

RESEARCH ON THE QUALITY OF SWEET CORN HYBRIDS GROWN UNDER THE CONDITIONS OF TRANSYLVANIAN PLAIN

Greco (Păcurar) Luana¹, Maria Apahidean², Voichita Has¹, Alexandru I. Apahidean^{2*}, F. Russu¹

¹Turda Agricultural Development Research Station (SCDA Turda), 27 Agriculturii, Street, Turda, Cluj, Turda; ²University of Agricultural Sciences and Veterinary Medicine, 3-5 Mănăștur Street, Cluj-Napoca, 400372, România; *Corresponding author: apahidean_alx@yahoo.co.uk

Abstract: Carotenoids have antioxidant functions in plant photosynthetic processes, as well as in actions of disease reduction in mammalian systems. Lutein and zeaxanthin are important dietary carotenoids. Sweet corn is one of only a few vegetable sources high in zeaxanthin. Zeaxanthin, along lutein, are the major carotenoids contributing to the characteristic color of sweet-corn. From a human health perspective, these two carotenoids are also specifically accumulated in the human retina, and are thought to protect the photoreceptor cells of the eye from blue light oxidative damage and to improve visual acuity. As humans cannot synthesize these compounds, they must be accumulated from dietary components containing zeaxanthin and lutein. Seven sweet corn hybrids were tested, purpose being to identify carotenoid content of each hybrid, differences between them and the way that pedo-climatic conditions of Transylvanian Plain influence carotenoid content. The experience was set up in two different locations. Average carotenoid content obtained in the two locations is higher at Jubilee hybrid. Highest values of β -cryptoxanthin and zeaxanthin content are recorded by the Jubilee hybrid in both localities.

Keywords: grains, carotenoids, β -cryptoxanthin, zeaxanthin.

INTRODUCTION

Sweet corn, belonging to *Zea Mays*, is a monocotyledon from Gramineae family, var. *rugosa* (Bonaf), convar. *Saccharata* (Sturt.), and differentiates from normal maize by the presence of one or more mutant genes that affect the metabolism of carbohydrates in the endosperm (Săvulescu and Zaharidi 1957). Goldman and Tracy, (1994) state that sweet corn is one of the most sought-after vegetables on the American market, occupying seventh place from freshly consumed vegetables. In the US, sweet corn is one of the most popular vegetables, being consumed almost all year round both fresh and preserved (annual consumption is 4 kg/capita).

At technological maturity, grains contain 25-27% dry matter, 14-15% carbohydrates, 5-5.5% protein, 0.75% fat and amino acids: tryptophan and lysine. It also contains: vitamins: C-6.5 mg, B1- 0.4 mg, B2- 0.08 mg, B6- 3.8 mg, PP-1.2 mg, E- 1.3 mg, and mineral elements: K- 311 mg, P-125 mg, Ca-19 mg, Mg-117 mg, Fe-7 mg, (Bojurian and Turcanu 1980 quoted by Stan, 1992), energy value being 370 kJ. Values are reported per 100 g of fresh product. Sweet corn is consumed in milk-wax phase when grain consists of endosperm and ovary wall (the immature pericarp). Sweetness is the main component of sweet corn taste. Sweet corn is consumed as cooked corn, used to cook various pizzas, steaks, stews, corn cream soups, or as a raw material for preservation. For preservation, whole or pureed beans are used (Jugenheimer, 1976). Grinded sweet corn can be used to prepare many pastry products (Vâlceanu, 1982).

High food value of sweet corn has made the areas cultivated with sweet corn to grow over past two decades even in countries with no tradition for this crop (Tindall, 1983; Tracy, 1994; Voichița Has, 1998). Mature corn grains are rich in carotenoids. Pink grain color, reminiscent of the color of flamingo birds and salmon, is due to these carotenoids. Individual carotenoids can concentrate in certain tissues, providing specific protective effects. For example, lutein, found in fodder cabbage, turnips, peas, spinach and salad, is the main carotenoid concentrated in the retina. As a supplement, it reduces the risk of macular degeneration (<http://aaccipublications.aaccnet.org/doi/abs>). In humans, carotenoids function as biological antioxidants, protecting cells from the destructive effects of free radicals (<http://www.csid.ro/health/sanatate/betacaroten-pentru-sanatate-efect-antioxidant>).

Accumulation of carotenoids in maize is conditioned by temperature and humidity in the period from June to August and the brightness of June. Generally, temperatures of 18-20° C and normal precipitations positively influence the accumulation of carotenoids in all maize hybrids (<http://www.scribub.com/economie/agricultura/Porumbul-Zea-mays>).

MATERIAL AND METHOD

Starting from food and therapeutics importance of sweet corn, which is important due to carotenoid content of cultivars, an experience was initiated at SCDA Turda, Cluj County, Romania, with seven sweet corn hybrids, purpose being to identify carotenoid content of each hybrid, differences between them and the way that pedo-climatic conditions influence carotenoid content. Experience was carried out during 2016 and was located in two different locations, as a bifactorial experience of type A X G where factor A was represented by localities (Turda and Vișoara) and factor G, the seven hybrids. Hybrids used were: First, Estival, Deliciul Verii, Dulcin, Delicios, Estival and foreign hybrid Jubilee.

In table 1 are the hybrids created at SCDA Turda, used as biological material in the experience.

Table 1

Characterization of sweet corn hybrids created at S.C.D.A. Turda

Specification	DULCIN	PRIMA	ESTIVAL	DELICIUL VERII
Year of registration	1988	1991	2002	2004
Hybrid type	trilinear	simple	trilinear	simple
Precocity (FAO)	200-300	100-200	100-200	100-200
Maturity group	Half late	Very early	Very early	Very early
Vegetation period (no. of days from sowing-harvest)	98	75-80	80-85	80-90
Grain texture	sweet	sweet	sweet	sweet
Low temperature resistance	medium	medium	medium	medium
Resistance to falling	good	low	medium	medium
Production potential (t/ha)	14.7-18.5	14.2-17.8	14.4-19.7	15.8-20.0
Average corn cob weight(g, 75% humidity)	230-270	181-209	220-230	220-240
Corn cob length (cm)	18-19	17-18	17-19	17-20
Number of rows of grains	16	10-12	16-18	16
Grain color	Yellow normal	Yellow-orange	Light yellow	Light yellow
Yield crude grains (%)	65	69	62	65
M.M.B. (seeds g)	280-290	250-260	230-240	230-235
Culture area	In all areas, irrigated, especially in leguminous pools, isolated at 80-100 m from other crops of corn.			
Density (thousands of plants)	40-50	50-60	50-60	50-60

Jubilee is a foreign hybrid, one of the most popular sweet corn hybrids in the world, with a high proliferation. Most plants form two cobs of very good quality. Grains are deep narrow, bright yellow and are excellent for freezing. This hybrid is also known as Popular or Golden Jubilee, super-sweet, with a fine aroma, and clear texture, very yellow core, attractive to the market for the yellow color. Maturation time is 85 days.

Carotenoids were determined using the UV-VIS T80 + spectrophotometer and the Flexar HPLC system (Perkin Elmer, USA), following the working protocol characteristic of carotenoid assays, determinations were made on material obtained from grains that reached technological maturity (milk - wax).

RESULTS AND DISCUSSIONS

Regarding total carotenoid content from the seven hybrids, Jubilee hybrid achieves the highest average value in the two localities, namely $11.13 \mu\text{g}/100 \text{ g}$ (fig. 1) followed by hybrid Deliciul Verii, which under conditions in Turda recorded values of $11.9 \mu\text{g}$ carotenoids/100 g. Of the seven hybrids Prima has the lowest total carotenoid content in both locations, which is probably due to the fact that this hybrid is the earliest of studied hybrids.

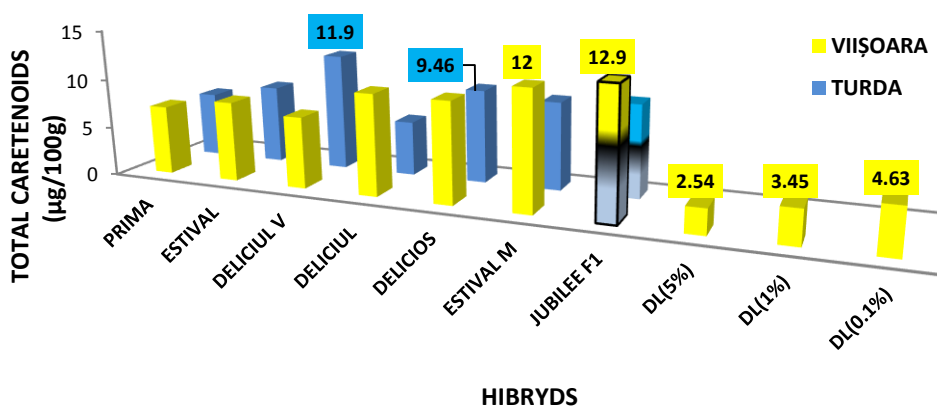


Fig. 1. Total carotenoid content in the seven hybrids in the two localities, Turda and Viișoara (2016)

From carotenoids, lutein is not synthesized the human body. It is naturally obtained from species of *Calendula officinalis* (marigold). Human body does not synthesize lutein, what is needed assimilates from vegetal foods, ex. *Spinacia oleracea* (spinach). Because of their oxidative properties, lutein and zeaxanthin act as a partially absorbing filter of light radiation.

Regarding lutein content, it can be seen that four of the seven hybrids recorded significant fluctuations in lutein content (Figure 2), which was directly influenced by the location where experience was carried out. Best hybrid among those analyzed with regard to lutein content is Deliciul Verii. Prima hybrid records low levels of lutein content, very significant negative values compared to the control (hybrids average). Also in the case of this carotenoid, vegetation period or technological precocity directly influences the process of lutein accumulation. In the other hybrids studied, lutein content varies between $3.24 - 7.33 \mu\text{g}$ lutein/100 g. Lutein and zeaxanthin are present in retina, eating foods rich in these carotenoids may slow vision degradation, preventing cataracts.

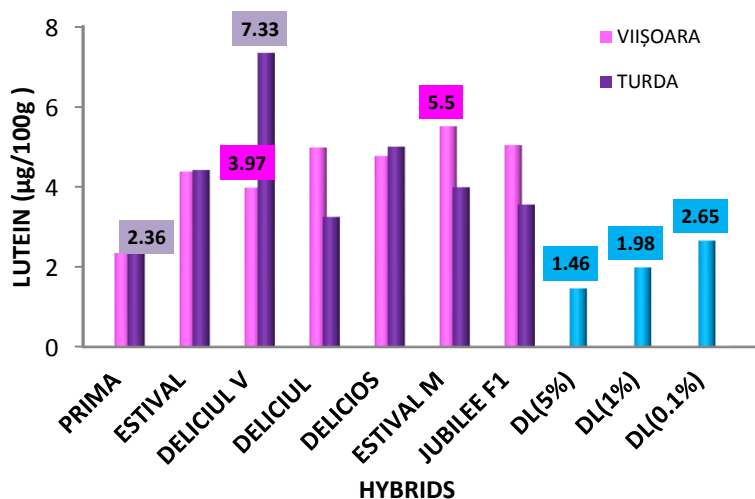


Fig. 2. Content of lutein in the seven hybrids in Turda and Viișoara (2016)

Zeaxanthin is the most predominant of carotenoids. Graphical representation of the behavior of the seven hybrids in concerning zeaxanthin content is presented in figure 3. Most hybrids recorded higher values of zeaxanthin content under conditions of Viișoara, lowest values being obtained by Estival and Deliciul Verii hybrids that recorded values significantly lower zeaxanthin values compared to experience average. Group performer was the Jubilee hybrid with an average of 2.74 µg/100 g of zeaxanthin in the two localities, followed by Prima hybrid with 2.65 µg/100 g. It can be considered that accumulation of zeaxanthin is not influenced by the precocity of the hybrid. In the case of zeaxanthin, pedoclimatic conditions in the two localities directly influence accumulation process.

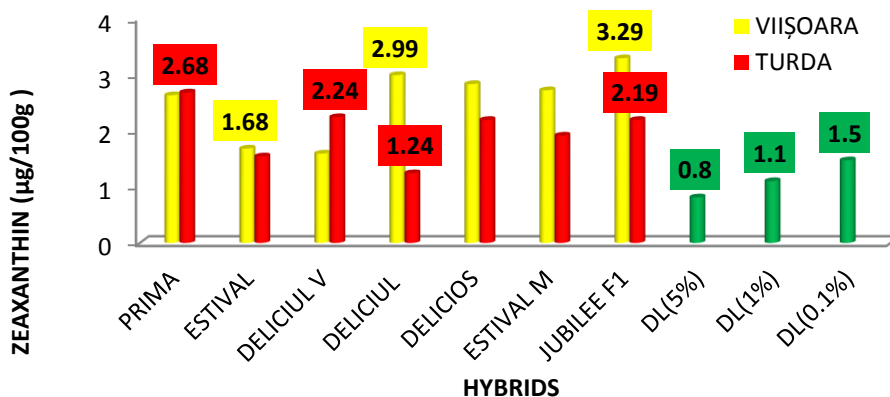


Fig. 3. Zeaxanthin in the seven hybrids in Turda and Viișoara (2016)

Most important natural source of zeaxanthin for the human body is found in: corn, egg yolk, yellow pepper and leek. Zeaxanthin (zeaxanthin) and lutein (lutein) are the only carotenoids found in retina and crystalline. Many studies have been done to determine their

effects on the eyes. A diet rich in zeaxanthin and lutein may slow vision degradation and prevent cataracts from occurring. ([Http://cesamancam.ro/luteina-zeaxantina.html](http://cesamancam.ro/luteina-zeaxantina.html))

Betacryptoxanthin (a cryptoxanthin) is a carotenoid like β -carotene, pro-vitamin A, is a very effective antioxidant reducing the effects of oxidative stress on the body. Antioxidant nature of betacryptoxanthin can prevent various diseases such as cardiovascular ones (<http://cesamancam.ro/beta-criptoxantina.html>).

Data on the content of β -cryptoxanthin in the seven studied hybrids are shown in figure 4. Highest values in terms of β -cryptoxanthin content are recorded by Jubilee hybrid in both localities, showing very significant and significantly positive gains compared to experience average, considered control. Reaction of other hybrids is quite similar in both localities, with the exception of Estival and Deliciul Verii hybrids, that have achieved superior values of β -cryptoxanthin content in Turda.

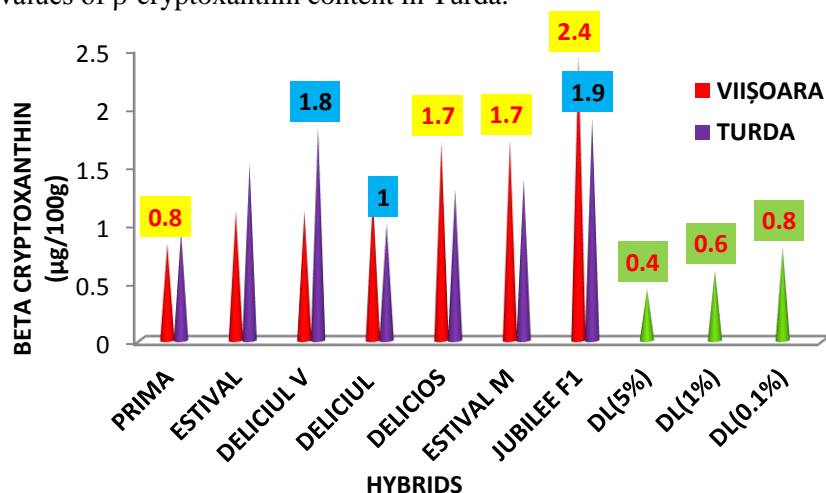


Fig.4. β -cryptoxanthin content of the seven hybrids in the two Turda and Viișoara localities

In a study carried out by Scott and Eldridge (2005) different levels of β -cryptoxanthin content were reported depending on the analyzed sweet corn hybrid, ranging between 0.4 $\mu\text{g}/100\text{ g}$ of in sweet corn with white grains and 31.6 $\mu\text{g}/100\text{ g}$ in sweet corn with golden-yellow grains. Values identified in this study are above the values recorded by Scott and Eldridge (2005) for corn grains with white grains and below those identified in the one with golden yellow grains.

CONCLUSIOS

From the seven studied hybrids, Prima cultivar has the lowest carotenoid content in both locations. We believe this is due to the fact that this hybrid is the earliest of those studied.

Average carotenoid content obtained in the two locations is higher at Jubilee hybrid.

Highest values of β -cryptoxanthin and zeaxanthin content are recorded by the Jubilee hybrid in both localities;

This study shows that the synthesis process of carotenoid pigments is influenced by agro-ecological factors and in an important part by genetic factors.

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