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EFFECT OF CULINARY PROCESS ON BEET ROOTS QUALITY

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ABSTRACT

Effect of peeling and cooking methods on quality of beetroots were studied. Six different cooking methods were used: in pot starting with cold and boiling water, in pressure cooker in water and in steam, in acuthermal pot and in microwave oven. The best nitrates and nitrites elution were obtained during cooking beetroots in big amounts of water (in pot starting with cold and boiling water and in pressure cooker in water). Beetroots cooked by these methods received the lowest scores in sensory quality (especially colour). Because beetroots are very popular mostly for their colour these methods shouldn't be used to cook this product. To save specific colour of beetroots it's better to use cooking methods with small amounts of water (in pressure cooker in steam, in acuthermal pot, in microwave oven).

Key words: beetroots, nitrates, nitrites, sensory quality, culinary process

INTRODUCTION

Beetroot is one of the most popular vegetables in Poland especially because of its specific colour. That makes colour one of the most important factors of beetroots quality. This specific colour is a result of betalaina pigment content which consists of red-violet betacyanins and yellow betaxantins [9]. The main ingredient of betacyanins is betanina and of betaxantins - vulgaxantina I.

Above pigments can be destroyed by a number of factors involved in technological process like: temperature, oxygene, pH, enzymes, light, water activity and others [1,2,3,6,11]. Losses of pigments during culinary process

cause changes of original colour. Direction of these changes depends on proportions of initial red and yellow pigments level [4,7,12,16]. According to Zalewski [17] red betacyjan pigments are decomposed faster during cooking than yellow betaxantin pigments.

Quality of beetroots depends also on contamination level. Because of tend to nitrates and nitrites accumulation in beetroots (even over 2000 mg $NaNO_3$ and over 2 mg $NaNO_2$ in 1 kg of fresh product) very important is to reduce the content of these factors during culinary process [5,8,10,15].

Many studies show that culinary process affects nutritive value, sensory quality as well as nitrate levels in vegetables. In many studies sensory quality and contamination level changes during cooking vegetables have been overlooked although it is very important. It relates to beetroots investigation, too.

The main goal of this study was to establishe the best cooking method of beetroots to achieve high sensory quality combine with low nitrate and nitrite level.

MATERIALS AND METHODS

Experiments were carried out on Red Ball variety of beetroot grown in conventional cultivar. Beetroots were peeled with peeling knife. Peel consisted of aprox. 16% of the root. After peeling beetroots were washed, cubed (2 cm x 2 cm) and boiled in 500 g samples by 6 methods (Tab. 1).

Table 1. Cooking conditions for each method

Cooking method	Amount of water [cm^3]	Cooking time (min)
In pot starting with boiling water	1000	36
In pot starting with tap water		40
In pressure cooker in water		20
In pressure cooker in steam	200	20
In acuthermal pot	100	45
In microwave oven [1]	100	27

[1] - microwave power 750W, beetroots were cooked in glass pot

Cooking time was established separately for each method by bringing beetroots to proper texture evaluated by sensory panel using category (verbal) scale according to PN- ISO 4121. Beetroots were cooked in three different times. Texture was estimated as very tough, tough, slighty tough, proper, slighty soft, soft, very soft. After selecting texture closest to the "proper" one, beetroots were cooked again in three different times closer to the time chosen in the first try. Experiment was repeated until proper texture was established. Conditions of cooking methods are shown in Table 1.

Dry matter content was determined by drying (6 g sample) at 105°C, after preliminary drying at 70°C according to PN–90/A–75101/03. Nitrates were reduced to nitrites with cadmium powder and measured by colorimetric method after colour reaction with Griess reagent according to ISO 6635–1984 [E].

Sensory quality of cooked beetroots (taste, aroma, colour, texture and overall quality) was evaluated by unstructured graphical scale method (10 cm) and ranking method according to PN-ISO 4121 by 10-person panel consisting of Catering Technology Chair's employees, trained in these methods. Sensory quality of cooked beetroots was evaluated right after cooking, at the consumption temperature – about 50°C (max. 10 min after cooking).

For instrumental determination of beetroots colour Minolta Chroma Meters CR-300 in L*a*b* methods (C.I.E. systems) was used. Parameters of colour were determined by C light source [Instruction of Minolta, 1994].
On each stage of experiment, the analyses were repeated three times, but instrumental determination of colour were repeated 10 times.

Statistical evaluation comprised estimation of standard deviation and one-way analysis of variance. The results (differentiation in analysed compounds determined by the least significant difference [$p < 0.05$]) is only announced in text without presenting the record tables. Results were analysed by statistic program Statgraphics 5.

RESULTS AND DISCUSSION

Dry matter content was tipical for beetroots – aprox. 14.7%. Nitrates level wasn't very high (as for beetroots) – 553.5 mg $NaNO_3$/kg, nitrites – 2.29 mg $NaNO_2$/kg. After peeling nitrates and nitrites content decreased by 20.0% and 6.6% respectively. Results are shown in Table 2.

Table 2. Effect of peeling beetroots on dry matter, nitrates and nitrites content

Beetroots	Dry matter [%]	Nitrates [mg $NaNO_3$/kg]	Changes after peeling [%]	Nitrites [mg $NaNO_2$/kg]	Changes after peeling [%]
Before peeling	14.7	553.5 ±27.8	-	2.29 ±0.21	-
After peeling	14.1	442.4 ±29.1	↓ 20.0	2.14 ±0.09	↓ 6.6

Similar results for nitrates were reported by Szponar et al. [14]. He observed higher decrease of nitrites after peeling (aprox. 39%) what was connected with higher contents of this factor in his material. Opposite results was reported by Sokolow [13] who obtained the highest amounts of nitrates in core.

The next and critical step in culinary process of beetroots with the highest changes of colour, nitrites and nitrates was cooking. The effect of different cooking methods on nitrates, nitrites content, colour (measured by instrumental method) and sensory quality are shown in Tables 3,4 and 5.

Table 3. Effect of cooking method on content of the investigated components in fresh beetroots

Cooking methods	Content of investigated component after cooking				
	Dry matter [%]	Nitrate [mg $NaNO_3$/ kg]	Changes after cooking [%]	Nitrite [mg $NaNO_2$/kg]	Changes after cooking [%]
Raw material after peeling	14.1 ± 0.2 d	442.4 ±29.1 e	-	2.14 ± 0.09 e	-
In pot starting with boiling water	8.1 ± 0.3 a	198.1 ± 18.2 b	↓ 55.2	0.83 ± 0.08 b	↓ 61.2
In pot starting with tap water	7.9 ± 0.1 a	149.6 ± 12.5 a	↓ 66.2	0.65 ± 0.04 a	↓ 69.6
In pressure cooker in water	8.8 ± 0.1 b	228.2 ± 12.8 c	↓ 48.4	0.96 ± 0.11 c	↓ 55.1
In pressure cooker in steam	13.2 ± 0.1 c	407.4 ± 21.5 d	↓ 7.9	1.81 ± 0.16 d	↓ 15.4
In acuthermal pot	14.4 ± 0.2 d	416.7 ± 19.0 d	↓ 5.8	1.86 ± 0.10 d	↓ 13.1
In microwave oven	18.1 ± 0.2 e	545.1 ± 24.1 f	↑23.2	2.55 ± 0.18 f	↑19.2

In table showed average data, ± standard deviation
a, b....- the same letter in each column indicates no statistically significant differences between results
↑↓ - changes direction

Table 4. Sensory quality of boiled Beetroots in unstructured graphical scale method *

Cooking methods	Colour	Odour	Taste	Texture	Overall quality
In pot starting with boiling water	6.0 ± 1.0 b, c	7.0 ± 0.4 b	6.5 ± 0.7 b	7.4 ± 0.8 c	6.4 ± 0.8 b
In pot starting with tap water	5.3 ± 0.4 b	6.1 ± 0.7 a	5.9 ± 1.0 a, b	7.0 ± 0.8 b, c	5.8 ± 0.6 a, b
In pressure cooker in water	4.2 ± 0.7 a	5.9 ± 0.7 a	5.4 ± 0.4 a	6.6 ± 0.6 a, b	5.2 ± 0.8 a
In pressure cooker in steam	8.9 ± 0.8 d	7.9 ± 0.4 c	8.1 ± 0.7 c	8.5 ± 1.1 d	8.3 ± 1.0 d
In acuthermal pot	8.6 ± 1.4 d	7.8 ± 0.8 c	7.6 ± 1.0 c	6.8 ± 0.4 b, c	8.1 ± 0.8 c, d
In microwave oven	6.5 ± 1.1 c	7.6 ± 1.0 c	7.9 ± 0.4 c	6.1 ± 0.6 a	7.4 ± 1.0 c

In table showed average data, ± standard deviation, * scale = 10 cm
a, b....- the same letter in each column indicates no statistically significant differences between results

Table 5. Effect of cooking method on beetroots colour estimated by instrumental method

Cooking method	L Lightness	A +a -red - a - green	B + b - yellow - b - blue	☯ Colour intensity	Δ E
Raw material	27.0 ± 0.9 c,d	+24.9 ± 0.9 d	+5.4 ± 0.8 d	4.6	-
In pot starting from boiling water	28.2 ± 0.9 d,e	+ 16.3 ± 1.0 c	+ 3.6 ± 0.5 b,c	4.5	8.9
In pot starting from cold water	28.3 ± 0.8 e	+ 14.8 ± 0.5 c	+ 3.4 ± 0.5 b	4.4	10.4
In pressure cooker in water	29.1 ± 0.7 e	+ 15.6 ± 0.3 c	+ 4.1 ± 0.8 c	3.8	9.6
In pressure cooker in steam	25.9 ± 0.5 b,c	+ 10.6 ± 0.6 b	+ 0.5 ± 0.2 a	21.2	15.2
In acuthermal pot	25.3 ± 0.5 b	+ 10.0 ± 0.7 a,b	+ 0.8 ± 0.2 a	12.5	15.7
In microwave oven	23.8 ± 0.4 a	+ 8.2 ± 0.3 a	+ 0.5 ± 0.1 a	16.4	17.7

In table showed average data, ± standard deviation
a, b....- the same letter in each column indicates no statistically significant differences between results

As it shown in Table 3 the best cooking methods for nitrate and nitrite elution from beetroots were the methods where the biggest amounts of water were used (cooking in pot starting with tap and boiling water and in pressure cooker in water). Decrease of nitrates and nitrites content reached about 50–66% and 55–70% respectively. For methods where less amounts of water were used decrease of nitrates and nitrites was much lower (6–8% and 13–15% respectively). Observed increases of nitrates and nitrites content cooked in microwave oven were caused by high dry matter content decrease after cooking. After calculating data on dry matter base real decrease of these factors has been estimated.

Szponar et al. [14] has reported approx. 50% decrease of nitrates and nitrites content (without showing the cooking conditions).

Cooking methods have also the effect on changes of sensory quality factors especially colour (Table 4).

As it shown in Table 4 the effect of cooking method on sensory quality of beetroots was opposite than on nitrates and nitrates content. The methods with small amounts of water were better than cooking with big amounts of water for all sensory factors. The above results obtained by using unstructured graphical scale were confirmed by ranking method. The best method was cooking beetroots in pressure cooker in steam. The results for all sensory factors for beetroots cooked this way were statistically significantly better than others. The worst method was cooking in pressure cooker in water.

Colour of cooked beetroots was estimated by instrumental methods also. The results are shown in Table 5.

During cooking beetroots in big amounts of water (in pot starting from cold and boiling water and in pressure cooker in water) lightening of colour was observed (increase of L*). The highest changes were obtained after cooking in pressure cooker in water. When beetroots were cooked in small amounts of water (in pressure cooker in steam, in acuthermal pot and in microwave) the darkening of colour was observed (decrease of L*). The highest changes of colour was obtained after microwave cooking.

Cooking beetroots by all methods causes changes of trichromatic coefficient a and b. Coefficient a changes from red into green colours and coefficient b from yellow into blue colours. These changes are more intensive during cooking in small amounts of water.

During cooking in big amounts of water intensity of beetroots colour decrease in comparison to raw material and the lowest intensity was observed in beetroots cooked in pressure cooker in water where the lowest colour intensity was observed among all samples (Table 5), and the highest lightening of colour also what has been mentioned before. The above results were confirmed by sensory estimation where beetroots cooked in pressure cooker in water obtained the lowest score for colour (Table 4).

Cooking beetroots in small amounts of water causes increase of colour intensity in comparison to raw material. The highest colour intensity was observed in beetroots cooked in pressure cooker in steam and in microwave

oven (Table 5). During cooking in microwave oven the highest darkening of colour and increase of colour intensity was observed. These results were confirmed by sensory estimation (Table 4) where colour of beetroots cooked in microwave obtained lower scores in comparison to the beetroots cooked in pressure cooker in steam and in acuthermal pot as a result of dark colour.

Statistical evaluation showed significant effect of cooking method on colour lightness (L) and trichromatic coefficient (a) and (b).

Similar effect was found by Grzesińska [6] who obtained better colour parameters for beetroots cooked in steel pots using method "without water" in comparison to the beetroots cooked in water.

To sum up, the effects of cooking method on beetroots quality taking into consideration sensory quality and nitrates and nitrites level, advantages and disadvantages are presented in Table 6.

Table 6. Comparison of different cooking methods for beetroots

Cooking methods	Nitrates level	Sensoryquality	Total of advantages and disadvantages
In pot starting with boiling water	++	+	+3
In pot starting with tap water	++	±	+2
In pressure cooker in water	+	±	+1
In pressure cooker in steam	-	++	+1
In acuthermal pot	-	++	+1
In microwave oven	-	+	0

* four - score scale: (+ +) - very advantageous, (+) - advantageous, (±) - neutral, (-) - disadvantageous

From the results shown in Table 6 we can see that the best cooking method for beetroots is cooking in pot starting with boiling water and tap water where the elution of nitrites and nitrates was highest. The worst method was cooking in microwave oven where removal of contaminants was lowest and sensory quality wasn't good. That is shown in the table 6, but when we consider that beetroots are mostly used because of their specific colour we should estimated their quality consider different factors – mainly colour. In this case the best methods are cooking in acuthermal pot and in pressure cooker in steam where the scores for colour were highest (8.6–8.9). The worst methods were cooking in pressure cooker in water and in pot starting with cold water. The reason was elution of the pigment into the brine what didn't take place in methods where just small amounts of water were used.

CONCLUSIONS

1. Investigated beetroots were contaminated with nitrates and nitrites on level 553.5 mg $NaNO_3$ and 2.29 mg $NaNO_2$ /kg of fresh matter.
2. Peeling decreased nitrates and nitrites content by 20% and 6.6% respectively.
3. Beetroots as a product used mainly for specific colour should be cooked by methods with small amounts of water which allowed to obtain the best dish colour what was confirmed by sensory and instrumental methods. For the best elution of contaminants beetroots should be cooked by methods with high amounts of water.

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