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RESEARCH ON DETERMINATION OF LUTEIN AND ZEAXANTHIN CONTENT IN SUGAR CORN GROWN IN BLACK CRIȘULUI MEADOW UNDER THE CONDITIONS OF THE YEAR 2025, ROMANIA

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Abstract. *This research investigates how different fertilization strategies influence the accumulation of lutein and zeaxanthin in sweet corn grown in the Crișului Negru Meadow. The experimental design included four treatment variants: a non-fertilized control variant, a compost-based organic fertilized variant, a mineral-fertilized variant with NPK complex fertilizer, and a combined variant consisting of NPK supplemented with microelements. Carotenoid concentrations were determined by high-performance liquid chromatography (HPLC). The data obtained contribute to a better understanding of the relationship between fertilization practices and the nutritional profile of sugar maize, highlighting the potential of organic nutrient management in increasing the concentration of phytochemicals with beneficial effects on health.*

Keywords: lutein and zeaxanthin, organic fertilization, carotenoids, HPLC chromatography.

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1. Introduction

Agronomy and carotenoids are areas of major interest in the current context of the development of functional foods and agriculture oriented towards nutritional quality [1], [4]. In this context, sugar maize (*Zea mays saccharata*) occupies an important place both for its economic value and for its high content of bioactive compounds with beneficial effects on human health [1], [5]. Due to its pleasant

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taste, high sugar content and its varied use in the food industry, sugar corn is considered one of the most valued horticultural and agricultural crops [4].

In addition to their energy and technological value, sugar maize grains are an important source of carotenoids, especially lutein and zeaxanthin [1], [5], [6, 7]. These compounds play an essential role in protecting the body against oxidative stress and are recognized for their contribution to maintaining eye health [1]. Lutein and zeaxanthin accumulate in the retinal macula, where they filter blue light radiation and reduce the risk of age-related macular degeneration (AMD) [1], [5]. For this reason, interest in identifying plant sources rich in these carotenoids has increased significantly in recent years [2], [8].

The lutein and zeaxanthin content of sugar maize is influenced by a number of genetic, pedoclimatic and technological factors, among which fertilization plays a decisive role [2], [3], [8]. The type and manner of fertilizer administration influences the physiological and metabolic processes of the plant, including the biosynthesis of carotenoid compounds [2], [4]. Organic fertilization can help improve soil structure and biological activity, favoring balanced nutrient uptake and accumulation of bioactive compounds [4]. At the same time, NPK-based mineral fertilisation ensures the rapid availability of essential nutrients for crop growth and development [4]. Supplementation with microelements can intensify the enzymatic processes involved in the synthesis of carotenoid pigments [2], [8].

In the current conditions of modern agriculture, which are increasingly oriented towards obtaining products with high nutritional value, the evaluation of the influence of different fertilization technologies on the biochemical quality of sugar maize is of particular practical and scientific importance [2], [4]. Studies on the accumulation of lutein and zeaxanthin according to the fertilization system can contribute to the optimization of nutrient management and the development of sustainable agricultural technologies [2], [8].

The research presented in this paper was carried out in the specific pedoclimatic conditions of the Crișului Negru Meadowl, in the village of Căpâlna, an area characterized by fertile alluvial soils and favorable conditions for the cultivation of sugar corn. The aim of the study was to evaluate the influence of organic and mineral fertilization on the lutein and zeaxanthin content of the berries of the DessertR78 hybrid, using the high-performance liquid chromatography (HPLC) method. The results obtained contribute to highlighting the relationship between fertilization technology and the nutritional value of sugar maize, providing useful information for the development of efficient agricultural practices oriented towards the production of functional food [2], [5], [8].

2.Materials and methods

The research on the determination of the lutein and zeaxanthin content of sugar corn was carried out under the conditions of 2025, in the area of the Crișului Negru meadow, Căpâlna village, Bihor County, an agricultural region recognized for its high soil fertility and favorable conditions for corn cultivation. The study looked at the influence of different fertilization systems on the accumulation of carotenoids in sugar corn kernels.

Fig. 1. Black Crisul Meadow

The soil on which the experiment was carried out is a gleated alluvial soil, specific to meadow areas, characterized by a clayey-clayey texture, high fertility and good water retention capacity. This type of soil favors the optimal development of maize crops due to the high availability of nutrients and the favorable water regime.

The biological material used in the experiment was represented by the sweet corn hybrid DessertR78, appreciated for its high sugar content and for the ability to accumulate carotenoid compounds, especially lutein and zeaxanthin. The hybrid has a good adaptability to the pedoclimatic conditions specific to the alluvial areas in western Romania.

The experiment was organized according to the Latin rectangle method, an experimental method used to reduce the influence of uncontrolled variations of environmental factors and to increase the statistical accuracy of the results. Four experimental variants were placed, each plot having the dimensions of 5 m wide and 20 m long.

Photo 2. Dessert R78

The following fertilization variants were applied in the experiment:

- V1 – unfertilized control;
- V2 – compost-based organic fertilization;
- V3 – mineral fertilization with NPK complex fertilizer;
- V4 – fertilization with NPK complex fertilizer supplemented with microelements (Fe, Zn, Mn, Cu and Mo).

The sowing of sugar corn was carried out in two different eras, in order to assess the influence of climatic conditions on the accumulation of carotenoids. The cultivation technology applied was uniform for all experimental variants, the differences between the plots being determined exclusively by the type of fertilization used.

Photo 3. Sowing sweet corn

Table 1. Climate data 2025

Month	Amount of precipitation	Average air temperature
January	28.2	3.4
February	12.2	1
March	84.0	8.9
April	9.1	12.6
May	35.3	14
June	9.0	23.3
July	42.4	23.4

The climatic conditions between January and July 2025 were generally favorable for the development of sugar corn. Temperatures rose progressively from 1.0°C in February to over 23°C in June and July, ensuring optimal conditions for the growth and maturation of the crop, as well as for the accumulation of carotenoids.

The rainfall pattern was uneven. The highest amount of precipitation was recorded in March (84.0 l/m²), while the months of April and June were characterized by water deficit, with about 9 l/m². These periods of drought, associated with high summer temperatures, may have influenced plant development and the lutein and zeaxanthin content of sugar corn grains.

Sample collection was carried out at full maturity of the plants, at which time the berries reached optimal development and maximum concentration of carotenoids. Ten representative cobs were harvested from each experimental variant, and the beans were separated by hand and prepared for laboratory analysis.

The determination of the lutein and zeaxanthin content was carried out by the high-performance liquid chromatography (HPLC) method, a method recognized for its high sensitivity and accuracy in the analysis of carotenoids. The analyses were carried out at the University of Debrecen using the HITACHI Elite LaChrom HPLC system (Merck, Darmstadt, Germany), equipped with a quaternary pump, automatic injector and diode string detector (DAD). The separation and quantification of the compounds were carried out based on the analytical standards of lutein and zeaxanthin, using the external calibration method.

The extraction of carotenoids from the samples of sugar corn was carried out with acetone, after which the extracts were filtered and introduced into the chromatographic system. The identification of the compounds was carried out based on the retention times and absorption spectra specific to the standards used.

For the interpretation of the results, the descriptive statistical indicators, respectively the mean and the standard deviation for each experimental variant, were calculated. The evaluation of the differences between the fertilization variants was carried out by analysis of variance (ANOVA), and in order to identify the statistically significant differences between the means, post-hoc tests were applied at the significance threshold $p<0.05$.

2. Results and discussions

The results obtained highlighted the significant influence of fertilization on the lutein and zeaxanthin content of sugar corn grains grown under the conditions of 2025. The determined values varied depending on the type of fertilization applied and the sowing time (Table 2).

Table 2. Lutein content (%) in sugar corn grains by fertilization and sowing time from 2025

Variation	Epoch I	Epoch II	Media (%)	Difference from the witness	Statistical significance (p<0.05)
V1	0.44	0.44	0.44	-	-
V2	0.60	0.62	0.61	+38.64	Significant
V3	0.51	0.52	0.51	+15.91	Significant
V4	0.52	0.54	0.53	+20.45	Significant

As for the lutein content, the lowest values were recorded in the control version (V1), where the average was 0.44%. The application of organic fertilization with compost (V2) caused the highest accumulation of lutein, the average reaching 0.61%, which represents an increase of 38.64% compared to the control. The variants fertilized with NPK (V3) and NPK supplemented with microelements (V4) also showed values higher than the control, respectively 0.51% and 0.53%, the differences being statistically significant ($p<0.05$).

The results suggest that organic fertilization favors the accumulation of lutein to a greater extent than mineral fertilization. This effect can be explained by the improvement of the physical and biological properties of the soil and the gradual release of nutrients, which stimulate the metabolic processes involved in the biosynthesis of carotenoids.

Table 3. Zeaxanthin content (%) in sugar maize grains by fertilization and sowing time from 2025

Variation	Epoch I	Epoch II	Media	Difference from the witness	Statistical significance ($p<0.05$)
V1	0.23	0.23	0.23	-	-
V2	0.36	0.38	0.37	+60.87%	Significant
V3	0.29	0.30	0.30	+30.43%	Significant
V4	0.30	0.30	0.30	+30.43%	Significant

The content of zeaxanthin followed a similar trend. The control variant recorded the lowest average value, of 0.23%, while organic fertilization (V2) determined the highest concentration, respectively 0.37%, representing an increase of 60.87% compared to the non-fertilized version. The variants fertilized with NPK and NPK + microelements recorded average values of 0.30%, with statistically significant differences compared to the control.

The results obtained confirm that the application of fertilization positively influences the accumulation of carotenoids in sugar corn grains. Organic fertilization has proven to be the most effective option for increasing the lutein and zeaxanthin content, highlighting the importance of using sustainable agricultural technologies aimed at improving the nutritional value of agricultural production.

The relatively small differences between the sowing times indicate that the type of fertilization had a greater influence on the carotenoid content than the time of sowing. At the same time, the climatic conditions in 2025, characterized by favorable temperatures and unevenly distributed rainfall, may have contributed to the variations observed between the experimental variants.

The results of this study are in line with research in the literature, which highlights the role of fertilization and nutritional management in stimulating the accumulation of bioactive compounds in agricultural crops.

Conclusions

Following the research carried out on the influence of fertilization on the lutein and zeaxanthin content of sugar corn grown in Lunca Crișului Negru, under the conditions of 2025, the following conclusions can be formulated:

(1) Fertilization significantly influenced the accumulation of carotenoids in sugar corn grains, all fertilized variants showing higher values compared to the control variant.

(2) The highest concentration of lutein and zeaxanthin was recorded in the organically fertilized compost (V2) version, demonstrating the efficiency of organic fertilization in stimulating the synthesis of bioactive compounds.
(3) Mineral fertilization with NPK and fertilization with NPK supplemented with microelements also led to significant increases in carotenoid content, but the values obtained were lower than the organic variant.
(4) The average lutein content increased by up to 38.64% and that of zeaxanthin by up to 60.87% compared to the non-fertilized version, highlighting the positive effect of nutritional management on the biochemical quality of production.
(5) The differences between the sowing times were reduced, indicating that the type of fertilization had a greater influence on the carotenoid content than the time of sowing.
(6) The climatic conditions of 2025, characterized by favorable temperatures and unevenly distributed rainfall, influenced the development of the crop and the accumulation of carotenoid compounds.
(7) The results obtained confirm the importance of using organic fertilization and sustainable agricultural technologies to increase the nutritional value of sugar maize and to obtain agricultural products with high functional potential.

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