value). The results illustrated the absence of toxic compounds and that this product meets the requirements of FAO quality standards in terms of biochemical components and nutritional value.

Key words: wheat, organic farming, grain quality.

INTRODUCTION

The development of agriculture in the second half of the XXth century resulted in a considerable increase of agri-food production, so that they began to meet the consumption needs of human collectives, in economically developed countries in Europe and North America. As a result, since the 8th decade of the century, the demands of consumers in these countries have increased towards the quality of agri-food products, while intensifying concerns about diminishing the negative effects of agricultural activities on the environment (Roman et al., 2011). These trends led to the initiation and development of new concepts regarding agricultural production systems and the formulation of stricter regulations regarding the quality of agri-food products (Nastase and Toader, 2016). Compared to the intensive agricultural production system, based on the mechanization and chemization of technologies, the new concepts regarding agricultural production systems - called *sustainable, conservative, organic farming* - promoted the limitation or even prohibition of the use of chemical fertilizers and synthetic

pesticides, in order to reduce the polluted impact on the environment and the quality of agricultural products.

Among the new concepts, organic farming has undergone an important evolution, especially in economically developed countries, and for organic products has developed its own market, which is currently in full development (Nastase et al., 2018). The organic production system is regulated by very strict laws and directives, issued by national, regional and global authorities, who concern the whole chain, from the production processes, to the processing and marketing of products. In Romania, the organic farming system has developed considerably in the last decades and is regulated by decisions issued by national and European Union authorities (Roman et al., 2015).

For this purpose, there are control and certification bodies for operators in organic farming, which operate under the authority of the Ministry of Agriculture and Rural Development.

The operators - the economic agents that work in this field - are registered in the official records and are permanently monitored in compliance with the legal provisions in force, and the organic products are compulsory

analyzed in terms of quality, with priority of the content in pesticide residues.

The present paper presents the results of the quality analyzes performed at the common wheat crops (wheat for bakery) produced in organic farms on the territory of Romania, in 2016 and 2017. The nutritional value (the contents in biochemical compounds and the energy value) were analyzed, as well as and the contents in compounds with potentially negative effect on product quality - pesticide residues, nitrites, nitrates and mycotoxins.

MATERIALS AND METHODS

There were analyzed samples of common wheat (wheat for bakery) produced in certified organic crops, taken from important areas of winter wheat cultivation on the territory of Romania. The paper presents the results obtained by analyzing the wheat samples from the organic crops from Meadows of Prut River (Vaslui County), Tecuci Plain (Galati County), Gavanu-Burdea Plain (Teleorman County), Balacitei Plain, south of the Getic Plateau (Dolj County), Arad Plateau (Arad County), Barcau Valley (Bihar County) (Figures 1 and 2). The sampling for the analyzes was carried out in accordance with the regulations in force (Standard SR EN ISO/IEC 17065:2013 and Regulations (EC) 834/2007 and 889/2008), specific to organic farming (Figure 3). The quality analyzes were performed in specialized and accredited laboratories, from Germany and Bulgaria.



Figure 1. Organic winter wheat in Bihor County, 2016



Figure 2. Organic winter wheat at harvesting, in Bihor County, 2017



Figure 3. Samples of wheat grains for analysis

The following methods of analysis were used to determine the nutritional value (content in biochemical compounds): for *carbohydrates* - High Performance Liquid Chromatography (HPLC) with RI detection (refractive index); for *proteins* - Dumas Method; for *lipids* - Nuclear Magnetic Resonance Method - MRI; for *mineral substances* - Gravimetric method; for *food fibers* - Enzymatic method; for *dry matter* - by drying in the oven. Based on the results of these analyzes, the *nutritional value* was calculated, using the relation:

$W = P (g) \times 4.1 (kcal/g) + L (g) \times 9.3 (kcal/g) + G (g) \times 4.1 (kcal/g)$, in which: P = proteins content; L = lipids content; G = carbohydrates content.

To recalculate the results in joule, the relationship was used:

$$1 \text{ kcal} = 4.18 \text{ joule}$$

Also, the *lipid energy* was calculated, starting from the fact that 1 g of lipids generates 9.3 kcal.

The presence of *pesticide residues* was analyzed according to Standard EN 15662: 2008 ("Foodstuffs of vegetable origin. Determination of pesticide residues by GCMS and/or LC-MS/MS after extraction/separation of acetonitrile and cleaning by SPE dispersion-QuEChERS method"), elaborated by the EU.

The content of *mycotoxins* was analyzed by High Performance Liquid Chromatography (HPLC) with UV detection (PDA detector), with purification on the immunoaffinity column. The content of *nitrites and nitrates* was analyzed by High Performance Liquid Chromatography (HPLC) with UV detector.

RESULTS AND DISCUSSIONS

The nutritional value of common wheat produced under ecological conditions. The moisture content of the wheat samples analyzed (Tables 1 and 2) was on average 11.15% and 12.16%, respectively, values at which good conditions for the conservation of the crops are ensured. In one case, a slightly higher humidity of 13.90% was found in 2016, in Bihor County.

The analysis of the obtained results shows that, in all cases, the protein content exceeded the value of 11% - minimum admitted to the wheat for baking. The average values were 12.59% in 2016 and 13.03% in 2017.

It should be noted that, in 2016 - a favorable year for autumn wheat crops in terms of natural conditions - the organic wheat harvested in Galati and Arad Counties contained 13.70 to 13.71% proteins.

The other biochemical compounds (Figure 4) analyzed were within the normal limits for wheat for baking. Specifically, the analyzes revealed for **carbohydrates** contents of 65.65% on average, with variations between 60.10 and 67.44% in 2016 and of 66.22%, on average, with variations between 65.10 and 67.11% in 2017.

Table 1. The nutritional value of common wheat grains produced under organic agriculture conditions in 2016

No. crt.	Biochemical compound	U.M.	Region of organic wheat production						Average
			North-East (Vaslui County)	South-East (Galați County)	South (Teleorman County)	South-West (Dolj County)	West (Arad County)	North-West (Bihor County)	
1.	Carbohydrates	g/100 g	66.45	67.44	65.80	67.32	66.78	60.10	65.65
2.	Proteins	g/100 g	12.66	13.70	12.60	11.06	13.71	11.80	12.59
3.	Lipids	g/100 g	1.32	1.23	1.83	1.22	1.42	1.73	1.46
4.	Mineral Substances (Ash)	g/100 g	1.47	1.47	1.56	1.46	1.88	1.70	1.59
5.	Dietary Fibers	g/100 g	1.34	1.33	2.10	2.65	2.54	1.80	1.96
6.	Dry Matter	g/100 g	88.81	87.90	87.90	88.43	87.90	86.10	87.84
7.	Water	g/100 g	11.19	12.10	12.10	11.57	12.10	13.90	12.16
8.	Nutritional value	Kj/100 g	1388	1438	1451	1438	1435	1370	1420
9.		Kcal/100 g	332	344	338	333	343	328	336
10.	Lipid Energy	Kj/100 g	51	48	71	47	55	64	56
11.		Kcal/100 g	12	11	17	11	13	15	13

Table 2. The nutritional value of common wheat grains produced under organic agriculture conditions in 2017

No. crt.	Biochemical compound	U.M.	Region of organic wheat production			
			North-East (Vaslui County)	West (Arad County)	North-West (Bihor County)	Average
1.	Carbohydrates	g/100 g	66.45	67.11	65.10	66.22
2.	Proteins	g/100 g	11.56	13.73	13.80	13.03
3.	Lipids	g/100 g	1.32	1.22	1.73	1.42
4.	Mineral Substances (Ash)	g/100 g	1.47	1.51	1.80	1.59
5.	Dietary Fibers	g/100 g	1.34	2.04	1.80	1.72
6.	Dry Matter	g/100 g	88.81	88.94	88.79	88.85
7.	Water	g/100 g	11.19	11.06	11.21	11.15
8.	Nutritional value	Kj/100 g	1388	1433	1421	1414
9.		Kcal/100 g	332	343	340	338
10.	Lipid Energy	Kj/100 g	51	47	67	55
11.		Kcal/100 g	12	11	16	13

Lipids represented 1.46% on average in 2016, with variations between 1.22 and 1.85%, and 1.42% on average in 2017, with variations between 1.22 and 1.73%.

The content in **mineral substances** (ash) was on average 1.59% in both years, with variations between 1.46 and 1.88% in 2016, and between 1.47 and 1.80% in 2017.

Fibers represented 1.96% on average in the case of organic wheat harvested in 2016 (variation limits 1.33-2.65%) and 1.72% in 2017 (variation limits 1.34-2.04%).

The calculations regarding the **nutritional value** of the products harvested in the organic crops analyzed in 2016 revealed values of 1370-1451 kJ/100 g, on average 1420 kJ/100 g or 328-344 kcal/100 g, on average 336 kcal/100 g.

In the second experimental year (2017), the values resulting from the calculations were 1388-1433 kJ/100 g, on average 1414 kJ/100 g, or 332-340 kcal/100 g, on average 338 kcal/100 g.

The **lipid energy** of the organic wheat harvested in 2016 was 47-71 kJ/100 g on average 56 kJ/100 g or 11-17 kcal/100 g on average 13 kcal/100 g in 2016. In 2017, the values results of calculation for lipid energy were similar, namely 55 kJ/100 g, with variations between 47 and 67 kJ/100 g or 13 kcal/100 g, with variations between 11 and 16 kcal/100 g.

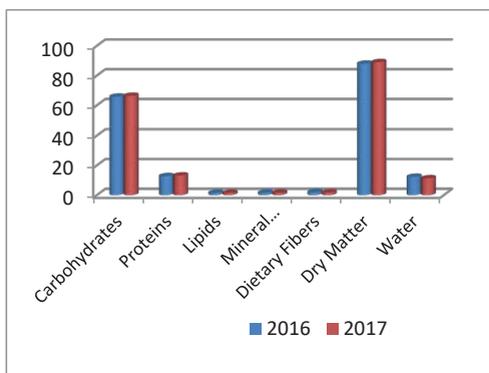


Figure 4. Biochemical compounds of organic winter wheat, on period 2016-2017 (%)

Analyzing the presence of **pesticide residues** from organic wheat samples is very important because their absence from the harvest is an essential condition to enable the use of organic

products on a specific market. The analysis of the obtained results showed that in all cases (Table 3), the presence of pesticide residues in the studied wheat samples was not reported, which reflects the correctness of the technologies applied by organic farmers.

Also, the analysis of the contents of the organic wheat samples in **nitrites** and **nitrates** have relevant absence of these compounds in most cases. In two cases, in 2016, the analyzes reported the presence of nitrite content of 6.6 mg/kg in Arad County and 5.1 mg/kg in Bihor County, which exceeded the maximum allowed limit of 1.0 mg/kg (Table 4).

Table 3. Results of analyzes on the pesticide residues content of wheat grains produced under organic conditions

Substances residues	2016	2017	Maximum permissible limit for products conventional (Regulation (EC) No 396/2005)
Glyphosat+Glufosynat	None product detected	None product detected	0.01 mg/kg
Acid aminomethylphosphoric			0.01 mg/kg
Chlormequat			0.01 mg/kg
Mepiquat			0.01 mg/kg

Table 4. Results of analyzes on the nitrate and nitrite content of wheat grains produced under ecological conditions

Compound	Production region of wheat	2016	2017	Maximum allowable limit for conventional products (Directive 91/676 / EEC and Reg. (EC) no. 396/2005)
Nitrite	West (Arad County)	6.6 mg/kg	No nitrites were detected in the others samples analyzed	1.0 mg/kg
	North-West (Bihor County)	5.1 mg/kg		
Nitrate	All regions analyzed	No nitrates were detected in the samples analyzed		50 mg/kg

The analysis of the causes revealed that, on the respective surfaces, organic fertilizers administered and the high fertility of the respective lands determined nutrition with

excess nitrogen. The respective products were directed to other non-food uses; at the same time, recommendations were made to avoid excess nitrogen nutrition in the future.

The analysis of **mycotoxins** contents was also considered a priority of the research carried out because, in the absence of treatments with synthetic chemicals for the control of pathogens, it is considered that there is a danger of occurrence, in the organic crops, as well as on the storage-processing chains-commercialization of some pathogens-microorganisms - phytopathogens or epiphytes (mold fungi) - that lead to contamination of the products with mycotoxins.

Table 5. Results of analyzes on the mycotoxin content of wheat grains produced under organic conditions

Compound	Production region of wheat	2016	2017	Maximum allowable limit for conventional products (Directive 91/676/CEE), Reg.(EC) 396/2005)
Deoxynivalenol (DON)	North-Wwest (Bihor County)	146 $\mu\text{g}/\text{kg}$	No compounds were detected in the other organic crops analyzed	750 $\mu\text{g}/\text{kg}$
Aflatoxin B ₁	No compounds were detected in the other organic simples analyzed			2 $\mu\text{g}/\text{kg}$
Aflatoxin B ₁ +B ₂ +G ₁ +G ₂				4 $\mu\text{g}/\text{kg}$
Fumonisin B ₁ +B ₂				1900 $\mu\text{g}/\text{kg}$

The analysis of mycotoxins contents from the organic wheat produced in different areas on the Romanian territory in 2016 and 2017 did not reveal the presence of mycotoxins. In one case, in 2016 at an organic wheat sample from Bihor County, a content of deoxynivalenol (DON) of 146 $\mu\text{g}/\text{kg}$ was found, but does not exceed the maximum allowed limit of 750 $\mu\text{g}/\text{kg}$ (Table 5). As a result, the respective product was directed to consumption in human nutrition.

CONCLUSIONS

Research conducted in 2016 and 2017 on the quality of common wheat crops (wheat for bakery) produced in organic agriculture conditions revealed the superior quality of the

crop in terms of nutritional value, as well as the absence of compounds that can negatively influence the quality of the harvest.

In terms of nutritional value, the average contents were as follows: 87.84-88.85% dry matter, 65.65-66.22% carbohydrates, 12.59-13.03% protein, 1.42-1.48% lipids, 1.59% mineral substances, 1.72-1.96% dietary fibers. The nutritional value was 1414-1420 kJ/100 g or 336-338 kcal/100 g and the lipid energy of 55-56 kJ/100 g or 13 kcal/100 g. These values correspond to the recommendations for wheat intended for baking.

The analyzes carried out are relevant, in all cases, the absence of pesticide residues from organic wheat produced in Romania, which illustrates that the recommendations regarding the technologies of cultivation of organic wheat have been respected.

Also, the analyzed samples, with two exceptions, did not contain nitrites and nitrates or mycotoxins. In two cases, nitrite contents resulted above the allowed limits; the origin of which was determined by the high fertility of the lands on which the wheat was grown, as well as the application of high doses of organic fertilizers.

The presence of mycotoxins (deoxynivalenol) was found in only one case, in 2016 at an organic wheat crop produced in Bihor County. This indicates a *Fusarium* attack, but the determined values are well below the maximum limits allowed for wheat intended for baking.

Following the research carried out, it can be concluded that the wheat produced in 2016 and 2017 in the organic crops from the main cultivation areas in Romania meets higher quality conditions and is not contaminated with compounds that diminish their quality.

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