DOI: https://doi.org/10.53040/cga12.42 UDC: 633.15:631.527.5

VARIABILITY OF THE PHYSICOCHEMICAL PROPERTIES OF SELECTED MAIZE GENOTYPES AND PROSPECTS OF THEIR APPLICATION FOR VARIOUS PURPOSES

Valentina NIKOLIĆ, ORCID: 0000-0002-5834-6683
valentinas@mrizp.rs
Slađana ŽILIĆ, ORCID: 0000-0001-8299-9185
Marijana SIMIĆ, ORCID: 0000-6719-7982
Beka SARIĆ, ORCID: 0000-0001-5918-6151
Danka MILOVANOVIĆ, ORCID: 0000-0002-6915-2606
Vojka BABIĆ, ORCID: 0000-0002-2719-1260

Maize Research Institute Zemun Polje, Slobodana Bajića 1, Belgrade, Serbia

Abstract. *This study aimed to analyze the grain's physical properties and chemical composition from fifteen maize hybrids produced and cultivated at the Maize Research Institute Zemun Polje, Serbia. The investigated genotypes were selected based on their diverse genetic backgrounds and different FAO maturity groups (100-700). The results showed notable differences in the physical and chemical characteristics of the investigated maize genotypes, indicating they could be beneficial for various uses in food and animal feed production, as well as in different processing industries. The 1000 kernel weight, a desirable attribute for wet milling as it typically results in increased starch and protein yields, varied between 255.70 g and 411.10 g, while starch content ranged from 65.45 to 70.18 % dry matter (d.m.) basis. Protein content (10.31-12.12%) further qualifies studied grains as valuable sources of nutrients. These findings suggest that selecting appropriate hybrids based on their genetic traits can optimize yield and quality for specific applications. Further research is needed to explore the potential of these hybrids in enhancing food security and sustainability within agricultural practices.*

Keywords: chemical composition, genetic variability, maize genotypes, physical properties, potential application.

INTRODUCTION

Maize (*Zea mays* L.) is regarded as one of the most important cereal crops utilized as a raw material for food, feed, energy, and industrial applications. Approximately 1.22 billion metric tons of maize were produced globally during the 2024–2025 timeframe, according to data from USDA (2025) [1]. Despite maize being a crucial food crop, its demand as livestock feed has markedly risen over the past twenty years. This was mostly attributable to the swift economic growth in the densely populated regions of Asia, the Middle East, and South America, which heightened the demand for food products from chicken and cattle among affluent consumers.

The chemical makeup of maize grains largely determines their usable value; however, the intrinsic value of maize depends on its application; each new use increases its worth [2]. The extensive variety of maize grain characteristics enables modifications in grain composition concerning the quantity and quality of specific components. This is accomplished through the breeding process [3]. Maize grain comprises roughly 70% starch on average [2]. Additionally, certain experts assert that maize serves as an important framework for investigating genetics, evolution, and domestication. The Organisation for Economic Co-operation and Development (OECD), in conjunction with the Food and Agriculture Organization of the United Nations (FAO), states that maize will persist in its expansion and diversification as a research model, industrial resource, and crop for feed and fuel in the foreseeable future (OECD/FAO, 2013). Serbia is a significant global producer of maize, and the surplus of this cereal grain, not utilized for food or animal feed, should be judiciously channelled towards the production of sustainable and eco-friendly products such as biodegradable packaging, bio plastics, biofuels, etc.

MATERIALS AND METHODS

Fifteen maize hybrids (FAO 100-700) were cultivated in a two-replicate trial following the randomized complete-block design at the experimental field of the Maize Research Institute, Zemun Polje, Serbia (44°52'N, 20°19'E, 81 m asl). Maize ears from each replication were collected at full physiological maturity from two inner rows. The experiment was conducted under rain-fed conditions in 2023. Ten representative maize ears per replication were chosen for subsequent laboratory tests. The methodologies employed to ascertain kernel physical properties, including 1000-kernel weight (TKW), test weight (TW), flotation index (FI), milling response (MR), percentage of hard endosperm (HE) in kernel weight, percentage of soft endosperm (SE) in kernel weight, and water absorption index (WAI), were thoroughly elucidated in a previously published paper (Radosavljević et al., 2000). The water absorption index was determined by quantifying the volume of water absorbed by a specific quantity of maize kernels under rigorously controlled conditions. The milling response (MR) assessed by the Stenvert-Pomeranz test (Pomeranz et al., 1985) quantifies kernel hardness, indicating the duration (s) required to grind 20 g of maize kernels in a micro hammer mill operating at 3600 rpm until the material passes through a 2-mm sieve and accumulates to a volume of 17 ml in a glass cylinder (125×25 mm). The cornmeal samples collected post-grinding of maize kernels during the experiment are combined and filtered using a 0.5 mm diameter nylon mesh. The portion that passes through the sieve is referred to as the soft endosperm, while the portion that remains is termed the hard endosperm. The fractions were subsequently measured, and the hard and soft endosperm portions were quantified. The whole grain maize flour was produced by a dry grind milling method (Perten Instruments, Hägersten, Sweden) for fine sample preparation (mesh 0.5 mm). The moisture content of the kernels

was assessed by drying the ground samples at 105˚C until a consistent weight was achieved. The starch concentration was assessed using the Ewers polarimetric method (ISO 10520, 1997). The total protein content was ascertained using the Kjeldahl method, calculated as total nitrogen multiplied by 6.25 (AOAC, 1990). The oil content was assessed using the Soxhlet standard method (AOAC, 2000). The crude fiber content was assessed using the Weende method modified for FibretecTM Systems, Foss, Denmark (Agricultural food products, 1993). The ash concentration was ascertained through the gradual burning of the sample at 650°C (AOAC, 1990). The results are shown as percentages of dry matter (d.m.). All analyses were conducted in duplicate.

RESULTS AND DISCUSSION

The results obtained after physical and chemical characterisation of the selected maize genotypes' grain are shown in Tables 1 and 2.

Table 1. Physical properties of maize hybrid grain

Hybrid	TKW	TW	FI	WAI	MR	HF	SF
ZP 161	255.70	827.06	17.45	0.208	13.80	62.82	37.18
ZP 200	285.36	791.91	82.13	0.247	12.07	57.30	42.70
ZP 341	374.83	822.65	32.45	0.254	11.67	58.56	41.44
ZP 4242	350.58	791.63	75.86	0.242	12.70	35.15	44.85
ZP 5090	339.20	778.16	75.70	0.271	11.17	57.02	42.98
ZP 555	368.71	827.81	26.53	0.253	13.20	63.28	36.72
ZP 5550	369.92	819.43	31.43	0.224	12.47	58.68	41.32
ZP 5011	377.10	821.68	25.24	0.219	14.43	62.24	37.76
ZP 606	381.88	810.32	60.87	0.204	12.50	57.79	42.21
ZP 6364	410.82	830.51	25.68	0.212	12.30	61.34	38.66
ZP 6715	353.68	835.90	21.92	0.224	12.37	60.81	39.19
ZP 707	411.10	824.86	29.61	0.196	13.20	60.72	39.28
ZP 7357	409.47	828.43	15.35	0.192	13.37	62.41	37.59
ZP 7578	379.72	819.82	61.31	0.212	11.50	55.36	44.64
ZP 7900	407.64	787.11	89.74	0.231	11.07	56.17	43.83
Min	255.70	778.16	15.35	0.19	11.07	35.15	36.72
Max	411.10	835.90	89.74	0.27	14.43	63.28	44.85
Average	365.05	814.49	44.75	0.23	12.52	57.98	40.69
SD	44.80	18.21	26.25	0.02	0.96	6.81	2.80

**TKW – 1000 kernel weight (g); TW – test weight (kg·m^{-3});FI – flotation index; WAI — water absorption index; MR – milling response (s); HE – percentage of hard endosperm portion in kernel weight; SE – percentage of soft endosperm portion in kernel weight.*

The maize genotype ZP 161 exhibited a TKW of 255.70 g, indicating a relatively high value of this parameter, which is often associated with higher grain quality and yield potential. The TW of 827.06 kg/m³ suggests good density and indicates that the grain is likely to have favorable storage and handling

characteristics. The Flotation Index (FI) of 17.45 indicates a moderate level of grain integrity, with higher values typically correlating to better quality. The WAI of 0.208 suggests a reasonable capacity for water uptake, which can influence cooking and processing characteristics. The MR of 13.80 s indicates a relatively quick milling process, which is advantageous for efficiency in grain processing. The HF of 62.82% and SF of 37.18% reveal a predominance of hard over soft endosperm, which is favourable for wholegrain flour production.

Table 2. Chemical composition of maize hybrid grain

Hybrid	Starch (%)	Protein (%)	Oil (%)	Crude fiber (%)	Ash (%)
ZP 161	66.92	11.30	4.15	2.46	1.55
ZP 200	65.45	11.45	4.12	2.41	1.53
ZP 341	66.96	10.38	4.54	2.70	1.55
ZP 4242	67.87	10.31	3.67	2.10	1.49
ZP 5090	66.53	11.87	4.33	2.63	1.55
ZP 555	67.72	11.45	4.36	2.77	1.47
ZP 5550	67.89	10.91	4.67	2.49	1.36
ZP 5011	67.43	12.12	3.82	2.46	1.54
ZP 606	69.17	10.54	2.70	2.24	1.34
ZP 6364	68.80	11.12	3.11	2.03	1.49
ZP 6715	67.10	11.46	4.29	2.61	1.41
ZP 707	67.80	11.62	4.15	2.37	1.51
ZP 7357	70.18	11.18	4.01	2.35	1.50
ZP 7578	66.80	10.63	4.30	2.30	1.43
ZP 7900	67.79	11.00	4.25	2.05	1.46
Min	65.45	10.31	2.70	2.03	1.34
Max	70.18	12.12	4.67	2.77	1.55
Average	67.63	11.16	4.03	2.40	1.48
SD	1.15	0.53	0.53	0.23	0.07

Starch (%) had the highest mean value (67.65%) among all genotypes, with a moderate standard deviation (0.60), indicating some variability across hybrids. The starch content ranged from 65.45% to 70.18%. Protein (%) averages 11.16% with a standard deviation of 0.58, suggesting relatively consistent protein levels among the hybrids (range: 10.31% to 12.12%). Oil (%) had a mean of 3.99% and a standard deviation of 0.58, with values ranging from 2.70% to 4.67%. Crude fiber (%) shows a mean of 2.40% and a low standard deviation (0.24), indicating little variation (range: 2.03% to 2.77%). - Ash (%) has the lowest mean (1.48%) and the lowest variability (std dev 0.07), with values between 1.34% and 1.55%. Overall, starch was the predominant component, while ash and crude fiber were present in

smaller and more consistent amounts. The relatively low standard deviations for most components suggest that the chemical composition is fairly stable across the maize hybrids in this investigation. The results are in accordance with previously published studies conducted in Maize Research Institute, Zemun Polje [2, 3, 9, 10].

CONCLUSIONS

The grain of the investigated maize genotypes showed significant differences regarding physical and chemical properties, offering a diverse spectrum of applications in the production of food, animal feed and various industries.

Acknowledgement: This study was supported by the Ministry of Science, Technological Development, and Innovation of the Republic of Serbia (Grant No. 451-03-136/2025-03/200040).

REFERENCES

1. USDA, Foreign Agricultural Service, U.S. Department of Agriculture, 2025, Production – Corn, [accessed 13.05.2025.] https://www.fas.usda.gov/data/production/commodity/0440000
2. MILOVANOVIĆ, Danka, NIKOLIĆ, Valentina, SARIĆ, Beka, SIMIĆ, Marijana, ŽILIĆ, Slađana. Comparison of wet-milling properties and starch characterization of ten maize genotypes for potential food industry applications. In: *Genetika*. 2024. vol 56, nr 3, pp 459-474. . ISSN 1820-6069.
3. NIKOLIĆ, Valentina, Babić,Vojka , KRAVIĆ, Natalija, FILIPOVIĆ, Milomir, ŽILIĆ, Slađana, Simić, MARIJANA, RADOSAVLJEVIĆ. The variability and interdependence of basic technological quality parameters of maize hybrids in long-term research. Selekcija i semenarstvo. 2022, vol 27, nr 2, pp. 21-33. ISSN 0354-5881
4. Agricultural food products (1993): Determination of crude fibre. General method NF-V03-040 (status: certified standard ref. ISO 5498), Assn. Fr. De Normalisation, Paris.
5. AOAC (1990): Association of Official Analytical Chemists, Official Methods of Analysis, ed. by Herlich K. AOAC, Arlington, VA. pp. 70–84.
6. AOAC (2000): Association of Official Analytical Chemists, Official Methods of Analysis, 17th international edition. AOAC International, Gaithersburg, MD.
7. ISO 10520 (1997): Determination of starch content - Ewers polarimetric method. International standard, 1: 1-8
8. POMERANZ Y, CZUCHJOWSKA Z, MARTIN C R, LAI F. Determination of corn hardness by Stenvert hardness tester, 1985, *Cereal Chemistry*, vol 62, pp. 108–110. ISSN 0009-0352.
9. RADOSAVLJEVIĆ M, BEKRIĆ V, BOŽOVIĆ I, JAKOVLJEVIĆ J (2000): Physical and chemical properties of various corn genotypes as a criterion of technological quality. *Genetika*, 2000, vol 32, nr 3, pp. 319–329. ISSN 1820-6069.
10. SEMENČENKO, Valentina, RADOSAVLJEVIĆ Milica, TERZIĆ Dušanka, MILAŠINOVIĆ-ŠEREMEŠIĆ Marija, TODOROVIĆ Goran, MOJOVIĆ, Ljiljana. A genetic base of utilisation of maize grain as a valuable renewable raw material for bioethanol production. *Genetika.* 2015, vol 47, nr 1, pp. 171-184. ISSN 1820-6069.