Changes in the Carotene Content of Nantes Type Carrots during Storage

Némethy, H.[1] and Fehér, M.[2]

[1]Szent István University, Faculty of Horticulture, Dept. of Vegetable and Mushroom Growing
H-1118 Budapest, Ménesi út 44.
[2]National Institute for Agricultural Quality Control, Dept. of Vegetable Crops
H-1024 Budapest, Keleti Károly u. 24.

Summary: *Changes in carotene content occurring during winter storage in Nantes type carrot hybrids grown on soils of different quality (sand and loam) have been investigated. The carotene content of the samples grown in a rainy year (1999) was lower than that of the samples grown in a dry year (2000). Lower carotene content was found in carrots produced on sandy soil (Szatymaz) than on loam soil (Tordas). The increase in carotene content (2–11 mg/100 g) measured at the end of winter storage was related to the season's character.*

Key words: carrot, storage, carotene content

Introduction

Carrots are consumed on a rather small scale in Hungary. They are, however, of considerable dietary value and of increasing importance owing to the development in our eating habits. Today, not only the consumers but also the growers pay attention, above yield indices, to the dietary value of the crop. The latter is due to its carotene content.

Carotene, The provitamin of vitamin A, has essential influence on the health and on the functioning of the human organism. Among vegetables, carrot is an important source of vitamin A.

According to different surveys, human nutrition is insufficient in vitamin A all over the world (FAO / WHO, 1988; *West* et al., 1993).

The daily requirement of man is RE=100 μg vitamin A (1 retinol equivalent=6 mg β carotene = 12 mg of other vitamin A carotenoids). High importance is set on the ingestion of β-carotene in preventing cancerous diseases. In the USA, the Department of Agriculture is managing a special research program on the carotenoid content of fruit and vegetables. Several surveys have been made on the state of supply with different vitamins in our country, too. They are summarised in *Table 1*.

Among carrots, Nantes type varieties are increasingly in demand. The majority of the varieties introduced for release belong to this type *(Fehér,* 2001). Their popularity is due to the fine texture and the good taste of the root which are important properties on the fresh market. In addition, this group of varieties is increasingly used for winter storage, too.

Our research work has been aimed at the study of the changes in the carotene content of Nantes type carrot varieties in cold storage.

Table 1 Daily requirement of β-carotene and carrot consumption in Hungary (1999)
(Hofsommer et al., 1985; Varsányi & Szántóné, 1994 a, b)

Average carotene content in carrot mg / 100 g (Bíró, 1993; Souci, 1989)	Retinol equivalent expressed in β–carotene mg / 100 g	Daly per capita consumption necessary for 1 RE, g	Average production + import 1000 t	Degree of supply (to 10 million inhabitants) %
12.0	2.0	50	66.5	41

The β-carotene content of the young carrot root is low, almost equal to α-carotene content. According to trials in Germany, β-carotene content redoubled during the growing process, while the change in α-carotene content was insignificant. *(Müller,* 1997). *Moussa* et al. (1986) have found higher carotene content in carrots grown on loess than on sandy soil. Data on carotene content after different authors are shown in *Table 2*.

Table 2 Carotene content in fresh carrot

Authors	Extreme values of carotene content g / 100 g fresh weight
Herrmann (1995.)	2.1–12.0
Hofsommer–Gherardi (1985.)	7.9–16.5
Souci et al. (1989.)	6.0–21.0
Takácsné (2000.)	15.8–21.3

With the traditional methods of storage, increase in carotene content has been found *(Herrmann,* 1995). In cold-

storage at 0 – +1 °C, carotene content remained almost unchanged *(Le Dily,* 1994).

Material and method

Trials were made with four varieties of Nantes type: *Bolero* F_1, *Ivor* F_1, *Tagus* F_1, *Puma* F_1.The sites of the experiments were the Tordas Station of the National Institute for Agricultural Quality Control (OMMI) and the horticultural farm of András Barna at Szatymaz.

The main characteristics of the trial sites and the most important data on growing technology are summarised in *Table 3*.

Carotene content was lower in every variety grown on brown sandy soil (at Szatymaz) than on chernozem soil with residual forest (Tordas) in each year of the experiment.

Ivor F_1 contained relatively few carotene (8.14–9.52 mg/100 g) at both sites.

Bolero F_1 showed balanced carotene content as regards production sites in the two years of the trial (Tordas: 16.28–17.82 mg/100 g, Szatymaz: 11.96–12.22 mg/100 g).

During the winter storage season 1999/2000, carotene content of *Bolero* F_1 slightly diminished, independently from production site. The carotene content of *Ivor* F_1 grown on chernozem soil with residual forest significantly increased (from 9,52 to 16,30 mg/100g) during storage.

Table 3 The most important data on the production

soil type:	TORDAS		SZATYMAZ	
	chernozem soil with residual forest		brown sandy soil	
Soil hardness (texture) after Arany:	44		28	
	First year	Second year	First year	Second year
Precipitation during the vegetation period	415 mm	152 mm	428 mm	69 mm
Sowing date	1999.05.08.	2000.05.10	1999.04.30	2000.05.08.
Harvest date	1999.09.20.	2000.10.05	1999.09.20.	2000.10.05
Date of chemical analysis during winter storage	2000.02.14.	2001.01.24.	2000.02.14.	2000.01.24.
End of winter storage	2000.05.02.	2001.03.21.	2000.05.02.	2001.03.21.

The long term storage took place at the Fertőd Station of OMMI in 1999–2000 and in 2000–2001 as well. After lifting, the roots were put into plastic crates and kept in cold-storage of 1–2 °C temperature and 90 per cent relative humidity.

Carotene content was determined by photometry from raw, grated samples at harvest, during storage and at the end of storage. The dates of the analyses during storage were 14 February 2000 and 24 January 2001, respectively. Storage was finished on 2 May 2000 and on 21 March 2001, respectively.

Results and discussion

The carotene content of the different varieties and the changes in carotene content during storage are shown in *Tables 4, 5, 6, 7* and in *Figs 1, 2, 3*.

At the date of harvest 1999, the highest carotene content -above 16 mg/100 g- was found in the variety *Bolero* F_1. In every variety, higher carotene content was found in 2000 than in 1999.

Table 4 Carotene content in Nantes type carrot varieties at Tordas, storage season: 1999–2000 (mg/100g)

Variety	At harvest	During storage	At the end of storage
BOLERO F1	16.29	16.08	18.32
IVOR F1	9.52	16.30	14.51
TAGUS F1	14.91	13.49	15.78
PUMA F1	16.03	14.51	16.14

Table 5 Carotene content in Nantes type carrot varieties at Szatymaz, storage season: 1999–2000 (mg/100g)

Variety	At harvest	During storage	At the end of storage
BOLERO F1	12.22	9.42	11.71
IVOR F1	8.14	8.4	7.13
TAGUS F1	11.70	13.49	13.23
PUMA F1	10.43	10.69	9.93

Table 6 Carotene content in Nantes type carrot varieties at Tordas, storage season: 2000–2001 (mg/100g)

Variety	At harvest	During storage	At the end of storage
BOLERO F1	17.82	25.96	29.52
IVOR F1	17.05	20.11	17.82
TAGUS F1	18.32	18.38	26.00

Table 7 Carotene content in Nantes type carrot varieties at Szatymaz, storage season: 2000–2001 (mg/100g)

Variety	At harvest	During storage	At the end of storage
BOLERO F1	11.96	19.34	19.60
IVOR F1	10.69	14.51	12.22
TAGUS F1	12.85	15.02	19.09

Such intensive increase wasn't found in *Ivor* F_1 grown on sandy soil. The positive or negative changes in the carotene content of the remaining varieties (*Tagus* F_1 and *Puma* F_1) are insignificant.

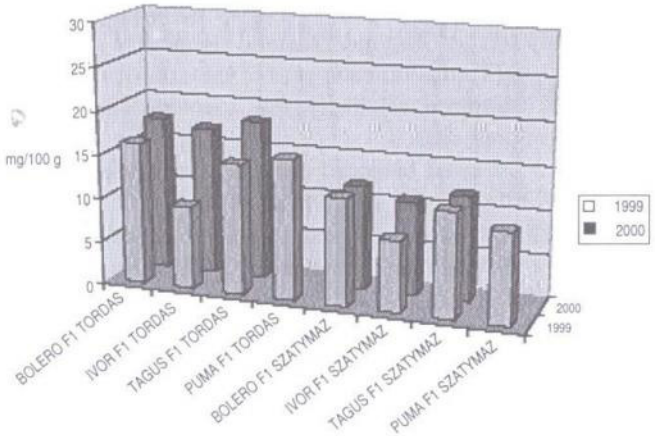

Figure 1 Carotene content at harvest (lifting)

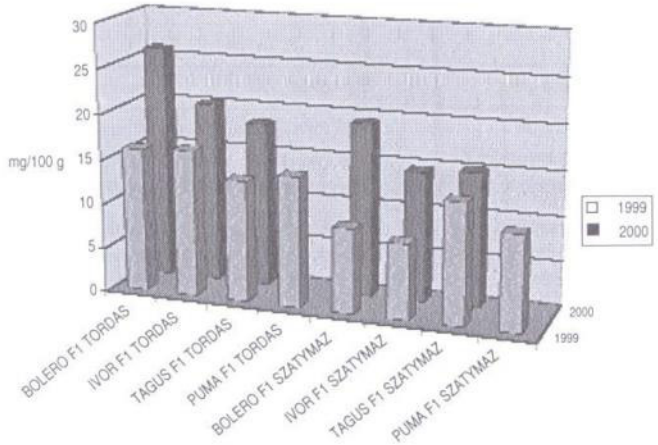

Figure 2 Development of carotene content during storage

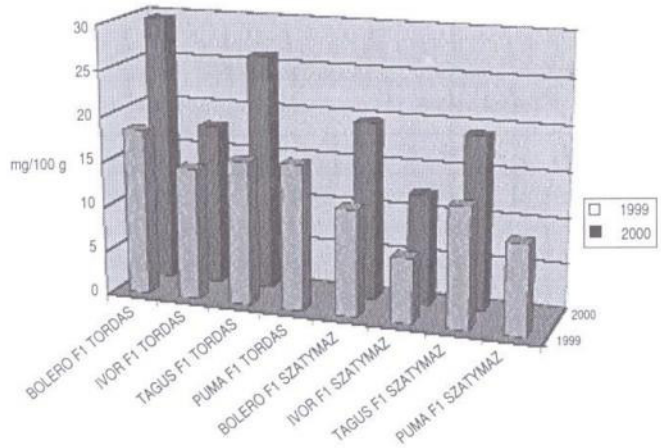

Figure 3 Carotene content at the end of storage

In the course of the winter storage season 200–2001 *Bolero* F_1 showed as an increase of 8.14 mg/100 g in carotene content. In *Ivor* F_1, the increase was 3–4 mg/100 g. In *Tagus* F_1, the growth in carotene content depended on the production site. In all the varieties from both production sites carotene content augmented by 3–8 mg/100g during storage, with the exception of *Tagus* F_1 grown a Tordas on chernozem soil with residual forest.

In the storage season 1999–2000, the carotene content of the varieties grown at Tordas increased continuously till the end of storage with the exception of *Ivor* F_1. In this variety, carotene content considerably decreased till the end, independently of the production site (Tordas or Szatymaz).

The carotene content of the varieties grown on Szatymaz sand diminished till the end of the storage, except *Bolero* F_1.

During the storage season 2000–2001, the carotene content of *Bolero* F_1 and *Tagus* F_1 increased continuously till the end of storage. The change of carotene content in *Bolero* F_1 was 7.64-11.7 mg/100 g, in *Tagus* F_1 7.68–6.24 mg/10 g.

Conclusions

Changes in the carotene content of the studied varieties of Nantes type may be characterised as follows:

- Carotene content of the varieties is higher if they are grown on chernozem soil with residual forest (Tordas) than on brown sandy soil (Szatymaz) and this difference remains till the end of winter storage.
- As a result of high rainfall in summer (1999) (July, August, September) less carotene is formed in the carrot root than in a dry summer season (2000).
- Among the varieties tested, *Ivor* F_1 is the poorest in carotene.
- The carotene content of *Tagus* F_1 and *Bolero* F_1 is almost equal, independently of season and soil.
- In the rainy year (1999), the carotene content of the varieties may be regarded as almost equal at lifting and at the end of storage, independently of the production site, i.e. differences of only 2–3 mg/100 g were found. In the dry year (2000), however besides higher carotene content at harvest, considerably higher values were measured at the end of storage than in the previous year's experiment. In several cases, these values surpass the values given by *Herrmann* (1995) and by *Hofsommer & Gherardi* (1985). This phenomenon needs interpretation by further experiments.

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