Colour components of different table beet varieties

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INTERNATIONAL JOURNAL OF HORTICULTURAL SCIENCE
AGROINFORM Publishing House, Hungary

Key words: table beet, pigment content, pigment components, betanin, isobetanin, betanidin, isobetanidin, BC/BX ratio

Summary: Information of the total pigment content of table beet roots is not sufficient enough to estimate their suitability to processing. Differences in the occurrence of the red pigment components of different thermostability determine the mode of processing of the varieties. Pigment extraction methods which require heat treatment (e.g. table beet root powder) need raw materials of higher betanin content.
Of the tested varieties – Bonel, Nero, Favorit, Rubin and Detroit – Bonel and Favorit had the highest betanin content (50.03 and 49.53 mg/100g, respectively).
The isobetanin quantity varies according to varieties (13.10–26.62 mg/100g). Values between 2.92–6.63 mg/100g and 0.96–2.96 mg/100g, respectively were found for betanidin and isobetanidin.
Data revealed the highest BC/BX ratio in the variety Rubin (2.08) indicating good inner colour in sensory tests. However, the high total pigment content (81.01 mg/100g) was associated with lower betanin content (46,26 mg/100g) and at the same time, with higher isobetanin (25.16 mg/100g), betanidin (6.63 mg/100g) and isobetanidin (2.96 mg/100g) contents. Out of the tested varieties Nero had the lowest total red pigment content (57.43 mg/100g) but the relative betanin value was the highest with nearly 70 %.
Laboratory testing of the table beet root varieties will be required to find the most suitable material to produce colouring agents.

Introduction

Recently rigorous prohibitive measures have been introduced in the use of additives – including colouring agents – in food industry. It is well known that many of the artificial colouring agents is unwholesome.

Table beet root pigments contain betalaines consisting of a mixture of yellow betaxanthins (BX) and red betacyanins (BC). It is their ratio (BC/BX) that determines the intensity of inner colour in the root.

Red beet roots are excellent natural sources of colouring agents used not only in the food industry but also in cosmetics (make-up, powder, etc.).

The term betacyanin refers collectively to several red colour components. These compounds are chemically a mixture of two glycosides and their aglycons which degrade easily at high temperature, intense light and humide atmosphere. They are the most stable in slightly acid medium (*Elbe* et al., 1974*; Takácsné Hájos & Gyuris,* 1994.).

Betanin is the red pigment found in the highest quantity mounting up to 75–95 % of the total pigment content (*Elbe,* 1975).

The rest consists of isobetanins, betanidins, isobetanidins and prebetanins. Their percentage depends greatly on the variety. *Pourrat* et al. *(*1987*)* established 60 % for betanin, 20 % for isobetanin, 12 % for betanidin, 4 % for isobetanin and 4 % for prebetanin in their studies using a HPLC method.

It is generally known that the listed pigments vary greatly in heat stability. During processing betanin is the slowest to degrade, so, it is desired in the highest possible quantity in the raw material.

The colouring agent produced of table beet roots is marketed under the label of betanin E 162 and used for colouring bottled cherry, soya products, fruit yoghurt, ice-cream, sausage and tinned beef.

It is meant to limit the use of azocolour amarant E 123 (naphtol red S) (*Schmadke,* 1978).

Juice can also be made of beet roots by lactic acid fermentation. Table beet root pigments are antioxidants and fix the free roots causing harmful growth of the cells. *Rašić* et al. (1984) fed mice with table beet root sap and reduced the appearance of Ehrlich ascites tumors by 59 %.

Table beet root pigments are used as powder and colour concentrations produced by fermentation. When fermented the extraction is affected considerably by the species of the yeast and the quantity of sugars in the root. Accordingly the yield of pigment extraction can vary between 56–62 % (*Drdák* et al., 1992).

The higher sugar content of the raw material affects pigment extraction adversely and also deteriorates the quality of the final product due to caramelisation in the production of beet root powder (*Watson & Gabelman*, 1984). Varieties of high relative pigment content only are suitable as raw material.

Table beet root varieties can be divided into 4 groups according to their colour intensity (betacyanin/betaxanthin – BC/BX ratio) the evolution of which is regulated by the genotype as below (*Wolyn & Gabelman*, 1986, 1989).

BC/BX ratio	phenotype	marking	genotype
0.020–0.061	low	L	R r
0.513–0.813	small	LR	$R^{t'}$ r
1.10–1.73	moderate	MR	$R^{t'}$ $R^{t'}$
2.01–5.65	high	HR	R' R' or $R^{t'}$ R

Material and method

In our trials 2 Dutch (*Bonel, Nero*) and 3 Hungarien (*Favorit, Rubin, Detroit*) table beet root varieties were tested. Roots were grown in a meadow silt soil in the Agropark of the Research Institute for Irrigation.

Characteristic data of the soil include: pH: 7.76; N:3.03 mg/kg; P:1.16 mg/kg; K: 8.06 mg/kg; Ca: 33.9 mg/kg; Mg: 14.63 mg/kg; Na: 17.47 mg/kg; Cl: 11.33 mg/kg. Measurements were performed in the Department for Chemistry and Pedology of the DATE College of Agricultural Water- and Environment Management.

Roots were sampled on 6th October 1998 as being about 100 days old.

Tests were performed in the Central Research Institute for Food Industry using a HPLC method. A sample consisted of 5 roots cut, mixed and frozen prior to processing to prevent degradation. 2 g samples were weighed, digested with 40 ml eluent (1:5 mixture of methanol and 0.01 M sodium dihydrophosphate) by rubbing with quartz sand then filtered and 20 µl of the filtrate was injected into the column (ODS-273). Flux velocity: 0.5 ml/min. Red pigments were detected at 535 nm while betaxanthins at 476 nm light. The trial was financed by an OTKA grant No. T-23841.

Results and discussion

When studying the composition of red pigments in table beet roots 4 important components were found *(Table 1)*.

Table 1 – Red pigment content (mg/100g) and composition in table beet root varieties, Szarvas, 1998.

Components Variety	Betanin	Isobetanin	Betanidin	Isobetanidin	Red pigments total
BONEL	50.03	26.62	4.20	0.96	81.81
NERO	40.29	13.10	2.92	1.12	57.43
FAVORIT	49.53	24.04	4.61	2.10	80.24
RUBIN	46.26	25.16	6.63	2.96	81.01
DETROIT	43.35	21.29	5.13	1.16	70.93
Themean of varieties	45.89	22.03	4.70	1.66	74.28
LSD (0.05)	4.31	1.91	0.52	0.34	6.62

Betanin has the highest percentage followed by isobetanin. Betanidin and its iso-variant only amount to some mg/100g). The quantity of total red pigments *(Fig. 1)* is nearly identical in the varieties Bonel Rubin and Favorit (81.81, 81.01 and 80.24 mg/100g) while Nero has the lowest value (57.43 mg/100g).

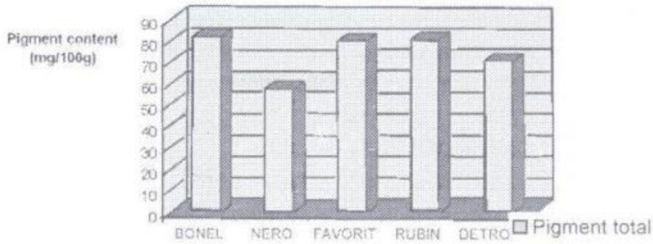

Figure 1 Red pigment content (mg%/100g) of table beet root varieties Szarvas, 1998

Our statement is affirmed by former trials (Takácsné Hájos, 1998). Betanin, the most stable colour component evolved differently from the order stated for total pigment.

The varieties Bonel and Favorit had the highest betanin content (50.03 and 49.53 mg/100g, respectively) while in Rubin the quantity of isobetanin (25,16) and betanidin (6.63 mg/100g) increased at its expense *(Fig. 2)*.

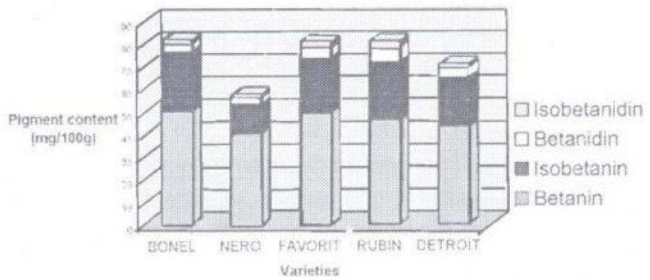

Figure 2 Red pigment composition of table beet root varieties, Szarvas, 1998

At the same time betanin content of Detroit and Nero differed in some mg/100g only.

Considering the percentage distribution of pigments *(Fig. 3)* it is remarkable that Nero has the highest betanin ratio within the total of red pigments. It can be concluded that not only total pigment quantity but also the ratio of betanin content is decisive.

The near 30 % isobetanin ratio in Rubin supports the poorer colour stability of the variety as also affirmed by former trials.

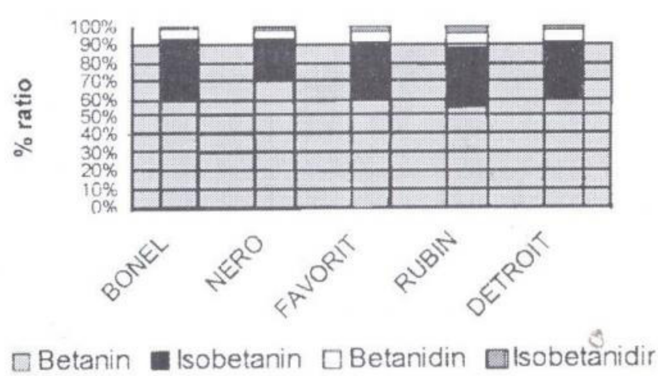

Figure 3 Percent distribution of pigment components in different table beet root varieties, Szarvas, 1998

The presence of yellow pigments affects the inner colour intensity, which is very important mostly in organoleptic trials.

In our trials Vulgaxanthin I and II components were separated. Vulgaxanthin II is only found in some mg% quantity (2.63-5.53 mg/100 g) compared with the 52.92 mg/100 g of vulgaxanthin I in the mean of varieties *(Table 2)*.

Table 2 – Yellow pigment content (mg/100g) and composition of table beet root varieties, Szarvas 1998

Components Varieties	Yellow pigment total	Vulgaxanthin I.	Vulgaxanthin II.	BC/BX ratio	Red pigments total
BONEL	47.60	42.07	5.53	1.72	81.81
NERO	34.56	31.90	2.63	1.66	57.43
FAVORIT	43.33	40.57	2.77	1.85	80.24
RUBIN	39.00	35.30	2.97	2.08	81.01
DETROIT	41.10	36.77	3.70	1.73	70.93
The mean of varieties	37.19	37.32	3.52	1.81	74.28
$LSD_{(0.05)}$	3.94	4.26	0.56	–	6.62

Varieties can be ranged into various genotypes according to the ratio of their red and yellow pigments. Accordingly, Rubin belongs to the group of high BC/BX ratio. The root cut through is of violet red colour which is judged favourably in sensory tests. However, the colour of powder made of it is rather poor which may be explained by the lower betanin content. The other varieties can be ranged into medium categories according to the occurrence ratio of red and yellow pigments.

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