sciendo

DOI: 10.2478/bile-2022-0012

Biometrical Letters
Vol. 59 (2022), No. 2, 171-177

The role of maize variety (*Zea mays* L.) in shaping the grain vitamin content

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SUMMARY

The Faculty of Agronomy at the University of Life Sciences in Poznań conducted laboratory tests on the content of B vitamins in the grain of three varieties of yellow-colored fodder maize. The grains of the variety ES Metronom had the statistically significantly highest content of vitamins B1 and B9. In the case of vitamin B3, the significantly highest concentration was recorded in the grain of the variety ES Abakus, while the lowest concentration was found for the variety ES Metronom. In contrast, the grain of the variety ES Bombastic had significantly higher vitamin B6 content than that of the varieties ES Abakus and ES Metronom. The grain of the variety ES Metronom had significantly higher vitamin B9 content than the other two varieties tested. In general, it should be concluded that the content of B vitamins in maize grain is not determined by the type of maize hybrid.

Key words: maize, variety, vitamins

1. Introduction

The kernel of maize (*Zea mays* L.) is the edible part of the plant (Rouf Shah et al. 2016). This fruit provides a very wide variety of nutrients, including fiber, vitamins and minerals. The most important maize vitamins include two fat-soluble substances: vitamin A (beta-carotene) and vitamin E (Gąsiorowski 2008). Moreover, different maize varieties contain significantly different phytochemical

profiles in the flavonoid and carotenoid fractions. Blue, red and purple varieties contain more anthocyanins (up to 325 mg/100 g), including cyanidin derivatives (75–90%), peonidin derivatives (15–20%) and pelargonidin derivatives (5–10%). Yellow varieties, on the other hand, are rich in carotenoids (up to 832 ug/100 g), including fractions such as lutein (50%), zeaxanthin (40%), beta-cryptoxanthin (3%), beta-carotene (4%) and alpha-carotene (2%) (Igielska-Kalwat et al. 2015). The presence in the diet of vitamins A, C and K along with beta-carotene and selenium helps improve the functioning of the thyroid gland and the immune system. In addition to the use of maize for fodder purposes (Szulc et al. 213, Szulc et al. 2020), maize grain is widely processed into a range of products, such as maize flour, grits, starch, and various types of snacks and breakfast cereals. In addition, cornmeal is used to make flatbreads, which are mainly consumed in some northern Indian states (Mehta and Dias 1999). Due to the interest in nutraceutical development, phytochemical compounds derived from maize and their health properties have recently become a major research topic. The aim of this study was to determine the content of six vitamins in the grains of three varieties of fodder maize with yellow kernels, to better understand the nutritional and health potential of maize, and consequently to improve its consumption.

2. Methods

2.1. Varieties

The grain of three varieties of yellow-colored fodder maize was used in the experiment. These were the following varieties (hybrids): 1. ES Bombastic (FAO 230-240) – a single cross hybrid (SC); 2. ES Abakus (FAO 230-240) – a three-way cross hybrid (TC, stay-green); and 3. ES Metronom (FAO 240) – a single cross hybrid (SC, stay-green + roots power). The choice of varieties was not random, because the varieties were obtained from the same seed company, Euralis, currently Lidea.

2.2. Determination of grain vitamin content

Content of the vitamins B2, B3, B6, B9 and B12 (riboflavin, niacin, pyridoxine, folic acid, cobalamin) was analyzed using an Acquity H UPLC system equipped with a Waters Acquity PDA detector (Waters, USA) after prior enzymatic and acid extraction. The enzymatic hydrolysis was carried out for 2 hours at 50 °C in the presence of tacadiastase, and acid hydrolysis with 0.6 M hydrochloric acid in contact with a temperature of 90 °C for one hour. An Acquity UPLC® BEH C18 column (50 mm × 2.1 mm, particle size 1.7 μm) (Waters, Ireland) was used for the determinations. The phase is formed by a precipitate of methanol and 0.05 M NaH_2PO_4 containing 0.005 M hexanesulfonic acid, pH 3.0. Elution was performed using a gradient. Thiamin (B1) was converted to the thiochrome derivative with 1% potassium hexacyanoferrate (II) and immediately quantified using the Acquity UPLC® BEH C18 column (150 mm × 2.1 mm, particle size 1.7μm). The flow rate was 0.4 ml/min. The concentrations of the analyzed substances were determined using an internal standard at wavelength λ = 214 nm for vitamins B3, B6, B9 and B12, and 267 nm for vitamins B1 and B2. Compounds were identified by comparing the retention time of the analyzed peak with the retention time of the standard, and by adding a specific amount of standard to the analyzed samples and reanalyzing. The detection level is 1 μg/g.

2.3. Statistical analysis

One-way analysis of variance (ANOVA) was used to determine whether there were any statistically significant differences between the mean contents of B vitamins in maize grain. In addition, correlation coefficients were used to measure the strength of the statistical relationships between the tested vitamins. All calculations were carried out using the STATISTICA 13.3 software package (2017). Statistical significance was set at the level α = 0.05.

3. Results

The varieties considered in the study had a significant impact on the content of

vitamins B1, B3, B6, and B9. There was no significant effect from these varieties on the content of vitamins B2 and B12 (Table 1). A detailed analysis (Table 2) showed:

1) The significantly highest mean content of vitamin B1 in the grain (0.41 mg/100 ml) was obtained for the variety ES Metronom. In turn, significantly the lowest mean value of the thiamin content (0.24 mg/100 ml) was recorded for the variety ES Abakus.

2) In contrast, the significantly highest mean vitamin B3 content in the grain (3.77 mg/100 ml) was obtained for the variety ES Abakus, whereas the significantly lowest mean niacin value (3.07 mg/100 ml) was that of the variety ES Metronom.

3) The significantly highest mean vitamin B6 content in the grain (0.64 mg/100 ml) was recorded for the variety ES Bombastic. This mean was significantly different from the mean values for the varieties ES Abakus (0.53 mg/100 ml) and ES Metronom (0.47 mg/100 ml).

4) On the other hand, the significantly highest mean content of vitamin B9 in the grain (0.21 mg/100 ml) was observed for the variety ES Metronom. This mean was significantly different from the mean values for the varieties ES Bombastic (0.17 mg/100 ml) and ES Abakus (0.17 mg/100 ml).

Moreover, the power of the relationships of the tested vitamin grain contents was determined. The results are given in Table 3. Significant negative correlations were found between grain contents of vitamin B1 and vitamin B3, and between grain contents of vitamin B3 and vitamin B9. This means that:

1) If the content of vitamin B1 in the grain increases, the content of vitamin B3 in the grain tends to decrease.

2) If the content of vitamin B3 in the grain increases, the content of vitamin B9 in the grain tends to decrease.

Table 1. Results of one-way analysis (ANOVA)

Source of variability	Degrees of freedom	Mean squares					
		B1	B2	B3	B6	B9	B12
Varieties	2	0.0232**	0.0012	0.3900**	0.0232**	0.0019**	0.0100
Error	6	0.0001	0.0012	0.0033	0.0008	0.0003	0.0033

** – significant at p-value < 0.01

Table 2. Mean values of traits for varieties (mg/100 ml)

Factors	Levels of factors	B1	B2	B3	B6	B9	B12
Varieties	1	0.35 b	0.16 *ns*	3.57 b	0.64 a	0.17 b	0.13 *ns*
	2	0.24 c	0.12 *ns*	3.77 a	0.53 b	0.17 b	0.23 *ns*
	3	0.41 a	0.13 *ns*	3.07 c	0.47 b	0.21 a	0.13 *ns*

1 – ES Bombastic, 2 – ES Abakus, 3 – ES Metronom.
Values in columns marked with the same letter do not differ significantly;
ns – not significant.

Table 3. Pearson correlation coefficients for vitamins

	B1	B2	B3	B6	B9
B1					
B2	0.1995				
B3	–0.8751**	–0.1106			
B6	–0.1805	0.2300	0.5055		
B9	0.6372	–0.0710	–0.8148**	–0.6107	
B12	–0.6510	–0.4433	0.5031	–0.0589	–0.3169

** – significant at p-value < 0.01

4. Discussion

Maize grain is rich in B vitamins, which include vitamin B1 (thiamine), B2 (riboflavin), B3 (niacin), B5 (pantothenic acid), and B6 (pyridoxine) (Serna-Saldivar 2010). Thiamin, i.e. aneurin, is necessary for carbohydrate oxidation, as it is part of acetyl coenzyme A carboxylase and enzymes that control energy intake from the diet. Its deficiency may result in disorders in metabolic processes, damage to tissues that produce energy from carbohydrate oxidation, or disturbances in amino acid metabolism. Losses of this vitamin in the grain during

storage are low. Riboflavin is a component of flavin mononucleotide and flavin adenine dinucleotide. It is involved in the metabolism of sugars, amino acids or fatty acids. However, it is present in small amounts in the grain (Gąsiorowski 2008). Ascorbic acid, which is a precursor of vitamin C, is therefore a good target for product biofortification (Smirnoff 2000).

Finally, it should be noted that the inference is based on small samples (due to analysis costs). This means that some caution should be exercised in drawing final conclusions.

5. Conclusions

The tested cultivars differed in the content of individual vitamins from group B. The grain of the variety ES Metronom had the highest contents of vitamins B1 and B9. As regards vitamin B3, the significantly highest concentration was determined in the grain of the variety ES Abakus, and the lowest in the variety ES Metronom. In contrast, the grain of the variety ES Bombastic had a higher vitamin B6 content than the varieties ES Abakus and ES Metronom. The grain of the variety ES Metronom had a significantly higher vitamin B9 content than the other two varieties. For vitamins B2 and B12, there was no significant effect of the variety on the content of these vitamins in the grain. In addition, the results indicate a negative correlation between the grain contents of vitamin B1 and vitamin B3, and between the grain contents of vitamin B3 and vitamin B9.

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