Proximate and Mineral Composition of Selected Cereal Genotypes in Western Region of Romania

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ABSTRACT

Cereal and legume grains are fundamental components of human and animal diets due to their high protein, fiber, and mineral contents. Understanding the chemical and nutritional composition of different genotypes is essential for improving food quality and guiding breeding programs. This study aimed to evaluate the chemical and mineral composition of cereal and legume genotypes, including 23 wheat, 7 triticale, 4 barley, 7 oat, and 14 soybean samples. The genotypes were cultivated in the western region of Romania at two experimental locations: the Agricultural Research and Development Station Turda, and the Agricultural Research and Development Station Lovrin. Soybean and oat exhibited the highest mean protein and fiber contents, while soybean showed the highest fat concentration. Carbohydrates accounted for approximately 70% of the total composition in all analyzed samples, except for oat and soybean. Regarding mineral composition, soybean displayed the highest levels of both micro- and macroelements, with the exception of manganese and lead. The highest manganese concentrations were observed in wheat, triticale, and oat. Samples cultivated at the Lovrin station generally exhibited slightly higher chemical and mineral contents compared to those from the Turda station. These findings provide valuable information for identifying cereal and legume genotypes with high nutritional value, which can be prioritized in breeding programs and human nutrition applications.

Keywords: cereals, legumes, crop genotypes, proximate composition, mineral composition, nutritional quality.

INTRODUCTION

Cereals have long been acknowledged as a fundamental component of the human diet. This group encompasses a wide range of grains, including wheat, durum wheat, maize, oats, rice, rye, barley, and sorghum, and accounts for approximately two-thirds of global human food intake. Cereals constitute a major source of energy and bioactive compounds with nutritional and health-promoting properties; therefore, the development of cereal-based foods with enhanced characteristics depends on the use of genetic resources possessing high levels of endogenous nutrients and phytochemicals (Borrelli and Ficco, 2025). In 2024, global wheat production reached 798.481 million hectares, according to FAO statistics (https://www.fao.org/faostat/en/#data/QCL/visualize). The top three wheat-producing countries were China (140 million tonnes), India (113,292 million tonnes), and Russia (82,588 million tonnes).

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops worldwide and a primary source of dietary energy for a large proportion of the global population. Wheat grain exhibits a complex chemical composition, comprising starch as the predominant component, together with storage proteins (gliadins and glutenins) that form the gluten network responsible for viscoelastic dough properties. In addition, wheat provides essential minerals (Cu, Mg, Zn, P, and Fe), B-group vitamins and vitamin E, as well as dietary fiber.

Triticale (*Triticosecale* Wittmack) is a valuable source of carbohydrates, proteins, and dietary fiber (both insoluble and soluble), and it contains bioactive compounds with

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antioxidant potential, such as alkylresorcinols and proanthocyanidins (Straumīte et al., 2017). It also contains significant amounts of phenolic acids, flavonoids, and vitamins with bioactive properties (Knudsen, 2014). Alkylresorcinols, phytoestrogens, vitamins, and microelements are also abundant in triticale, together with several phenolic compounds exhibiting antioxidant activity (Jonnala et al., 2010). In 2024, global triticale production reached 12.403 million hectares, according to FAO statistics (https://www.fao.org/faostat/en/#data/QCL/visualize). The top three titricale-producing countries were Poland (4,958 million tonnes), Germany (1,510 million tonnes), and France (1,087 million tonnes).

Barley (*Hordeum vulgare* L.) is considered one of the most important cereals worldwide due to its diverse uses as human food, animal feed, and a substrate for malting. The health-promoting effects of barley are largely attributed to its high content of dietary fiber, particularly β-glucans, as well as tocols. In 2024, global barley production reached 141,996 million hectares, according to FAO statistics (https://www.fao.org/faostat/en/#data/QCL/visualize). The top three barley-producing countries were Russia (16,667 million tonnes), Australia (13,265 million tonnes), and Germany (10,610 million tonnes).

Oat (*Avena sativa* L.) is unique among cereals due to its rich nutrient profile, which supports human food, animal feed, health, and cosmetic applications (Varma et al., 2016). Oat represent an important source of carbohydrates, soluble dietary fiber, balanced protein, lipids, phenolic compounds, vitamins, and minerals (Joyce et al., 2019). Minor components with health-promoting properties include tocols (tocopherols and tocotrienols) and various phenolic compounds, such as avenanthramides, ferulic acid, caffeic acid, sinapic acid, tricin, apigenin, luteolin, kaempferol, and quercetin (Sterna et al., 2016). Together, these compounds give oats strong free-radical scavenging ability, making them a unique functional food with broad health benefits (Soycan et al., 2019). In 2024, global oat production reached 22,432 million hectares, according to FAO statistics (https://www.fao.org/faostat/en/#data/QCL/visualize). The top three oat-producing countries were Canada (3,357 million tonnes), Russia (3 million tonnes), and Poland (1,616 million tonnes).

Soybean (*Glycine max*) represent one of the most important food crops being rich in protein and vegetable oil (Sugiyama et al., 2015). Soybeanpossess a high amount of essential omega-3 fatty acid, alpha-linolenic acid (Messina and Messina, 2010) and, fiber (Fabiyi, 2006). In addition, soybean contains phytochemicals such as isoflavones and phenolic compounds which are beneficial to human health (Wang and Komatsu, 2017). In 2024, global soybean production reached 397,671 million hectares, according to FAO statistics (https://www.fao.org/faostat/en/#data/QCL/visualize. The top three soybean-producing countries were Brazil (144,473 million tonnes), United States of America (118,836 million tonnes), and Argentina (48.213 million tonnes).

Previous investigations have shown that agroecological factors significantly influence the protein and mineral content of cereal and legume crops such as soybean and wheat, highlighting the importance of genotype and environment interactions in determining grain composition (Popovic et al., 2013)

The aim of this study was to determine several physicochemical parameters, including moisture, protein, fat, fiber, and ash contents, as well as the concentrations of selected microelements (calcium, phosphorus, copper, iron, manganesse, zinc, lead, and cadmium) in cereal and legume samples. The analyzed materials were supplied by the National Institute for Agricultural Research and Development Fundulea, which coordinated the collection of cereal samples - wheat, triticale, barley, oats, and legume samples (soybean) from western Romania. The samples were obtained from the Agricultural Research and Development Station Turda and the Agricultural Research and Development Station Lovrin.

MATERIAL AND METHODS

Chemicals

All chemicals and reagents used for the determinations were of analytical grade. Sulfuric acid, sodium hydroxide, boric acid, hydrochloric acid, petroleum ether and nitric acid were purchased from Sigma-Aldrich (Steinheim, Germany). Standard solutions of calcium, phosphorus, lead, and cadmium for calibration were supplied by Merck (Darmstadt, Germany).

Materials

The samples were provided by the National Agricultural Research and Development Institute (NARDI) Fundulea and originated from the Agricultural Research and Development Station Lovrin and the Agricultural Research and Development Station Turda (western region of Romania). The samples were milled using a Grindomix GM 200 mill (Retsch, Haan, Germany) with a 0.5 mm sieve, resulting in a fine powder. Average samples were then prepared and stored in dry and dark environment at room temperature to preserve their quality until analysis.

Methods

Determination of chemical composition

The chemical composition of the collected samples was analyzed using standardized methods.

Crude protein content was determined by the Kjeldahl method (ISO 5983-2/2009) using a Kjeltec Auto 1030 system (Tecator Instruments, Höganäs, Sweden). Crude fat content was measured by Soxhlet extraction with organic solvents (SR ISO 6492/2001) using a Soxtec 2055 system (Foss Tecator, Höganäs, Sweden). Crude fiber content was determined by the intermediate filtration method (SR EN ISO 6865, 2002) using a Fibertec 2010 system (Foss Tecator, Höganäs, Sweden). Dry matter (ISO 6496/2001) and ash (ISO 2171/2010) were determined using a gravimetric method and a Nabertherm calcination furnace (Nabertherm GmbH, Lilienthal, Germany). The total carbohydrate content of samples was calculated (Frumuzachi et al., 2025).

Determination of Macro- and Micronutrients

The content of calcium (Ca) was determined through titrimetric method (SR 6490:1996), while the phosphorus (P) content was determined using a spectrophotometric method (Vărzaru et al., 2020). The content of lead (Pb), and cadmium (Cd), in the samples were determined by flame atomic absorption spectrometry (FAAS, Thermo Electron SOLAAR M6 Dual Zeeman Comfort, Cambridge, UK) after microwave digestion (Berghof, Eningen, Germany) as described by Untea et al. (2012).

Statistical analysis

All samples were analyzed in triplicate. Results are expressed as mean values ± standard deviation (SD). Statistical analysis was conducted using one-way analysis of variance (ANOVA), followed by Tukey's test to evaluate differences between means (Minitab software, Minitab Inc., Coventry, UK). A significance level of $p<0.05$ was considered statistically significant.

RESULTS AND DISCUSSION

Chemical composition

Wheat composition

The chemical composition of the wheat samples (Table 1) revealed noticeable differences among genotypes and growing locations. Moisture content varied within a relatively narrow range (8.49-10.76%). Variations in moisture content can be attributed mainly to genotypic differences, agronomic management, and climatic conditions during the grain development and maturation periods (Iqbal et al., 2015).

Wheat or flour with low moisture content is more stable during storage while moisture content higher than 14.5% attracts insects, bacteria and molds (Keran et al., 2009). The effect of wheat varieties was significant on crude protein content. Protein content showed marked variability between locations, with samples from the Lovrin station exhibiting higher values (15.42-18.42%) compared to those from Turda (11.45-17.33% d.m.).

Anjum (1993) and Gulzar et al. (2010) reported that the protein content ranged from 9.68 to 13.45% and 10.30-11.72%, respectively among the wheat varieties which is in accordance with the values reporte in current study.

Among the analyzed genotypes, Chapucion C15 recorded the highest protein content, followed by 37-2022 N100 and Anapurna C13, highlighting their potential suitability for applications requiring high protein levels. In contrast, Andrada N50 presented the lowest protein content. Protein content is mainly influenced by genetic makeup, climate, and prevailing growth conditions (Kent and Evers, 1994).

Table 1. Proximate composition of different wheat varieties

Wheat	Station	Moisture %	Protein %	Fat %	Fiber %	Ash %	Carbs %	Energetic value kcal/kg
Ciprian	Lovrin	8.94^{b}	15.42^{e}	1.67^{a}	4.34^{c}	1.35^{b}	68.28^{a}	4095.84^{d}
Biharia		9.86^{a}	15.89^{d}	1.07^{d}	5.10^{a}	1.14^{c}	66.94^{d}	4046.25^{e}
Dacic C16		8.49^{d}	16.20^{c}	1.37^{c}	4.98^{b}	1.66^{a}	67.30^{c}	4101.74^{c}
Anapurna C13		8.62^{c}	16.94^{b}	1.51^{b}	3.86^{d}	1.55^{a}	67.52^{b}	4112.90^{b}
Chapucion C15		8.87^{b}	18.42^{a}	1.56^{a,b}	3.54^{e}	1.35^{b}	66.26^{e}	4134.43^{a}
Average		**8.96**	**16.57**	**1.44**	**4.36**	**1.41**	**67.26**	**4098.23**
St. Dev.		**0.54**	**1.17**	**0.23**	**0.68**	**0.20**	**0.74**	**32.58**
Glosa N100	Turda	9.95^{H,I}	14.88^{C}	1.08^{K}	3.96^{J}	1.43^{D,E,F,G}	68.70^{J}	4008.21^{D}
Glosa N50		10.76^{A}	13.14^{F,G}	1.29^{F,G,H}	5.24^{B}	1.48^{C,D,E,F}	68.09^{L}	3964.51^{K}
Ursita N100		9.92^{H,I}	13.08^{G,H}	0.79^{L}	4.14^{G,H}	1.49^{B,C,D,E}	70.58^{E}	3964.72^{K}
Ursita N50		10.63^{B}	11.65^{L}	1.17^{I,J,K}	4.37^{E}	1.42^{D,E,F,G}	70.76^{D}	3937.55^{O}
FDL Abund N100		10.14^{E,F}	13.98^{D}	1.37^{D,E,F}	4.81^{C}	1.43^{D,E,F,G}	68.27^{K}	4007.06^{D}
FDL Abund N50		10.51^{C}	12.69^{I}	1.25^{G,H,I,J}	4.24^{F,G}	1.60^{A,B}	69.71^{I}	3954.62^{M}
Andrada N100		9.91^{H,I}	13.08^{G,H}	1.18 ^{H,I,J}	5.63^{A}	1.56^{A,B,C}	68.64^{J}	3992.24^{H}
Andrada N50		10.09^{F,G}	11.45^{M}	1.31^{E,F,G}	4.16^{G,H}	1.49^{B,C,D,E}	71.50^{A}	3960.20^{L}
Codru N100		10.33^{D}	12.97^{H}	1.18^{H,I,J,K}	4.16^{G,H}	1.48^{C,D,E,F}	69.88^{H}	3967.24^{K}
Codru N50		10.51^{C}	12.33^{J}	1.14^{J,K}	3.67^{K}	1.40^{E,F,G}	70.95^{C}	3947.98^{N}
Cezara N100		9.74^{J,K}	13.27^{E}	1.19 ^{H,I,J,K}	4.06^{I,J}	1.52^{A,B,C,D}	70.22^{F}	3994.74^{G}
Cezara N50		9.84^{I,J}	12.17^{K}	1.26^{F,G,H}	4.09^{H}	1.37^{F,G}	71.27^{B}	3983.69^{J}
Georgiana N100		9.99^{G,H,}	12.60^{I}	1.51^{B,C}	4.25^{F,G}	1.36^{G}	70.29^{F}	3998.84^{F}
Georgiana N50		10.25^{D,E}	12.99^{H}	1.44^{B,C,D}	4.32^{E,F}	1.39^{E,F,G}	69.63^{I}	3989.37^{I}
T100-18 N100		9.67^{K}	12.97^{H}	1.55^{B}	4.50^{D}	1.42^{D,E,F,G}	69.89^{H}	4019.10^{C}
T100-18 N50		9.84^{I,J}	13.23^{E,F}	1.31^{E,F,G}	4.21^{F,G}	1.40^{E,F,G}	70.01^{G}	4002.28^{E}
Feleacu N100		10.16^{E,F}	15.74^{B}	1.79^{A}	4.54^{D}	1.62^{A,B}	66.15^{M}	4046.3^{B}
37-2022 N100		9.93^{H,I}	17.33^{A}	1.41^{C,D,E}	4.19^{G,H}	1.46^{C,D,E,F,G}	65.68^{N}	4064.78^{A}
Average		**10.12**	**13.31**	**1.29**	**4.36**	**1.46**	**69.46**	**3989.08**
St. Dev.		**0.32**	**1.43**	**0.21**	**0.46**	**0.08**	**1.62**	**33.41**

The values are expressed as means ± standard deviations (n=3). Values followed by different letters in the same column are significantly different ($p<0.05$).

The presence of lipids is essential for proper gluten development in flour, while wheat oil exhibits low shelf stability and is susceptible to rapid rancidity (Iqbal et al., 2015).

In the present study, fat content remained low across all samples, ranging from 0.79 to 1.79%. The crude fat content of whole wheat flour was significantly influenced by differences among wheat varieties (Iqbal et al., 2015). Ash content varied between 1.14 and 1.66%, reflecting differences in mineral content likely associated with genotype and cultivation site.

Fiber content exhibited considerable variability, ranging from 3.54 to 5.10% for samples from Lovrin and between 3.96 and 5.63% for those from Turda. Higher values may be due to the variation in grinding conditions, extraction rate and type of flour. Overall, the observed variability in chemical composition underscores the combined effect of genotype and growing conditions on wheat quality attributes.

Triticale composition

The chemical composition of triticale vary due to the genotype. Physicochemical characteristics of triticale samples are shown in Table 2. As may be seen, the moisture values for triticale were between 9.10 and 10.32%. The lower moisture the higher stability during storage (Ghendov-Mosanu et al., 2024). Among triticale varieties, the protein content varied between 12.61 and 15.48% depending on genotype, which agrees with the values reported by others (Codină et al., 2025). Manley et al. (2013) reported values ranging from 7.5 to 16.2% for 131 triticale genotypes grown in South Africa. Similarly, Dennett et al. (2013) observed protein contents between 10.5 and 14.6% in 11 triticale genotypes, comparable to those reported for wheat. In addition, protein content in triticale grains from nine genotypes ranged from 11.8 to 15.2%. Various studies reported the protein content and composition of different triticale genotypes (Navarro-Contreras et al., 2014). Dennett et al. (2013) reported that the protein content in triticale grains is due partly to genotype, not only environment (e.g., soil available nitrogen).

Table 2. Proximate composition of different triticale varieties

Triticale	Station	Moisture %	Protein %	Fat %	Fiber %	Ash %	Carbohidrates %	Energetic value kcal/kg
Pietroasa	Lovrin	9.66^{b}	15.12^{b}	2.39^{a}	3.80^{c}	1.32^{b}	67.71^{b}	4097.44^{a}
Aselius		9.10^{c}	13.02^{c}	1.93^{b}	4.26^{b}	1.41^{b}	70.28^{a}	4062.82^{b}
Utrifun C17		9.99^{a}	15.48^{a}	1.33^{c}	5.77^{a}	1.63^{a}	65.80^{c}	4032.05^{c}
Average		**9.58**	**14.54**	**1.88**	**4.61**	**1.45**	**67.93**	**4064.10**
St. Dev.		**0.45**	**1.33**	**0.53**	**1.03**	**0.16**	**2.25**	**32.71**
Haiduc N100	Turda	10.16^{B}	13.25^{B}	1.26^{B}	3.48^{C}	1.50^{B}	70.35^{A}	3977.89^{B}
Utrifun N100		10.11^{B}	13.76^{A}	1.26^{B}	5.44^{A}	1.55^{A,B}	67.88^{C}	3997.94^{A}
Zaraza N100		10.32^{A}	12.61^{C}	1.39^{A}	4.15^{B}	1.64^{A}	69.89^{B}	3966.54^{C}
Average		**10.20**	**13.21**	**1.30**	**4.36**	**1.56**	**69.37**	**3980.79**
St. Dev.		**0.11**	**0.58**	**0.08**	**1.00**	**0.07**	**1.31**	**15.90**

The values are expressed as means ± standard deviations (n=3). Values followed by different letters in the same column are significantly different ($p<0.05$).

The lipid content of the resulting triticale ranged from 1.26 to 2.39%, which appeared to be a little higher than those reported by (Frás et al., 2016). The ash value is an indicator of flour mineral content (Codină et al., 2025). In a study conducted by Codină et al. (2025) the ash value varied between 1.53 and 1.78% for triticale varieties. Frás et al. (2016) reported that the ash content of 9 triticale genotypes ranged from 1.7 to 2.0%. The carbohydrate content of analysed sample ranged from 65.80 to 70.35%, making them its major component of triticale samples. Codină et al. (2025) analysed 7 triticale varieties cultivated in the Republic of Moldova and reported that the carbohydrate content represents over 71% of the total chemical content of triticale flour. Therefore, triticale may contribute to the growing healthy food market and to the development of new cereal-based products (Zhu, 2018).

Barley composition

The chemical composition of barley samples from Lovrin station is depicted in Table 3. The average of moisture content was 9.00%. Our moisture results are in line with the results (7.34%-16.82%) reported by Tavakoli et al. (2010). These differences might be due to a variety of differences, storage conditions, geological change, and water holding capacity (Hussain et al., 2021).

Table 3. Proximate composition of different barley varieties

Barley	Station	Moisture %	Protein %	Fat %	Fiber %	Ash %	Carbohidrates %	Energetic value kcal/kg
Astro	Lovrin	9.44[a]	11.11[a]	1.72[a]	8.32[c]	1.88[d]	67.53[a]	4013.42[d]
Rafaela		8.99[b]	15.25[b]	1.56[b]	7.38[d]	2.04[c]	64.78[b]	4075.33[b]
Lavanda		9.07[b]	15.85[b]	1.79[a]	8.49[b]	2.48[b]	62.32[d]	4082.09[a]
Mochina		8.48[c]	13.07[c]	1.74[a]	9.87[a]	2.66[a]	64.18[c]	4061.98[c]
Average		**9.00**	**13.82**	**1.70**	**8.52**	**2.27**	**64.70**	**4058.21**
St. Dev.		**0.40**	**2.17**	**0.10**	**1.03**	**0.37**	**2.16**	**31.00**

The values are expressed as means ± standard deviations (n=3). Values followed by different letters in the same column are significantly different (p<0.05).

Moreover, the results regarding the protein content were between 11.11 and 15.85%. Lavana and Rafaela genotypes presented the highest values, while Astro had the lowest protein content. According to Brennan and Cleary (2005), protein content in barley samples ranged from 10% to 17%. Comparable values were reported by Suriano et al. (2018), who found a total protein content of 12.75%, lower than the results of the present study, except Astro sample which had a value of 11.11% protein content. Regarding crude fat content, the values were very similar, ranging from 1.56 to 1.79%, with an average of 1.70%. Hussain et al. (2021) reported that the fat content in 4 barrley landlines were between 1.63-2.63%. Our findings were lower than those reported by Brennan and Cleary (2005), who observed a total lipid content of 2%-3%. The ash content of analysed samples ranged from 1.88 to 2.66%, while the fiber content was between 7.38-9.87%. According to Hussain et al. (2021), the ash content of four barley genotypes ranged from 2.10% to 2.86%, while fiber content varied between 11.73% and 16.50%. It can be observed that the fiber content is higher than our results. As reported by Rodehutscord et al. (2016), variations in environmental conditions such as rainfall, temperature, soil type, fertility, and genetic factors significantly affect the chemical composition and physical characteristics of cereals.

Oat composition

In the present study, the protein content in the 7 oat genotypes ranged between 13.05 and 25.17% (Table 4). The highest recorded value was for Vâlcele (25.17%) from Turda station, while Ovidiu genotype from Lovrin station had the lowest protein content, 13.05%. In a previous study, the protein content of oat groats ranges from 12.4 to 24.5% (Klose and Arendt, 2012). The results consisted to the present study.

Table 4. Proximate composition of different oat varieties

Oat	Station	Moisture %	Protein %	Fat %	Fiber %	Ash %	Carbohidrates %	Energetic value kcal/kg
Lovrin 1	Lovrin	8.92[b]	18.31[a]	4.21[b]	16.53[d]	2.59[b,c]	49.44[c]	4300.72[a]
Ovidiu		8.84[b,c]	13.05[c]	3.57[c]	19.27[c]	2.51[c]	52.76[a]	4208.74[d]
Sorin		8.82[b,c]	16.41[b]	3.33[d]	19.53[b]	2.50[c]	49.41[c]	4250.89[c]
Norik		8.79[c]	17.52[a]	3.44[d]	23.65[a]	2.63[b]	43.97[d]	4295.33[b]
Everest		9.08[a]	16.23[b]	5.55[a]	15.45[e]	3.33[a]	50.36[b]	4295.67[b]
Average		**9.59**	**19.31**	**2.57**	**17.75**	**2.85**	**47.93**	**4197.59**
St. Dev.		**0.28**	**8.29**	**0.51**	**0.95**	**0.23**	**6.32**	**116.67**
Mureșana	Turda	9.79[A]	13.45[B]	2.93[A]	18.42[A]	3.01[A]	52.40[A]	4115.09[B]
Vâlcele		9.39[B]	25.17[A]	2.21[B]	17.08[B]	2.69[B]	43.46[B]	4280.09[A]
Average		**8.89**	**16.30**	**4.02**	**18.89**	**2.71**	**49.19**	**4270.27**
St. Dev.		**0.12**	**2.01**	**0.92**	**3.19**	**0.35**	**3.22**	**39.88**

The values are expressed as means ± standard deviations (n=3). Values followed by different letters in the same column are significantly different (p<0.05).

Oats have the highest fat content of any cereal (Alemayehu et al., 2023). Analysed oat samples contain a fat content between 2.21-5.55%, while fiber content ranged from 16.53% to 23.65%. The high lipid content makes oat a valuable functional food ingredient in a wide range of industries (Banas et al., 2007). Scientific evidence indicates that oats, like other fiber-rich cereals, aid in weight management, lower blood cholesterol, and improve postprandial glycemic and insulinemic responses in healthy individuals and those with non-insulin-dependent diabetes mellitus (Alemayehu et al., 2023).

Soybean composition

Moisture content of 14 soybean genotypes from Turda station ranged from 6.78 to 7.21% with a mean value of 7.00%. The protein content varied from 34.86 to 38.88%, genotype Caro TD recorded maximum of protein content whereas genotype Onix exhibited minimum of protein concentration. Soybean is a major source of high quality protein and oil (Sharma et al., 2014). In a study conducted by Sharma et al. (2014), the protein content of 7 soybean varieties were between 39.40-44.40%, higher than the results reported in the present research. Earlier studies by different authors reported a mean protein content of 39.80% (Krishna et al., 2003) and 40.20% (Ramteke et al., 2010) respectively in different soybean varieties released in India. Soybean genotypes exhibited wide variation in their lipidic content. The fat content in the analysed soybean varieties varied from 11.32 to 16.52%. Isa TD and Ziana TD samples contained significantly higher amount of fat content as compared to other genotypes studied, while Raluca TD and Ilinca TD showed the lowest fat content.

Table 5. Proximate composition of different soybean varieties

Soybean	Station	Moisture %	Protein %	Fat %	Fiber %	Ash %	Carbohidrates %	Energetic value kcal/kg
Onix	Lovrin	6.99^{d,e,f}	34.86^{k}	14.37^{e}	16.58^{c,d}	4.88^{g}	22.32^{a}	5084.07^{h}
Felix		7.13^{a,b,c}	38.28^{d}	13.03^{j}	16.16^{c,d}	4.24^{i}	21.16^{d}	5083.90^{i}
Cristina TD		6.95^{e,f,g}	37.57^{f}	14.08^{f}	16.16^{c,d}	4.59^{h}	20.65^{f}	5121.77^{e}
Larisa		6.93^{e,f,g,h}	38.67^{b}	14.74^{d}	16.58^{b,c,d}	4.91^{f,g}	18.17^{k}	5164.10^{c}
Caro TD		7.02^{c,d,e}	38.88^{a}	13.66^{h}	16.50^{b,c,d}	5.38^{b,c}	18.56^{j}	5085.94^{g}
Ilinca TD		7.09^{b,c,d}	37.93^{e}	11.66^{l}	17.02^{b}	5.45^{a,b}	20.85^{e}	4962.00^{m}
Nicola TD		6.89^{f,g,h,i}	37.22^{h}	15.17^{c}	16.76^{b,c}	5.33^{c}	18.63^{j}	5149.81^{d}
Raluca TD		7.13^{a,b,c}	38.46^{c}	11.32^{m}	15.85^{d}	5.05^{d,e}	22.19^{b}	4959.85^{n}
Isa TD		6.87^{g,h,i}	37.48^{f,g}	16.52^{a}	16.79^{b,c}	5.01^{e,f}	17.33^{l}	5240.16^{a}
Iris TD		6.99^{d,e,f}	38.87^{a}	12.72^{k}	16.11^{c,d}	5.05^{d,e}	20.26^{g}	5048.28^{k}
Ziana TD		6.82^{h,i}	37.39^{g}	16.00^{b}	17.19^{b}	5.16^{d}	17.44^{l}	5209.36^{b}
Potaissa TD		7.21^{a}	38.28^{d}	13.39^{i}	16.76^{b,c}	5.33^{c}	19.03^{i}	5058.02^{j}
Romina TD		6.78^{i}	35.29^{j}	14.71^{d}	18.15^{a}	5.49^{a,b}	19.58^{h}	5101.91^{f}
Avatar		7.18^{a,b}	36.02^{i}	13.88^{g}	15.86^{d}	5.55^{a}	21.51^{c}	5035.61^{l}
Average		**7.00**	**37.51**	**13.95**	**16.61**	**5.10**	**19.83**	**5093.20**
St. Dev.		**0.13**	**1.29**	**1.48**	**0.61**	**0.37**	**1.68**	**81.34**

The values are expressed as means ± standard deviations (n=3). Values followed by different letters in the same column are significantly different ($p<0.05$).

Sinegovskaya et al. (2020) investigated the fat content of soybean cultivars with various genetic origins on growing conditions and cultivar genotypes during 3 years (2017-2019). In 2017, the fat content ranged from 18.50 to 20.30%, increasing slightly to 18.80-20.80% in 2018, and decreasing to 16.70-18.60% in 2020. These values were higher than those obtained in the present study. Fiber and ash contents of soybean genotypes were found to be in the range of 15.85-18.15% and 4.24-5.55%, respectively. Al Kahtani et al. (1989) reported that the ash content in soybean varieties ranged between 5.81-6.54%, higher than the present results.

Macro and Mictronutrient composition

On the basis of concentration in plant tissues, minerals are divided into two groups, i.e. macro- and micro-elements. The macro-elements are Ca, P, K, Mg, Na, Cl, and S, and the micro-elements are Co, Cu, Fe, I, Mn, Se, and Zn.

Wheat

The concentrations of 8 elements (Ca, P, Cu, Fe, Mn, Zn, Pb, and Cd) in wheat were determined. As we can see, the highest concentration were Fe, Mn, and Zn, while the content of Ca, P, and Pb were <1%. Cu content was between 8.240 and 10.040 mg/kg, in samples colected from Lovrin station, and from 2.290 to 6.060 mg/kg in genotypes from Turda station. The concentration of Cd was below the limit of detection (LOD). Different authors have also reported higher amounts of Fe, Mn, Zn and Cu in different einkorn varieties (Erba et al., 2011).

Table 6. Macro and micronutrient composition of different wheat genotypes

Wheat	Station	Ca, %	P, %	Cu, mg/kg	Fe, mg/kg	Mn, mg/kg	Zn, mg/kg	Pb, mg/kg	Cd, mg/kg
Ciprian	Lovrin	0.070^{a}	0.470^{c}	8.240^{e}	46.700^{e}	41.660^{d}	23.870^{e}	0.097^{c}	n.d.
Biharia		0.080^{a}	0.500^{a,b}	9.970^{b}	51.160^{d}	42.990^{c}	24.610^{d}	0.137^{a}	n.d.
Dacic C16		0.060^{b}	0.510^{a}	9.590^{c}	52.360^{c}	41.500^{e}	28.160^{c}	0.117^{b}	n.d.
Anapurna C13		0.060^{b}	0.490^{b}	8.300^{d}	59.850^{a}	50.160^{b}	29.530^{b}	0.099^{c}	n.d.
Chapucion C15		0.060^{b}	0.490^{b}	10.040^{a}	54.150^{b}	58.860^{a}	31.130^{a}	0.118^{b}	n.d.
Average		**0.066**	**0.492**	**9.228**	**52.844**	**47.034**	**27.460**	**0.114**	-
St. Dev.		**0.009**	**0.015**	**0.891**	**4.786**	**7.508**	**3.133**	**0.016**	-
Glosa N100	Turda	0.080^{A}	0.470^{A,B}	5.980^{A}	46.610^{N}	40.510^{G}	25.230^{C,D,E,F}	0.118^{B}	n.d.
Glosa N50		0.060^{B}	0.460^{B,C}	5.050^{B,C}	46.000^{O}	44.650^{C}	23.250^{F,G,H,I}	0.119^{B}	n.d.
Ursita N100		0.080^{A}	0.460^{B,C}	4.700^{B,C,D}	44.400^{Q}	35.920^{L}	22.090^{G,H,I,J}	0.139^{A}	n.d.
Ursita N50		0.070^{A,B}	0.430^{E}	4.650^{B,C,D}	40.880^{R}	37.740^{I}	21.280^{I,J}	0.118^{B}	n.d.
FDL Abund N100		0.080^{A}	0.430^{E}	4.500^{B,C,D}	48.030^{J}	33.750^{O}	24.740^{C,D}	0.138^{A}	n.d.
FDL Abund N50		0.080^{A}	0.440^{D,E}	3.380^{B,C,D}	47.920^{K}	37.750^{I}	25.370^{C,D,E}	0.118^{B}	n.d.
Andrada N100		0.080^{A}	0.450^{C,D}	5.080^{B,C}	56.110^{D}	41.930^{E}	24.800^{D,E,F}	0.116^{B}	n.d.
Andrada N50		0.070^{A,B}	0.460^{B,C}	3.790^{B,C,D}	48.770^{H}	37.580^{J}	20.180^{J}	0.117^{B}	n.d.
Codru N100		0.070^{A,B}	0.440^{D,E}	3.440^{B,C,D}	48.340^{I}	36.420^{K}	23.980^{E,F,G}	0.137^{A}	n.d.
Codru N50		0.080^{A}	0.440^{D,E}	2.790^{C,D}	45.730^{P}	35.440^{M}	21.790^{H,I,J}	0.135^{A}	n.d.
Cezara N100		0.060^{B}	0.460^{B,C}	4.060^{B,C,D}	57.860^{C}	49.310^{B}	29.810^{B}	0.119^{B}	n.d.
Cezara N50		0.080^{A}	0.470^{A,B}	3.890^{B,C,D}	51.320^{F}	50.560^{A}	26.980^{C}	0.097^{C}	n.d.
Georgiana N100		0.080^{A}	0.480^{A}	4.090^{B,C,D}	54.260^{E}	41.970^{D}	26.660^{C,D}	0.119^{B}	n.d.
Georgiana N50		0.060^{B}	0.440^{D,E}	2.290^{D}	47.190^{M}	38.770^{H}	20.580^{J}	0.097^{C}	n.d.
T100-18 N100		0.060^{B}	0.460^{B,C}	3.120^{C,D}	49.620^{G}	29.330^{Q}	23.600^{E,F,G,H}	0.139^{A}	n.d.
T100-18 N50		0.080^{A}	0.460^{B,C}	2.500^{C,D}	47.820^{L}	33.990^{N}	23.750^{E,F,G,H}	0.098^{C}	n.d.
Feleacu N100		0.070^{A,B}	0.450^{C,D}	6.060^{A,B}	60.450^{A}	41.500^{F}	33.350^{A}	0.119^{B}	n.d.
37-2022 N100		0.070^{A,B}	0.450^{C,D}	4.960^{B,C,D}	59.670^{B}	33.620^{P}	25.310^{C,D,E}	0.099^{C}	n.d.
Average		**0.108**	**0.453**	**4.129**	**50.054**	**38.930**	**24.597**	**0.119**	-
St. Dev.		**0.148**	**0.014**	**1.095**	**5.462**	**5.460**	**3.254**	**0.014**	-

The values are expressed as means ± standard deviations (n=3). Values followed by different letters in the same column are significantly different (p<0.05). n.d., not detected; below the limit of detection.

Golea et al. (2021) highlight the variation of the amount of mineral substances from thirty one varieties of wheat grains cultivated in Romania. The mineral content contributed by Fe, Mn, Zn, and Cd accounted for 1.396-3.886%, 1.631-5.617%, 0.565-2.876%, and 4.757-24.691% of the total mineral content of the analyzed wheat varieties, respectively. The range of variation in microelement contents of wheat grain cultivated in Russia was: Fe 15-22 mg/kg, Zn 14-21 mg/kg, and Mn 2.4-4.1 mg/kg (Bityutskii et al., 2017). These results were lower than our results. The mineral amount in wheat grains may be environmentally determined or may be due to the cultivar choice (Golea et al., 2023).

Triticale

For triticale, 3 samples from Lovrin (Pietroasa, Aselius, and Utrifun C17), and 3 from Turda (Haiduc N100, Utrifun N100, and Zaraza N100) were analysed in term of macro and micronutrient composition (Table 7). The Aselius sample showed the highest contents of copper (10.140 mg/kg) and manganese (45.490 mg/kg). In contrast, the Utrifun N100 sample exhibited the highest iron content (53.600 mg/kg), while Zaraza N100 presented the highest zinc content (34.550 mg/kg). The content of Fe, Zn and Mn showed also variability among genotypes of triticale cultivated in Russia. The concentration of iron varied between 24-79 mg/kg, zinc 6–33 mg/kg and manganesse 7-21 mg/kg (Bityutskii et al., 2017). Zhu (2018) has reported that triticale had a quantity of various minerals like calcium (35 mg/100 g), iron (2.59 mg/100 g), magnesium (153 mg/100 g), phosphorus (321 mg/100 g), potassium (466 mg/100 g), sodium (2 mg/100 g), zinc (2.66 mg/100 g).

Table 7. Macro and micronutrient composition of different triticale genotypes

Triticale	Station	Ca, %	P, %	Cu, mg/kg	Fe, mg/kg	Mn, mg/kg	Zn, mg/kg	Pb, mg/kg	Cd, mg/kg
Pietroasa	Lovrin	0.080[a]	0.450[b]	9.570[b]	43.150[c]	33.170[c]	18.020[c]	0.139[a]	n.d.
Aselius		0.070[a]	0.480[a]	10.140[a]	45.410[b]	45.490[a]	22.270[b]	0.117[b]	n.d.
Utrifun C17		0.080[a]	0.480[a]	9.500[c]	45.590[a]	36.680[b]	32.420[a]	0.099[c]	n.d.
Average		**0.077**	**0.470**	**9.737**	**44.717**	**38.447**	**24.237**	**0.118**	-
St. Dev.		**0.006**	**0.017**	**0.351**	**1.360**	**6.347**	**7.399**	**0.020**	-
Haiduc N100	Turda	0.080[A]	0.440[B]	3.710[B]	49.250[C]	36.060[C]	33.270[B]	0.137[A]	n.d.
Utrifun N100		0.060[B]	0.450[B]	4.450[A]	53.600[A]	44.020[A]	33.130[C]	0.116[B]	n.d.
Zaraza N100		0.080[A]	0.470[A]	3.400[C]	49.670[B]	39.680[B]	34.550[A]	0.118[B]	n.d.
Average		**0.073**	**0.453**	**3.853**	**50.840**	**39.920**	**33.650**	**0.124**	-
St. Dev.		**0.012**	**0.015**	**0.539**	**2.399**	**3.985**	**0.783**	**0.012**	-

The values are expressed as means ± standard deviations (n=3). Values followed by different letters in the same column are significantly different ($p<0.05$). n.d., not detected; below the limit of detection.

Codină et al. (2025) analysed seven triticale grain varieties for their content in minerals such as Ca, Zn, Fe, and Cu. Ca content varied between 188 and 224 mg/kg, Zn ranged between 11.18 and 11.68 mg/kg, Fe content ranged from 26.02 to 31.86 mg/kg, and Cu was between 3.27 and 4.52 mg/kg. These values were lower than those presented in this research. The average of phosphorus in spring triticale analysed in 2003-2012 period was 4.36 g/kg, while for calcium the average was 0.43 g/kg (Brzozowska et al., 2018).

Barley

The mineral composition of barley samples is presented in Table 8. Rafaela sample exhibited the highest concentrations of copper (10.280 mg/kg) and zinc (23.770 mg/kg). In contrast, the highest levels of iron and manganese were observed in the Lavanda and Astro samples, with concentrations of 36.440 mg/kg and 19.370 mg/kg, respectively. For all analysed samples, phosphorus concentration was lower than 0.5%. In a previous study, the mineral composition among different barley landlines was as follows: calcium 312-368 mg/kg, iron 43.3-65.6 mg/kg, and zinc 22.5-26.5 mg/kg (Hussain et al., 2021).

Table 8. Macro and micronutrient composition of different barley genotypes

Barley	Station	Ca, %	P, %	Cu, mg/kg	Fe, mg/kg	Mn, mg/kg	Zn, mg/kg	Pb, mg/kg	Cd, mg/kg
Astro	Lovrin	0.060[a]	0.490[a]	9.280[b]	30.810[d]	19.370[a]	17.050[c]	0.119[a]	n.d.
Rafaela		0.060[a]	0.450[b]	10.280[a]	35.840[b]	17.210[b]	23.770[a]	0.098[b]	n.d.
Lavanda		0.060[a]	0.460[b]	8.810[d]	36.440[a]	15.810[c]	22.450[b]	0.099[b]	n.d.
Mochina		0.060[a]	0.490[a]	8.980[c]	33.310[c]	13.310[d]	14.400[d]	0.119[a]	n.d.
Average		**0.060**	**0.473**	**9.338**	**34.100**	**16.425**	**19.418**	**0.109**	**-**
St. Dev.		**0.000**	**0.021**	**0.658**	**2.579**	**2.541**	**4.432**	**0.012**	-

The values are expressed as means ± standard deviations (n=3). Values followed by different letters in the same column are significantly different (p<0.05). n.d., not detected; below the limit of detection.

Yan et al. (2016) found that the Fe content in different barley samples ranged from 39.5-235.5 mg/kg, whereas Ma et al. (2004) revealed that the Fe content varied 40-60 mg/kg among different varieties of barley. These results were higher than those presented in this study. Maleki et al. (2011) reported that the mineral composition of barley grains varies according to environmental conditions and fertilization systems. Similarly, Rodehutscord et al. (2016) demonstrated that environmental factors such as rainfall, temperature, soil fertility, as well as genetic makeup, significantly influence the nutritional composition and physical characteristics of cereals.

Oat

The mineral content of oat genotypes was presented in Table 9. Sorin sample from Lovrin station had the highest content of copper (9.700 mg/kg), iron (58.870 mg/kg), and manganese (53.280 mg/kg), while Everest sample exhibited the highest content of zinc (24.400 mg/kg).

Table 9. Macro and micronutrient composition of different oat genotypes

Oat	Station	Ca, %	P, %	Cu, mg/kg	Fe, mg/kg	Mn, mg/kg	Zn, mg/kg	Pb, mg/kg	Cd, mg/kg
Lovrin 1	Lovrin	0.070[b]	0.500[a,b]	7.410[d]	45.590[d]	49.090[b]	22.440[c]	0.099[c]	n.d.
Ovidiu		0.080[a]	0.500[a,b]	8.900[c]	45.490[e]	45.270[e]	23.220[b]	0.119[b]	n.d.
Sorin		0.080[a]	0.460[c]	9.700[a]	58.870[a]	53.280[a]	21.090[d]	0.099[c]	n.d.
Norik		0.080[a]	0.510[a]	8.910[c]	46.630[c]	46.390[c]	17.380[e]	0.098[c]	n.d.
Everest		0.080[a]	0.490[b]	9.270[b]	47.800[b]	46.120[d]	24.400[a]	0.138[a]	n.d.
Average		**0.078**	**0.492**	**8.838**	**48.876**	**48.030**	**21.706**	**0.111**	-
St. Dev.		**0.004**	**0.019**	**0.863**	**5.664**	**3.265**	**2.701**	**0.018**	-
Mureșana	Turda	0.080[A]	0.500[B]	2.100[B]	46.720[B]	32.750[A]	20.080[B]	0.119[A]	n.d.
Vâlcele		0.080[A]	0.510[A]	2.880[A]	52.640[A]	27.680[B]	24.210[A]	0.099[B]	n.d.
Average		**0.080**	**0.505**	**2.490**	**49.680**	**30.215**	**22.145**	**0.109**	-
St. Dev.		**0.000**	**0.007**	**0.552**	**4.186**	**3.585**	**2.920**	**0.014**	-

The values are expressed as means ± standard deviations (n=3). Values followed by different letters in the same column are significantly different (p<0.05). n.d., not detected; below the limit of detection.

Regarding the samples colected from Turda station, Vâlcele sample showed the highest content of minerals except for manganesse and lead. Rodehutscord et al. (2016) analyzed 14 oat samples with respect to their mineral content. The mean concentrations were 1.08 g/kg d.m. for calcium, 69.1 mg/kg d.m. for iron, 29.2 mg/kg d.m. for manganese, 20.0 mg/kg d.m. for zinc, and 3.64 mg/kg d.m. for copper. These results were lower than the present resuls, except for the iron content.

In a study conducted by Alemayehu et al. (2021), 5 oat varieties were analysed. Iron, copper, zinc, magnesium, and calcium contents were 2.5-3.0, 0.2-0.4, 1.6-2.0, 62.4-89.1, and 44.0-102.7 mg/100 g d.m., respectively. Özcan et al. (2017) determined the macro- and microelement contents of oat grains harvested from several provinces in Turkey. The calcium content of oats ranged from 568.50 to 1269.97 mg/kg, while iron concentrations varied between 29.98 and 80.78 mg/kg. Zinc content ranged from 15.50 to 37.68 mg/kg, and manganese concentrations were reported between 25.82 and 62.55 mg/kg. Ciolek et al. (2007) reported that several oat strains and cultivars contained 0.326-0.423% K, 0.320-0.388% P, 0.0.83-0.117% Mg, 0.001-0.015% Ca, 32.0-58.2% Mn, 29.7-48.9% Fe, 23.6-41.7% Zn and 2.8- 5.5% Cu. These differences of the results might be due to growth conditions, genetic factors, geographical variations and analytical procedures (Ȍzcan, 2004). Other differences may result from harvest conditions, storage, and post-harvest treatments or other processes that the crop is subject to before final use (Weiss et al., 2006).

Soybean

Fourteen soybean genotypes from Lovrin station were analysed for their mineral content (Table 10). Calcium content was <0.5% in all samples, while phosohorus concentration was <0.9%. The highest content of copper and manganesse was presented by Potaissa TD, 20.710 mg/kg, and 26.480 mg/kg, respectively.

Additionaly, Felix sample showed the highest content of iron (109.710 mg/kg), and lead (0.139 mg/kg). For zinc content, the mean value was 48.580 mg/kg, Caro TD sample having a higher content than the average.

Ateye et al. (2025) evaluated the mineral content of soybean varieties sourced from two research centers, Kelafo and Dolo-Ado, alongside local market controls. Mineral concentrations varied, with calcium ranging from 48.9 to 157.2 mg/100 g, iron 5.37-12.06 mg/100 g, magnesium 658.5-2429.1 mg/100 g, and zinc 3.79-6.45 mg/100 g.

Table 10. Macro and micronutrient composition of different soybean genotypes

Soybean	Station	Ca, %	P, %	Cu, mg/kg	Fe, mg/kg	Mn, mg/kg	Zn, mg/kg	Pb, mg/kg	Cd, mg/kg
Onix	Lovrin	0.450[c,d]	0.830[b,c]	18.440[d]	103.970[b]	18.860[f]	46.430[k]	0.099[c]	n.d.
Felix		0.480[a]	0.840[a,b]	16.610[l]	109.710[a]	17.680[j]	49.780[d]	0.139[a]	n.d.
Cristina TD		0.470[a,b]	0.840[a,b]	15.160[n]	94.490[f]	19.810[e]	47.240[j]	0.118[b]	n.d.
Larisa		0.470[a,b]	0.850[a]	17.670[i]	93.230[g]	20.430[d]	49.900[c]	0.099[c]	n.d.
Caro TD		0.460[b,c]	0.830[b,c]	20.310[b]	95.460[e]	17.210[m]	58.440[a]	0.119[b]	n.d.
Ilinca TD		0.470[a,b]	0.800[e]	18.160[e]	86.890[k]	17.250[l]	47.730[h]	0.098[c]	n.d.
Nicola TD		0.470[a,b]	0.830[b,c]	18.040[g]	83.280[l]	17.740[i]	49.570[e]	0.138[a]	n.d.
Raluca TD		0.440[d,e]	0.820[c,d]	15.670[m]	76.540[m]	17.090[n]	46.110[l]	0.119[b]	n.d.
Isa TD		0.470[a,b]	0.800[e]	17.560[j]	99.210[d]	18.350[h]	43.330[n]	0.118[b]	n.d.
Iris TD		0.470[a,b]	0.820[c,d]	18.070[f]	74.390[n]	22.060[c]	47.590[i]	0.098[c]	n.d.
Ziana TD		0.430[e]	0.840[a,b]	16.810[k]	89.830[i]	18.380[g]	49.010[f]	0.099[c]	n.d.
Potaissa TD		0.470[a,b]	0.810[d,e]	20.710[a]	99.960[c]	26.480[a]	52.970[b]	0.136[a]	n.d.
Romina TD		0.460[b,c]	0.820[c,d]	19.610[c]	89.190[j]	17.370[k]	47.900[g]	0.098[c]	n.d.
Avatar		0.470[a,b]	0.810[d,e]	17.810[h]	90.030[h]	22.140[b]	44.120[m]	0.118[b]	n.d.
Average		**0.463**	**0.824**	**17.902**	**91.870**	**19.346**	**48.580**	**0.114**	-
St. Dev.		**0.014**	**0.016**	**1.582**	**9.843**	**2.674**	**3.752**	**0.016**	-

The values are expressed as means ± standard deviations (n =2). Values followed by different letters in the same column are significantly different ($p<0.05$). n.d., not detected; below the limit of detection.

The mineral (calcium, magnesium, iron, zinc, sodium, cadmium and phosphorus) concentrations (mg/100 g) of the flour sample of the soya bean were determined (Etiosa et al., 2017). Phosphorus had the highest (695.20 mg/100 g) followed by calcium 300.36 mg/100 g, zinc had the lowest value of 2.7 mg/100 g of mineral while cadmium was not detected. Calcium content of 300.36 mg/100 g obtained was far higher than range of values 62.93 mg/100 g - 217.38 mg/100 g reported (Eshun, 2012). An experiment conducted by Nwosu et al. (2019), analysed soybean genotypes in term of mineral composition. Calcium content ranged between 0.58-1.60%, while phosphorus exhibited a range values from 0.26 to 0.85%. The concentrations of several nutritionally significant minerals (P, K, Ca, Mg, Mn, Fe, Al, Cu, Zn, and Na) were determined in 16 samples of soybean meal obtained from the 2009 U.S. harvest (Batal et al., 2010). The mean mineral contents were 0.67% for phosphorus, 0.31% for calcium, 41 mg/kg for manganese, 172 mg/kg for iron, 15 mg/kg for copper, and 48 mg/kg for zinc. Compared with our results, manganese and iron concentrations were higher, whereas phosphorus, calcium, and copper levels were lower. Zinc content was comparable between the two studies.

CONCLUSIONS

Significant differences in proximate composition and mineral content were observed among the cereal and legume varieties cultivated in the western region of Romania. The present study confirms that cereal grains of different genotypes exhibit substantial variation in chemical composition and mineral characteristics, highlighting the importance of genotype selection in breeding and nutritional improvement programs. For certain parameters, the average chemical composition determined in this study differed from those reported in previous research, while for others, comparable values were obtained. Despite standardized agronomic practices, the potential effects of location and agronomic practices on chemical composition remain evident, warranting further investigation to optimize both yield and nutritional quality.

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