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QUANTITATIVE ANALYSIS OF NUTRITIONAL BIOACTIVE COMPOUNDS IN SOME MAIZE CULTIVARS (*ZEA MAYS* L.)

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ABSTRACT

Four maize cultivars grown locally, in Constanța county, were anlayized for their bioactive compounds contents.
They were found to contain variable amounts of carotenoids, 10-45 mg/kg, with notable amounts of lutein and lycopene. Phenolic inventory varied between 7,651-10,622 mg/kg, of which hydroxybenzoic acids were dominant (45-63%), followed by flavonoids (mostly flavanols, 21-29%). Ascorbic acid concentration was 165-219 mg/kg.
Soluble sugars were highly variable, with 24,558-62,327 mg/kg, the same being true for lipids, with 24,667-38,000 mg/kg. Oil content ranged from 6.1% in non-irrigated plants to over 11.7% in irrigated ones.
Among the four hybrids, P9415 scored highest in terms of carotenoids (total, lutein, lycopene), total phenolics, hydroxybenzoic acids; P0710 in terms of xanthins, flavonoids, anthocyanins, coumarins and stilbenes; P0023 in ascorbic acid and free sugars, while P0216 in terms of lipid content.

INTRODUCTION

Maize or corn (*Zea mays* L.) is one of the main crops worldwide. A key ingredient of human diet, maize grains and derivatives are mainly a source of starch, soluble sugars and lipid oil.

However, maize also contains many other valuable nutrients, which are drawing more and more attention, due to their benefits to human health. These include various carotenoids and the vast category of phenolic compounds: anthocyanins such as cyanidin, peonidin and pelargonidin glucosides, phenolic acids like caffeic, chlorogenic and especially ferulic acids, and flavonoids including rutin, quercetin, moringenin and especially morin and kaempferol.

These compounds are known to have various positive properties such as antitumoral, antiobesity, neuroprotective and generic antioxidant ones (Cristianini et al. 2020, Navarro et al. 2018).

The objective of this paper was to determine the bioactive compounds contents in four corn hybrids widely grown in Dobruja region.

MATERIAL AND METHODS

Four maize hybrids, namely Pioneer P0023, P0216, P0710 and P9415, were taken into analysis. Grains were collected from local farmers in Constanța county,

and taken for laboratory analyses to the „Ovidius" University. Samples were taken from a farm located inthe Cernavoda plateau, on the middle course of the Carasu Valley. The soil type is carbonaceous chernozem. The average monthly temperatures is 14.8ºC compared to the normal average of 11.6ºC. Annual precipitation of 318.10 mm compared to the normal 436 mm. The soils cultivated with the four hybrids were irrigated, through three interventions with a water input by aspersion with the norm of 400 m^3 per hectare.

According to the producer, P0023 is a medium-sized, aize variety. With median cob insertion, compact cob and dentate grains. A semi-tardive hybrid (FAO 400 group), it is drought-resistant and easily loses water at mature stage. 1,000-grain weight is 340-395 g.

P0216 is a semi-tardive (FAO 450) hybrid, also drought-resistant, with a strong root system. Cobs have high insertion and dentate grains. Has high resistance to corn smut. 1,000-grain weight is 365-400 g.

P0710 is also semi-tardive (FAO 450), with deep roots, and good resistance to drought, eroded soils and fall. 1,000-grain weight is 430-450 g.

P9415 is a semi-early hybrid (FAO 340), resistant to drought and acidic soils. 1,000-grain weight is 355-395 g (Corteva Agriscience).

For most analyses, grains were ground and extracted in 70% ethanol at 10% final concentration.

Total carotenoids were determined by dilution in 80% acetone and spectrophotometric absorption reading (ONDA UV-21 spectrophotometer) at 470 nm (Popoviciu et al. 2023).

Among individual carotenoids, β-carotene, lycopene, lutein (and lutein esters), cryptoxanthin and zeaxanthin were determined by dilution in acetone: petroleum ether, petroleum ether, ether, acetone, respectively ethanol and determining absorbance at 445, 446, 453, 505, 645, 663 nm according to Braniša et al. 2014, Sujith et al. 2010, Biehler et al. 2009, Butnariu et al. 2014.

The total amounts of phenolic compounds, Flavanols (catechins), by dilution in 70% ethanol and reading at 280 nm (Yaneva et al. 2020). Anthocyanins, by dilution in 70% ethanol and reading at 520 and 700 nm (Braniša et al. 2014).

Tannins were determined after thermal hydrolysis in water-hydrochloric acid mixture and reading at 550 nm (Moutari et al. 2018). Stilbenes, by dilution in 70% ethanol and reading at 304 nm (Bancuta et al. 2015). Coumarins, by dilution in 80% methanol and reading at 275 nm (Soares e Silva et al., 2012).

Total ascorbic and dehydroascorbic acid were determined by ethanol dilution, reaction with ammonium molybdate and sulfuric acid, and spectrophotometric reading at 494 nm (Riscahyani et al. 2019). Total soluble carbohydrates were determined by reacting extracts with sulfuric acid and phenol (5%) and reading at 490 nm (Agrawal et al. 2015).

Lipids were determined by grinding achenes in petroleum ether, filtration, solvent evaporation and gravimetry (Orphanides et al. 2011).

RESULTS AND DISCUSSIONS

The concentrations of various classes of compounds with bioactive potential are shown in Figures 1-2 and Table 1.

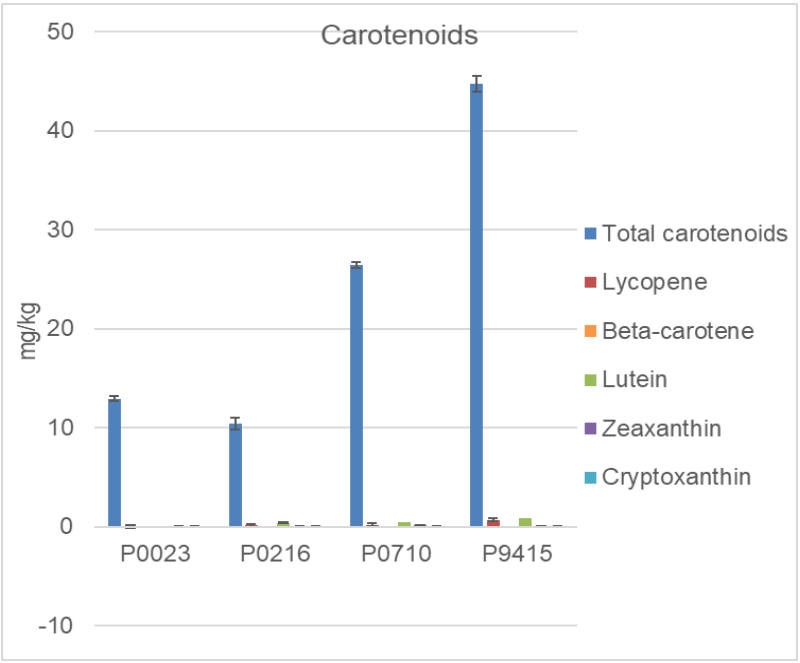

Figure 1. Concentrations of total and some individual carotenoids in corn grains (mg/kg FW).

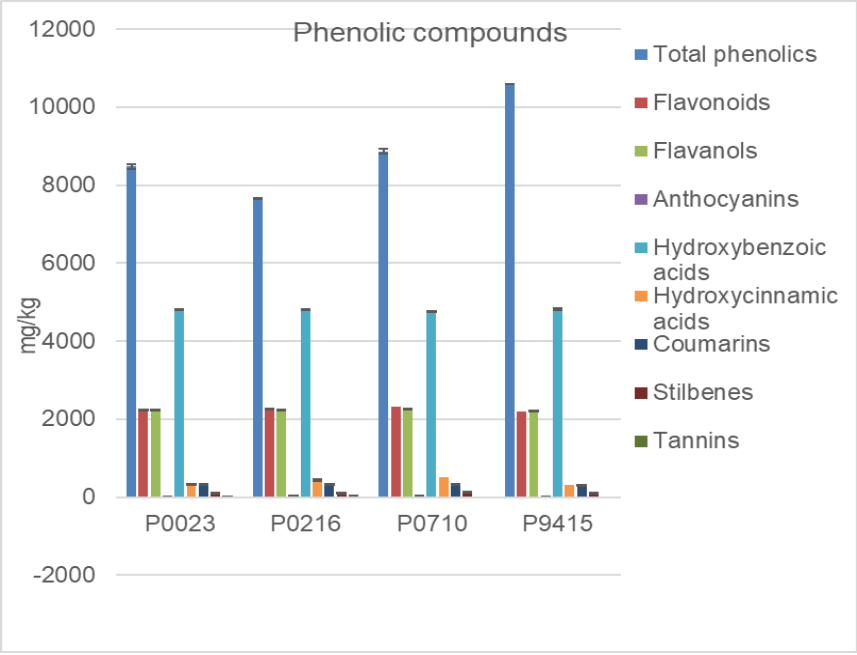

Figure 2. Concentrations of total phenolic compounds and some subclasses in corn grains (mg/kg FW).

Table 1. Other compound classes in corn grains (mg/kg FW).

	Ascorbic acid	Soluble Sugars	Lipids
P0023	219±3	62,327±804	26,667±192
P0216	205±5	50,263±679	38,000±333
P0710	203±3	40,873±540	24,667±192
P9415	165±2	24,558±405	31,000±333

Average carotenoid content was highly variable (Fig. 1), from 10 to 45 mg/kg, with the highest value in P9415 hybrid. Lycopene and lutein also reached their highest amounts (0.70 and 0.87 mg/kg, respectively), in this hybrid, while below detection limit in P0023. β-carotene was below detection limit in all hybrids, while xanthins were above 0.1 mg/kg only in P0710 (0.20 mg/kg, of which 80% zeaxanthin) and P9415 (0.14 mg/kg, of which 51% zeaxanthin). Values around 10 mg/kg are common for yellow maize varieties (da Cruz et al. 2022), with lutein and xanthins being usually dominant (Bacchetti et al. 2013).

Average total phenolic content also varied, with a minimum of 7,651 mg/kg (P0216) and a maximum of 10,622 mg/kg (P9415).

The dominant fraction was constituted by phenolic acids, especially hydroxybenzoic ones, with 4,759-4,821 mg/kg (45-63% of the phenolic inventory). Hydroxycinnamic acids only ranged between 318-516 mg/kg, with the maximum in P0710 hybrid.

Flavonoids were 2,206-2,307 mg/kg (21-29%), dominated by flavanols. Coumarins were 323-330 mg/kg, while stilbenes. 100-126 mg/kg. Tannins only formed a minor fraction of the phenolic inventory (from below detection limit to 40 mg/kg, maximum in P0216), the same being true for anthocyanins (up to 43 mg/kg in P0710).

Various researches have shown that phenolic content in maize is highly variable. Many cultivars have values below 2,000 mg/kg (Zhang et al. 2017; Sinay et al. 2022). Performant hybrids, however, can exhibit values over 5,000 mg/kg (da Cruz et al. 2022).

Flavonoids are always a minoritary fraction, of 5-30% (Sinay et al. 2022). They tend to have lower levels in yellow varieties than in red or blue ones, partly due to an obviously lower level of anthocyanins (Martínez-Martínez et al. 2019). On the other hand, phenolic acids are known to be dominant in maize, as in most cereals (like protocatechuic, p-hydroxybenzoic, vanillic, syringic, ferulic and caffeic ones; Dykes & Rooney 2007).

Ascorbic acid (Table 1) varied between 165 and 219 mg/kg, with the maximum in P0023. Ascorbic acid is not among the major nutrients in corn, with concentrations that are often below 100 mg/kg (Hooda & Kawatra 2013).

Much more variable was the amount of free, soluble sugars, reaching 62,327 mg/kg in P0023 and only 24,558 mg/kg in P9415. There were also differences in lipid content, with the maximum in P0216. Values of 50,000-80,000 mg/kg of soluble sugars are common in maize (Szymanek et al. 2015). Glucose, fructose and sucrose are among the main ones (Miya et al. 2018).

CONCLUSIONS

The four analyzed maize hybrids were found to contain variable amounts of carotenoids, 10-45 mg/kg, with notable amounts of lutein and lycopene.

Phenolic inventory was high compared to literature data and varied between 7,651-10,622 mg/kg, of which hydroxybenzoic acids were dominant (45-63%), followed by flavonoids (mostly flavanols, 21-29%). Ascorbic acid concentration was 165-219 mg/kg.

Soluble sugars were highly variable, with 24,558-62,327 mg/kg, the same being true for lipids, with 24,667-38,000 mg/kg. Oil content ranged from 6.1% in non-irrigated plants to over 11.7% in irrigated ones.

Among the four hybrids, P9415 scored highest in terms of carotenoids (total, lutein, lycopene), total phenolics, hydroxybenzoic acids; P0710 in terms of xanthins, flavonoids, anthocyanins, coumarins and stilbenes; P0023 in ascorbic acid and free sugars, while P0216 in terms of lipid content.

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