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ASSESSMENT OF PARTICULAR QUALITIES OF CARROT AVAILALBE IN SELECTED RETAILERS IN KRAKOW

Paulina Wrona[a*], Krystyna Pogoń[b], Magdalena Dróżdż[c]

[a] Institute of Machinery Exploitation, Ergonomics and Production Processes, University of Agriculture in Krakow
[b] Department of Raw Materials, Fruit and Vegetable Processing, University of Agriculture in Krakow
[c] Post-diploma student of Nutrition Science in Wroclaw

[*] *Corresponding author: e-mail: paulina.wrona@ur.krakow.pl*

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ABSTRACT

The objective of the paper was assessment of the selected qualities of carrot from retailer's shops, organic and traditional food shops in Krakow. The following quality parameters of the fruit pulp were investigated: content of extract, sugars, polyphenols, nitrite, flavonoids, beta-carotene, colour, and antioxidant activity. The investigation shows that the content of nitrogen (V) in the samples of carrot from traditional cultivations was higher than in case of carrot from organic crops, and in case of a sample from traditional cultivation it exceeds the admissible norms. However, the research which was carried out provides no justification for the statement that the content of nitrate (III) depends on the production system of carrot. The research on the content of polyphenols, flavonoids and antioxidant activity of juice proved the increased antioxidant ability of carrot that was traditionally cultivated with reference to carrot cultivated organically. However, the differences were not statistically confirmed. Beta-carotene content in all samples was comparable regardless the cultivation system. Content of extracts, total carbohydrates and sucrose was significantly higher for carrot from traditional crops than for eco-carrot.

Introduction

A rising consumers' awareness and desire to live healthy influence the increase of demand for organic products since it is a common belief that "bio" or "eco" food is healthier and of better quality than food produced traditionally. In the organic cultivation system, crop rotation, organic fertilization, and cultivation are main elements of agri-technology that decide on the organic carbon content in soil. It is the basic index of farming and soil fertility (Motyka, 2009). Comparison of quality parameters of traditional and organic cultivation products is considerably difficult since independent research confirm that besides cultivation in various production systems, varied cultivation conditions affect differences in the chemical composition of vegetables (Brandt and Mølgaard, 2001). Woese et al., (1997) quotes results of 41 publications on the issue on nitrites in vegetables and their processed

products with regard to various cultivation methods. Majority of research on this subject is not carried out as a comparison of eco and non-organic crops but as a comparison of various types of mineral and organic fertilization and in some research also of the combined one (mineral and organic) (Mäder et al.,1993; Plochberger, Velimirov, 1992).

Objective and scope of the study

It is a popular notion that the quality of fruit and vegetables depends, inter alia, on the method of cultivation. Therefore, the objective of this paper was to evaluate the quality properties of carrot (Nantes type) from organic and traditional cultivation available in shops in Krakow.

The paper covered determination of the extract with the refractometric method according to PN-90/A-75101/02 ,of the sugars content from DNS (a method with the use of 3.5 dinitrosalicilic acid), flavonoids content according to Ardesani and Yazdanparast (2007), polyphenols content according to Singleton et al., (1999), antioxidant activity towards cation radical ABTS according to Re et al., (1999) and FRAP method according to Benzie and Strain (1996), nitrite (III) content and nitrite (V) content with the spectrophotometric method according to PN-92/A/75112, assessment of beta-carotene content according to PN-90/A-75101.12 and the assessment of the colour was made with instruments in the CIE Lab. system: 1976 (2008) with the rebound method in two samples of carrot from traditional crops and two samples from organic crops.

Four representative samples of carrot Nantes type with 1 kilo mass from two markets (K1 and K2) and two organic food shops (E1 and E2) were the object of the research. A representative sample with 1 kilo weight constituted a research material. The selected material was fresh, average in size, with regular turgor and did not show any symptoms of decay or damage. To facilitate a laboratory experience from each kilo of carrot approximately 0.5 l of pulp juice which was used for further chemical analyses was used. All analyses were carried out in three iterations.

Research results and discussion

Sample K1 of carrot from traditional cultivation contained a higher amount of nitrates (III) in comparison to the remaining ones (Fig. 1). However, in the second traditional sample, the content was the lowest in comparison to all investigated samples, which enabled making some conclusions on the relation of the nitrite content with regard to the applied cultivation. Resolution of the Minister of Health (Journal of Laws 2003 No. 37, item 326) does not include admissible limits for $NaNO_2$ content in fresh vegetables and fruit, only in products for babies and children up to 3 years.

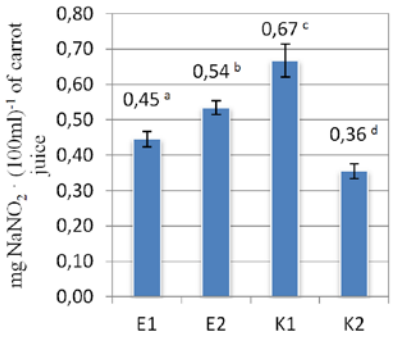

Figure 1. Nitrite content (III) expressed in mg mg $NaNO_2$·(100ml)$^{-1}$ of carrot juice

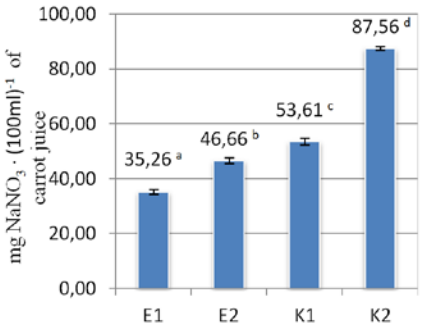

Figure 2. Nitrite content (V) expressed in mg mg $NaNO_3$·(100ml)$^{-1}$ of carrot juice

A lower content of nitrites (V) than in traditional carrot was reported in samples of juice from organic carrot (Fig. 2). In one of the samples of carrot juice from traditional cultivation K2 (437.8 mg·kg^{-1}of fresh raw material), the admissible nitrite content was exceeded. Pursuant to the Resolution of the Minister of Health (Journal of Laws of 2003, No. 37, item 326) the maximum nitrite (V) content in carrot may amount to 400 mg·kg^{-1} of fresh raw material while in vegetable products for children up to 3 years maximally to 250 mg·kg^{-1}.

The highest nitrite content was determined in carrot roots from traditional cultivation, which confirms literature data (Woese et al., 1997; Rembiałkowska, 2007; Paoletti et al., 2012). The nitrite content is strongly correlated with nitrogen fertilization, which in organic farms is limited only to organic fertilization (e.g. manure, compost or green fertilizer). Thus, one may assume that carrot from organic crops should include lower (admissible) amount of nitrites.

On the other hand, the polyphenols content found in carrot samples from organic farms (E1 and E2) and for one sample of traditional carrot (K1) did not differ significantly. Only one sample of carrot from a traditional farm (K2) had almost twofold total content of polyphenols in comparison to carrot samples from organic farming (Fig. 3).

According to the literature, the polyphenols content is usually higher for organic juices. However, some exceptions are reported for carrot (Gąstoł, 2009). In the authors' own investigations, a higher content of polyphenols for carrot juice obtained from traditionally cultivated carrot was proved. Folin- Ciocialteua's method is routinely applied for determination of the polyphenols content. However, its low specificity and the fact that reagent F-C may react with other compounds different than polyphenols, such as sugars, aminoacids, ascorbic acid and others that increases the content of polyphenol compunds (Domaradzki et al., 2013). Most probably, it results from obtaining non-uniform results in the analyses made.

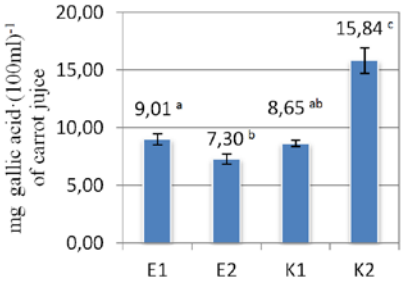

Figure 3. Total content of polyphenols in mg of gallic acid·(100ml)$^{-1}$ of carrot juice

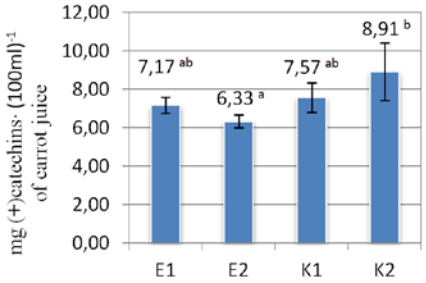

Figure 4. Content of flavonoids in mg +catechin·(100ml)$^{-1}$ of carrot juice

Results of determination of the total flavonoids (Fig. 4) prove that the values for one organic sample (E2) and one traditional sample (K2) differ statistically significantly. The remaining values of measurements are similar. However, the flavonoids content expressed in mg (+) catechins: (100ml)$^{-1}$of juice is decisively higher for traditional samples than for organic samples.

Determination of the antioxidant activity towards cation-radical ABTS (Fig. 5) generates results obtained for the organic sample marked as E1 and for the traditional sample (K2) although both had the highest antioxidant activity and do not differ statistically significantly. Analysis of antioxidant activity made with the FRAP method (Fig. 6) gave other results than the ABTS method. Both samples from traditional farming had higher antioxidant activity than samples from organic crops. Only for the traditional sample marked as K2 statistically significant differences in antioxidant activity in comparison to all remaining samples were reported. Regardless the determination method (ABTS or FRAP) organic sample E2 had the lowest antioxidant capacity and the traditional sample K2 had the highest. Due to high antioxidant activity of E1 sample in determination with the ABTS method, the relation between the cultivation type and antioxidant skills of particular samples of juices cannot be determined clearly.

In numerous scientific papers, it was proved that the antioxidant activity of the investigated material is directly proportional to the general polyphenols content (Pereira Lima et al., 2008; Puchalski et al., 2013). It is confirmed by analyses which were made since the content of polyphenols and flavoinoids is reflected in the results of antioxidant activity of the ABTS and FRAP since a sample with the highest content of polyphenols and flavonoids had the highest antioxidant activity and the sample with the lowest content of the mentioned compounds had the lowest activity. The research carried out by Capuano et al. (2012) show that vegetables from organic crops had better antioxidant properties due to a higher content of polyphenols. However, the research presented in the paper do not confirm this thesis.

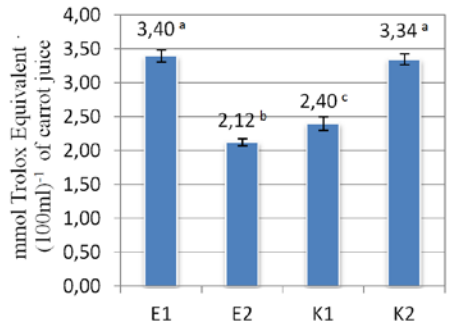

Figure 5. Antioxidant activity towards cation-radical ABTS (micromol Trolox Equivalent

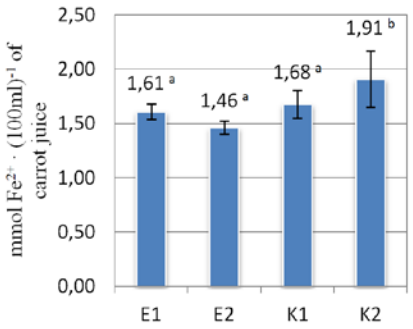

Figure 6. Antioxidant activity with FRAP method (millimol Fe^{2+})

No *statistically significant differences* between the investigated samples in the content of β-*caroten* (Fig. 7) were reported. Therefore, *we cannot clearly state that* β-*caroten content is related to the cultivation system.* The research carried out by Domaradzki et al. (2013) shows that in carrot juices available in Poland, beta-caroten content is within 4.99 mg to 9.89 mg·$(100g)^{-1}$. The obtained research results are identical to those values; however, it is impossible to differentiate between juices from traditional and organic juices based on the content of carotenoids.

The next investigated property, namely the content of extract was measured by means of refractometer. Samples from traditional crops had higher content of extract (K1 – 8.33°Bx, K2 – 8.87°Bx) in comparison to samples from organic farming (E1 – 7.40°Bx, E2 – 6°Bx), which may indicate a relation between the system of crops with the content of extract from carrot juice (Fig. 8).

In determination of directly reducing sugars in two organic samples (E1 and E2 and in one traditional sample (K1) no considerable differences were reported (in 100 ml of juice the following were marked: 2.90 g, 3.53 g, 3.11 g of sugars), and their highest content was in the traditional sample K2 – 5.87 g of sugars in 100 ml. No statistically significant differences were reported during investigation of the content of reducing sugars after inversion (in total) for organic samples (6.77 g·$(100ml)^{-1}$) and E2 (7.19 g·$(100ml)^{-1}$). Statistically significant differences were reported for traditional samples K1 (10.66 g·$(100ml)^{-1}$) and K2 (14.07 g of sugars·$(100ml)^{-1}$) (Fig. 9). The obtained differences between the samples of juice from eco-carrot and traditional crops are statistically significant and show both a relation of the content of extract as well as the total content of sugars. A higher content of extract and sugars was reported for juice obtained from traditionally cultivated carrot. Results

for sacharosis content are similar (Fig. 10). It is very important information since significant differences in the total content of sugars between the investigated samples may influence organoleptic assessment of carrot juice. Comparison of sacharosis content with the content of extract shows that in juice obtained from traditional carrot the main component of the extract are sugars, and in case of organic carrot juice also other components which are water soluble. The research carried out by Malik and Krukowska (2009) shows that the average content of sugars in carrot juice is between 9.87 and 13.28 g·(100g)$^{-1}$. A higher total content of sugars is usually reported for juices made of organic vegetables; however, authors' own research do not confirm this relation with regard to carrot juice.

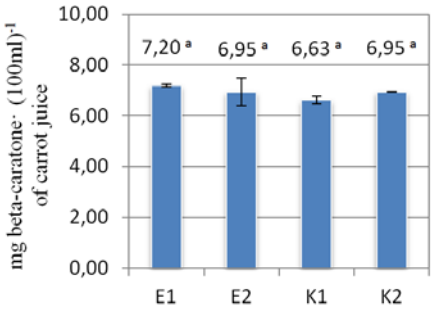

Figure 7. Content of beta-caratone in mg·(100ml)$^{-1}$ of carrot juice

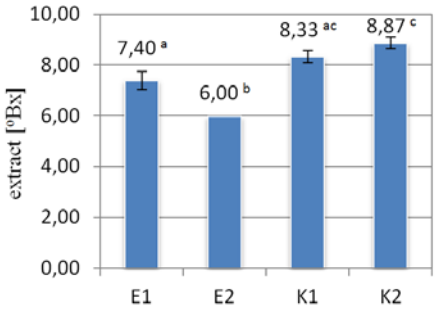

Figure 8. Content of extract expressed in °Brixa

Whereas Rembiałkowska et al., (2008) stated that there is no significant relation between the cultivation system and the reducing sugars content, but the total content of sugars in traditional carrot juice is considerably higher than in organic carrot. According to Wrona (2012), a factor that may influence the content of sugars in the carrot root may be storage time and temperature. The higher is temperature the higher is the content of simple sugars in the extract and it may be even twice higher after 6 months of storing in comparison to the initial state.

Assessment of colour of juices in the CIE Lab system (table 1) did not show significant differences for determination of blue or yellow colour participation (b*), colour intensity (C*) and angle of colour tone (h*).

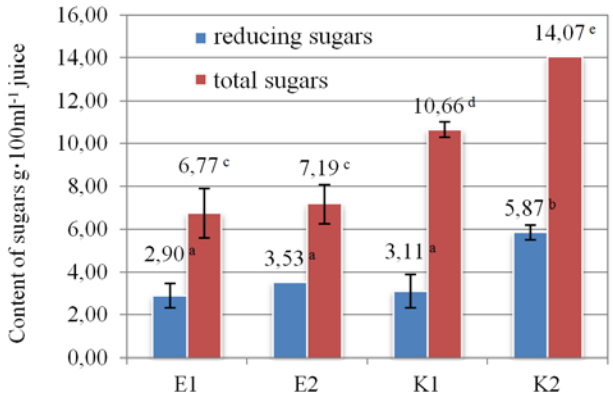

Figure 9. Reducing sugars content and total sugars expressed in g·(100 ml)$^{-1}$ of carrot juice

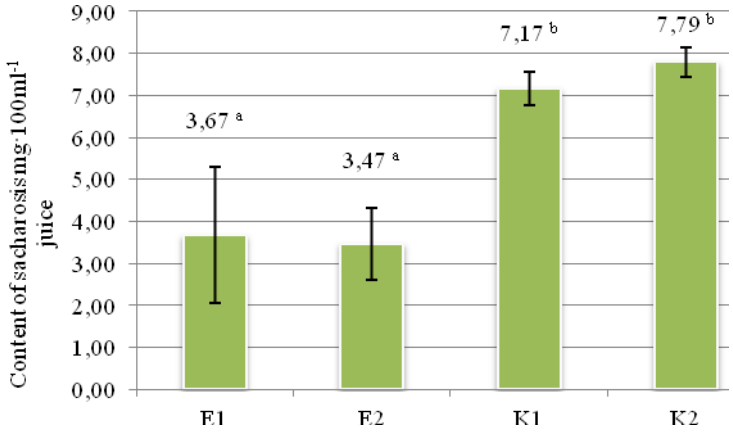

Figure 10. Content of sacharosis expressed in mg·(100 ml)$^{-1}$ of carrot juice

For the colour brightness index (L*), the highest value was obtained for traditional sample juice K2; however, results are comparable and do not indicate the relation of the colour with the cultivation system and the highest differences were obtained for the index of green or red colour participation (a*); however, they do not indicate the relation between the cultivation system and juice colour. Investigation of the juice colour with the use of suitable devices is often replaced by organoleptic assessment which is better for assessment of suitability of vegetables for sale and processing since it includes consumers' preferences. Paoletti et al., (2012) comparing changes of colour in the CIE Lab system only emphasised the humidity and thermal conditions and not the cultivation system.

Table 1.
Assessment of the colour of carrot juices in the CIE Lab system

Colour	L*	a*	b*	C*	h*
E1	35.71±0.31 [a]	22.97±0.69 [c]	35.66±0.65 [fg]	39.61±4.86 [g]	57.36±0.12 [h]
E2	34.80±0.47 [ab]	19.05±0.14 [d]	32.57±0.1 [f]	37.73±0.15 [g]	59.69±0.12 [i]
K1	36.19±0.47 [a]	20.71±0.86 [e]	33.12±0.74 [f]	39.10±1.1 [g]	57.95±0.55 [h]
K2	35.43±0.72 [ab]	18.37±0.31[d]	34.50±5.41 [f]	36.89±1.15 [g]	60.13±0.51 [i]

Symbols: L* – colour lightness, a* – participation of green or red colour, b* – participation of blue or yellow colour, C* – colour intensity, h* – angle of colour tone

During analysis of the obtained results of research, one should remember that majority of scientific information that compare products from various cultivation systems assesses them shortly after harvesting or storing in similar conditions and this paper aims at assessment of quality properties of carrot easily available in traditional or organic food shops. Clients have no information on the harvesting date, cultivar, time and conditions of storage.

Conclusions

1. The content of nitrogen (V) in the samples of carrot from traditional cultivations was higher than in case of carrot from organic crops and in one sample it exceeded the admissible norms. This research cannot clearly state that the content of nitrites (III) have the same relation.
2. The research on the content of polyphenols, flavonoids and antioxidant activity proves the increased antioxidant ability of carrot that was traditionally cultivated with reference to carrot cultivated organically. However, the differences were not statistically confirmed.
3. Regardless the applied cultivation system, the beta-carotene content in all the investigated samples of juice was at a similar level. The determined differences were statistically insignifcant.
4. Content of extracts, total carbohydrates and sucrose was significantly higher for carrot juice from traditional crops than for eco-carrot juice.

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OCENA WYBRANYCH CECH JAKOŚCIOWYCH MARCHWI DOSTĘPNYCH W WYBRANYCH SKLEPACH NA TERENIE MIASTA KRAKOWA

Streszczenie. Celem pracy była ocena wybranych cech jakościowych marchwi pochodzącej ze sklepów, z żywnością ekologiczną i konwencjonalną, na terenie miasta Krakowa. W przeprowadzonym doświadczeniu oceniano następujące parametry jakościowe soku przecierowego: zawartość ekstraktu, cukrów, polifenoli, azotynów i azotanów, flawonoidów, β-karotenu oraz oceniano barwę i aktywność przeciwutleniającą. Z przeprowadzonych badań wynika, że zawartość azotanów (V) w próbkach marchwi z upraw konwencjonalnych była wyższa niż w marchwi z upraw ekologicznych, a w jednej z próbek z upraw konwencjonalnych przekracza dopuszczalne normy. Jednak przeprowadzone badania nie dają podstaw do twierdzenia, że zawartość azotanów (III) uzależniona jest od systemu produkcji marchwi. Badanie zawartości polifenoli, flawonoidów oraz aktywności przeciwutleniającej soków wykazały zwiększoną zdolność antyoksydacyjną marchwi z uprawy konwencjonalnej w odniesieniu do marchwi uprawianej systemem ekologicznym, jednak różnice te nie zostały potwierdzone statystycznie. Zawartość β-karotenu we wszystkich próbkach była porównywalna niezależnie od systemu upraw. Zawartość ekstraktu, węglowodanów ogółem oraz sacharozy była istotnie większa dla marchwi z upraw konwencjonalnych niż dla eko marchwi.

Słowa kluczowe: marchew, jakość, uprawa, azotany, aktywność przeciwutleniająca