International Journal of Biological, Life and Agricultural Sciences
ISSN: 2415-6612
Vol:6, No:4, 2012

Chemical Composition of Variety 'Nante' Hybrid Carrots Cultivated in Latvia

Tatjana Rakcejeva, Ingrida Augspole, Lija Dukalska, Fredijs Dimins

***Abstract*—**carrot is one of the important root vegetable crops, and it is highly nutritious as it contains appreciable amount of vitamins, minerals and β-carotene. The major objective of current research was to evaluate the chemical composition of carrot variety 'Nante' hybrids in general and to select the best samples for fresh-cut salad production. The research was accomplished on fresh in Latvia cultivated carrots harvested in Zemgale region in the first part of October, 2011 and immediately used for experiments. Late-bearing variety 'Nante' hybrid carrots were used for analysis: 'Nante/Berlikum', 'Nante/Maestro', 'Nante/Forto', 'Nante/Bolero' and 'Nante/Champion'. The quality parameters as moisture, soluble solid, firmness, β-carotene, carotenoid, color, polyphenols, total phenolic compounds and total antioxidant capacity were analyzed using standard methods. For fresh-cut salad production as more applicable could be recommended hybrids 'Nante/Forto' and 'Nante/Berlikum' − mainly because it's higher nutritive value, as higher total phenolic compounds, polyphenols and pronounced antioxidant capacity.

***Keywords*—**carrots, chemical composition, evaluation

I. Introduction

STRAINED carrots sold in retail markets exhibit a diverse range of color and taste characteristics. From a single processor, this variability may be influenced by differences in raw product, growing conditions, processing parameters and the degree of physiological stress. However, much of this variability is avoided by selecting carrot cultivars for desirable color, taste and aroma characteristics [1].

Carrots are a globally important vegetable crop providing a source of important nutritional compounds (including pro-vitamin A) through their carotenoid content whilst adding flavour and texture to many diets across the world. Around 28 million tones of carrots are produced globally each year, giving the crop a financial and horticultural significance [2].

Carrot is one of the important root vegetable crops, and it is highly nutritious as it contains appreciable amount of vitamins B_1, B_2, B_6, and B_{12}.

It also contains many important minerals. Carrots have the highest β-carotene, a precursor of vitamin A, content among human foods [3].

T. Rakcejeva is with the Latvia University of Agriculture, Faculty of Food Technology, Department of Food Technology, Jelgava, Liela iela 2, LV-3001, Latvia (phone: 00-371-63005644; e-mail: tatjana.rakcejeva@llu.lv).

I. Augspole is with the Latvia University of Agriculture, Faculty of Food Technology, Department of Chemistry, Jelgava, Liela iela 2, LV-3001, Latvia (phone: 00-371-63005642; e-mail: ingrida.augspole@inbox.lv).

L. Dukalska is with the Latvia University of Agriculture, Faculty of Food Technology, Department of Food Technology, Jelgava, Liela iela 2, LV-3001, Latvia (phone: 00-371-63005644; e-mail: lija.dukalska@llu.lv).

F. Dimins is with the Latvia University of Agriculture, Faculty of Food Technology, Department of Chemistry, Jelgava, Liela iela 2, LV-3001, Latvia (phone: 00-371-63005642; e-mail: fredisd@tvnet.lv).

Main carrots nutrition's are phenolic compounds, carotenoids, soluble dry matter, β-carotene, sugars and others.

Carotenoids are fat soluble compounds that are associated with the lipid fractions. This class of natural pigments occurs widely in Nature. Furthermore, some of them are involved in the cell communication and xanthophylls have shown to be effective as free radical scavengers [4]. Carotenoids, the main pigments that are responsible for the color of carrots, are of importance to food and nutrition scientists due to their pro-vitamin A and antioxidant activity. β-carotene constitutes a large portion (60–80 %) of the carotenoids in carrots, followed by α-carotene (10–40 %), lutein (1–5 %) and the other minor carotenoids (0.1–1 %) [5].

Apart from carotenoids, phenolic compounds also reveal antioxidative properties in vegetables. Phenolic compounds, especially flavonoids, show various types of biological activity, but the most important is the antioxidant activity. The total content of phenolic compounds in carrot is a cultivar characteristic. However, it is greatly modified by the rate of N and the method of N fertilization, foliar nutrition, nitrogen form and also by the soil and climate conditions during cultivation [6].

Phenolics are iniquitous secondary metabolites in plant. They comprise a large group of biologically active ingredients – form simple phenol molecules to polymeric structures with molecular mass above 30000 Ds. On the basis of the number of phenol subunits, the modern classification forms two basic groups of phenolics – simple phenols and polyphenols. The group of simple phenols contains also the so-called "phenolic acids" or phenols with carboxyl group underlying the specific of their function. Polyphenols contain at least two phenol rings [7].

Major phenols in carrots include chlorogenic, caffeic, and *p*-hydroxybenzoic acids along with numerous cinnamic acid derivatives. The different carrot tissues have similar composition, but the individual phenolic content differs and it decreases from the exterior (peel) to the interior (xylem) [8]. The organoleptical (taste) qualities of carrot are controlled by a balance between a range of compounds including both reducing and non-reducing sugars and research indicates that sweetness is an important factor in the acceptance of new commercial vegetable cultivars [2].

Traditionally the harvesting of carrots in Latvia starts from middle of summer, however, main harvesting occur in autumn. World wide carrots have met purplish, yellow, green, white and black color, but in Latvia mainly bright orange. Main carrot variety is 'Nante' and its hybrids. The major objective of current research was to evaluate the chemical composition of carrot variety 'Nante' hybrids in general and to select the best samples for fresh-cut salad production.

II. MATERIALS AND METHODS

A. Materials

The research was accomplished on fresh in Latvia growing (*Daucus carota* L.) carrots harvested in Zemgale region in the first part of October, 2011 and immediately used for experiments. Serotinous 'Nante' cultivar carrot hybrids were: 'Nante/Berlikum', 'Nante/Maestro', 'Nante/Forto', 'Nante/Bolero' and 'Nante/Champion'.

B. Sample preparation

The time between harvest and compositional analysis was case-dependant, but would generally range from 0–5 days. To prepare the samples for analysis the carrots were cut into quarters. Two of the quarters in the opposite positions were sampled from five carrots and homogenized. For analyses, the carrots were divided into halves and one piece from each of five carrots was sampled and homogenized. This procedure was used because, for example, carotenoid accumulates heterogeneously in roots [9]. A variety and hybrid was considered when samples were collected.

C. Moisture

The vacuum oven method was used to determine moisture content. Sample portions were weighed, and then ground and mixed with a known weight of sand. The vacuum oven was used to obtain the dry matter of the samples. The drying condition was 70 °C for 5 h. After drying, the samples were cooled for 1 h, and then the residues were weighed [9].

The moisture content of carrots was determined using the equation:

$$X(\%) = \frac{M_1 - M_2}{M_1} \cdot 100 \quad (1)$$

Where X_0 moisture content (%), and M_1 is mass of sample before drying (g) and M_2 mass of sample after drying (g) [10].

D. β-carotene

For extraction, a representative portion of this sample (1 g) was accurately weighed in a glass test tube. Then 5 ml of chilled acetone was added to it, and the tube was held for 15 min with occasional shaking at 4 ± 1 °C, vortex at high speed for 10 min, and finally centrifuged at 1370 × g for 10 min. Supernatant was collected into a separate test tube, and the compound was re-extracted with 5 ml of an acetone followed by centrifugation once again as above. Both of the supernatants were pooled together and then passed through the Whatman filter paper No. 42. The absorbance of the extract was determined at 449 nm wavelength in a UV–Vis spectrophotometer [11].

Blank samples for raw carrots were prepared as described above. A working standard containing 32 µg/ml was prepared from the 1 mg/ml stock solutions kept at 4 °C. From this working standard different dilutions were made to spike the samples. Blank samples of 1.0 g were spiked with working standards to obtain final concentrations 16.0, 8.0, 4.0, 2.0, 1.0, 0.5, 0.25, 0.125, 0.062, 0.031 and 0.015 µg/g of β-carotene and extracted as described previously. Calibration curves were plotted by taking Optical Density value to the respective concentrations by back extrapolation methods. These curves were used to quantify the β-carotene content in the samples analyzed [11].

E. Carotenoids

A weight portion (2.00 ± 0.01 g) was used to measure the total carotenoids. The pulp obtained from carrots yellow-reddish colour was saponified to remove the chlorophylls. Subsequently, the carotenoids were extracted. The total carotenoids content was measured spectrophotometrically (using 6705 UV/VIS YENWAY) at 450 nm using the extinction coefficient of 2500 and the results were expressed as β-carotene equivalents (µg/g) of fresh weight [12].

F. Color analysis

Color of the carrots hybrids was evaluated by measuring CIE L*, a*, and b* parameters by means of ''ColorTec–PCM/PSM'' (ColorTec Associates, Clinton, USA). L*, a*, and b* indicate whiteness/darkness, redness/greenness, and blueness/yellowness values, respectively. The maximum value for L* is 100, which would be a perfect reflecting diffuser. The minimum for L* would be zero, which would be black. The values of a* and b* axes have no specific numerical limits. Positive a* is red and negative a* is green. Positive b* is yellow and negative b* is blue [13].

G. Total phenolics

The total phenolic content of carrots was determined by using Folin-Ciocalteu assay. An aliquot (1 ml) of extracts or standard solution of gallic acid 20, 40, 60, 80 and 100 mg/l) was added to 25 ml volumetric flask, containing 9 ml of distilled deionised water. Reagent blank using distilled deionised water was prepared. One milliliter of Folin-Ciocalteu's phenol reagent was added to the mixture and shaken. After 5 min, 10 ml of 7 % Na_2CO_3 solution was added to the mixture. The solution was diluted to volume 25 ml with distilled deionised water and mixed. After incubation for 90 min at room temperature, the absorbance against prepared regent blank was determined at 750 nm with UV–Vis spectrophotometer. Total phenolic content of carrots was expressed as mg gallic acid equivalents (GAE)/100g in fresh weight [7 and 14]. Then for result veracity a phenolic content of carrots was expressed as mg gallic acid equivalents (GAE)/100 g in dry matter.

H. Polyphenols

Phenolic compounds were determined using a high-performance liquid chromatography (HPLC) with UV detection (at 280 nm) [14, 15]. The contents of phenolic compounds were expressed in mg/100g dry weight.

I. Total antioxidant capacity (DPPH)

The antioxidant capacity was measured by the DPPH radical method according to A.L.K. Faller and E. Fialho, 2010 [16]. Briefly, a 100 µm DPPH solution was prepared with 80 %

methanol, giving an absorbance of 1.1 at 517 nm. In test tubes, 100 μl of each VE was weighed, with 3.9 ml of the DPPH solution (100 μm) added. The mixture was allowed to stand in the absence of light, and the absorbance was measured after 15, 30 and 60 min. DPPH solution alone was measured before the addition of the samples (A_0) and 80 % methanol was used as blank. The antioxidant capacity was represented as percent of radical scavenging capacity (RSC) remaining after each time according to the equation below:

$$\%RSC = \frac{A_0 - A_t}{A_0} \quad (2)$$

Where A_0 represents the absorbance of DPPH solution alone measured at zero time, and A_t is the absorbance for each sample at the times of 15, 30 and 60 min after the addition of the DPPH solution. The value of A_0 is considered 100 % [16].

J. Soluble solids

The soluble solids, recorded as a percentage of fresh juice of carrots, was estimated as the mean of ten digital refractometer readings taken of juice expressed from the 10 mm end caps removed from opposite ends of the vegetable [17].

K. Firmness

Structure analyzer "TA.XT.plus texture Analyser" (Stable Micro Systems Ltd., Surrey, UK) and measuring probe HDP/BSK (blade set with knife, supplied with the Texture Analyser) were used ford firmness determination. The system was equipped with a compression cell of 50 kg and software Texture Exponent 32. Firmness was measured as the maximum penetration force (N) reached during tissue breakage. The measuring parameters were: pre-test speed 2 mm/s; test speed 2 mm/s; post-test speed 10 mm/s; penetrating distance of 23 mm into the carrot. The measurement is triggered automatically at 0.04903 N. The maximum force required for sample cutting was calculated as an average of 10 measurements.

L. Mathematical data processing

Data are expressed as mean ± standard deviation; for the mathematical data processing p-value at 0.05 (One Way analysis of variance, ANOVA), was used to determine the significant differences. In case of establishing statistically significant differences, homogeneous groups were determined by Tukey's multiple comparison test the level of confidence $\alpha = 0.05$. The statistical analyses were performed using Microsoft Excel 2007. Experiments were carried out in tenfold.

III. Results and Discussion

A. Moisture and soluble solids content, firmness

Water migration phenomena and the resulting moisture content change in food products affect their shelf-life through undesirable modifications of their physical, sensory and microbial qualities [18]. Therefore, it is very important to determine the moisture content of carrots for the foreseeing of its shelf life in general. There are found relevant differences ($p < 0.05$) in moisture content (Table 1) between analysed carrots hybrids. Such results could be explained with individual hybrid properties as chemical composition and growing conditions. The higher moisture was established in hybrids 'Forto' and 'Champion', respectively 90.15 ± 0.13 and 89.07 ± 0.06 %, what was significantly higher ($p < 0.05$) comparing to hybrids "Bolero", "Maestro" and " Berlikum", which moisture content was very close to ~87.00 % (Table I).

Substantial differences in soluble solids content ($p < 0.05$) between analysed carrot hybrid samples were found (Table 1). It is known, that, for example, fruits are harvested unripe, although physiologically mature, and must be left to ripen (conversion of the stored starch into soluble solids) before consumption [16].

Therefore, the value of soluble solids is very significant. The higher soluble solid content was established in hybrids 'Maestro', 'Bolero' and 'Berlikum' respectively 10.30 ± 0.09, 10.00 ± 0.08 and 9.70 ± 0.09 ºBrix, the lowest soluble solid content was established in hybrid 'Forto' – 6.10 ± 0.07 ºBrix. In publication of Peng Y. and Lu R., 2008 [19] was mentioned about fruit firmness and soluble solid content interconnection. Therefore, the interconnection has been searched between mentioned parameters in present research of carrots as well. The close correlation was found in present experiments between soluble solids and firmness of carrots ($R^2 = 0.8197$, Fig. 1). Therefore, the changes (decreasing of content) of soluble solids could mean decreasing of hardness of carrots during storage, as a result carrot twisting could occur.

TABLE I
SOLUBLE SOLID, MOISTURE CONTENT AND FIRMNESS VALUE OF CARROTS DEPENDING ON HYBRID TYPE

Hybrid	Moisture, %	Soluble solid, ºBrix	Firmness, N
Champion	89.07 ± 0.06	8.20 ± 0.18	82.93 ± 15.08
Forto	90.15 ± 0.13	6.10 ± 0.07	81.28 ± 14.54
Berlikum	87.00 ± 0.17	9.70 ± 0.09	82.24 ± 14.78
Maestro	86.95 ± 0.07	10.30 ± 0.09	103.98 ± 16.19
Bolero	87.00 ± 0.06	10.00 ± 0.08	95.09 ± 21.01

The higher firmness value was detected in analysed carrot hybrids as 'Maestro' and 'Bolero', 103.98 ± 16.19 N and 95.09 ± 21.01 N respectively (Table 1). Mainly, higher firmness value could be described with higher soluble solid content in analysed samples (described previously).

Results of mathematical data processing show, that there are not found relevant differences ($p > 0.05$) in firmness value between carrots hybrids 'Forto', 'Champion' and 'Berlikum', 81.28 ± 14.54 N, 82.93 ± 15.08 N and 82.24 ± 14.78 N respectively (Table 1). However, such hybrids are ~1.3 times softer than 'Maestro' and 'Bolero'.

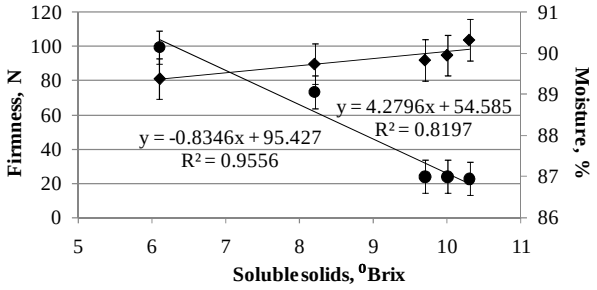

Fig. 1 Correlation between soluble solids and firmness (♦), and between soluble solids and moisture content (●) of carrots

Correlation is found between soluble solid content of carrots and moisture content (R^2 = 0.9556). As a result analysed quality compounds correlate between own. Thereby, for example, for foreseeing of the carrot soluble solid changes during storage it could be sufficiently to control only the carrot firmness.

B. Carotenoid and β-carotene content, color

In general, European orange roots accessions were richer in carotenoids (9.9 ± 0.5 mg/100g) than those originating from continental Asia (7.9 ± 0.4 mg/100g), while Japanese accessions contained more carotenoids (10.1 ± 0.4 mg/100g) than European ones. Among accessions with orange roots, advanced cultivars tend to possess more carotenoids than landraces either in Europe (10.1 ± 0.4 and 8.1 ± 0.5 mg/100g, respectively), continental Asia (8.4 ± 0.5 and 7.6 ± 0.5 mg/100g) or Japan (11.1 ± 0.4 and 7.7 ± 0.5 mg/100g) [20]. In the present experiments it was established, that there are found relevant differences between carotenoid content in analysed carrot samples; the carotenoid content range from 60.21 ± 0.66 to 79.47 ± 0.42 mg/100g (in dry matter) depends on hybrid (Table 2), however, acquired results are very similar to in scientific literature found data.

TABLE II
CAROTENOID CONTENT AND COLOR INTENSITY OF CARROTS DEPENDING ON HYBRID TYPE

Hybrid	Carotenoid content mg/100g (in dry matter)	Color intensity		
		L*	a*	b*
Champion	79.47 ± 0.42	54.66 ± 3.04	18.88 ± 2.67	42.22 ± 2.73
Forto	72.45 ± 1.77	53.27 ± 2.52	17.19 ± 1.26	35.70 ± 2.58
Berlikum	60.21 ± 0.66	53.92 ± 4.13	16.42 ± 1.64	29.39 ± 3.33
Maestro	76.47 ± 0.15	52.03 ± 3.12	14.17 ± 1.88	41.66 ± 3.39
Bolero	72.93 ± 1.48	52.11 ± 2.64	12.63 ± 6.47	36.11 ± 6.48

It is known that carotenoid's colour fluctuate from yellow to red, including orange, with variations of brown and purple. Carotenoids are highly sensitive to oxygen and light. When those factors are excluded, carotenoids in food are stable even at high processing temperature [21]. Therefore, main differences of carotenoid content in analysed carrot samples could be explained with growing conditions as light and fertilizer presence as follow.

The influence of different carrot hybrids on the values of lightness (L*), redness component (a*), and yellowness component (b*) is shown in Table 2. There is no found main differences in lightness (L*) values between analyzed carrot hybrids, what mainly could demonstrate similar color of analysed carrot samples. The yellowness (b*) was markedly dependent on carotenoid pigment concentration in carrot hybrids. That why, hybrid 'Champion' has higher carotenoid content as a result pronounced yellowness. Pronounced redness (a*) value was determined of 'Forto' and 'Champion' carrot hybrids.

There is found close interconnection (R^2 = 0.9313) between carotenoid content of carrots and yellowness value changes (Fig. 2), as a result increasing of carotenoid content, the b* (yellowness) value of analyzed carrot samples increase respectively. Therefore, the higher b* (yellowness) value indicate about higher carotenoid content in carrots.

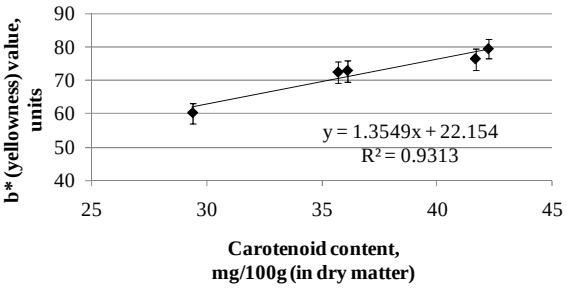

Fig. 2 Correlation between b* value (yellowness) and carotenoid content

Is found data, that more than 650 carotenoids have been described and isolated from natural sources, however, only about 60 are regularly present in the human diet, and about 20 carotenoids can be detected in human plasma and tissues, the most abundant being β-carotene, lutein, lycopene, α-carotene, β-cryptoxanthin and zeaxanth. In addition, some of these pigments (mainly β-carotene, α-carotene, and β-cryptoxanthin) have pro-vitamin A activity [22]. Therefore, the β-carotene content of carrots was analysed in current research. In the present experiments was not found close correlation between carotenoid, β-carotene and b* value of analysed carrot samples. The content of β-carotene range from 9.84 ± 0.39 to 12.19 ± 0.15 mg/100g (in dry matter), what is very similar with data in scientific literature described by P. Karnjanawipagul *et all.*, 2010 (6.19-14.59 mg/100g carrot [23]). Higher β-carotene content was determined in hybrids 'Forto', 'Champion' as a follow 12.19 ± 0.15 and 10.43 ± 0.60 mg/100g (in dry matter) respectively, however, the β-carotene content of hybrids 'Berlikum', 'Bolero' and 'Maestro' was 10.05 ± 0.70, 9.92 ± 0.16 and 9.84 ± 0.39 mg/100g (in dry matter) respectively.

C. Phenolics, polyphenols and antioxidant capacity

Carrots are not a major source of phenolic acids when compared to fruits (berries) and various leafy vegetables (spinach, broccoli). Increasing the level of phenolic acids in

carrots could increase the overall nutrient status of carrots [24].

In the present experiments relevant differences ($p < 0.05$) in total phenolic compounds (Fig. 3) of analyzed carrot hybrids was found. Obtained results are very similar to in scientific literature found. As follow, by Marinova D. *et all.*, 2005 [7] the total phenolics compounds in carrots was indicated as 96.0 (GAE)/100g in fresh weight. However, such result could be transformed. Therefore, the total phenolic compounds of carrots were ~800.0 (GAE)/100g in dry matter, what is similar to results obtained in the present experiments (Fig. 3).

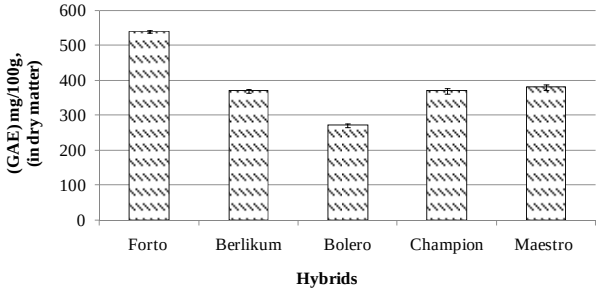

Fig. 3 Total phenolic compounds in hybrids of carrot cultivar "Nante"

The highest total phenolic content was found in hybrid's 'Forto' (539.76 ± 4.97 (GAE)/100g dry matter, the lowest in hybrid's 'Bolero' 271.21 ± 5.37 (GAE)/100g dry matter. High total phenolic content possibly is related with rich availability of hydroxycinnamic acids (chlorogenic acid, ferulic acid, p-coumaric acid, etc.) presented mainly in esterified form with organic acids, sugars or lipids in the analyzed hybrids [7].

Polyphenols bound to food indigestible fraction can account for a substantial part of total phenolic compounds in foods. While a minor part of dietary polyphenols can be absorbed in the small intestine, most dietary polyphenols are not bioavailable in the human upper intestine and may exert biological activity through the intestinal tract [25].

In general, in all analyzed carrot hybrids gallic acid, catechin and caffeic acid was detected (Fig. 4).

In the scientific literature gallic acid has been described as a strong natural antioxidant, which is able to scavenge reactive oxygen species, e.g., superoxide anions, hydrogen peroxide, hydroxyl radicals and hypochlorous acid. This antioxidant effect could prove beneficial to numerous disease states, including cardiovascular disease [26]. Therefore, the antioxidant effect could be foreseeing for analysed carrots, as a results longer shelf life. The higher content of gallic acid was font in hybrid 'Bolero' – 15.14 ± 0.90 mg/100g (in dry matter).

Catechin and epicatechin have two chiral centres (four enantiomers) and during biosynthesis, predominantly (+)-catechin and (−)-epicatechin are synthesised and other enantiomers are seldom found in plants. The enantiomers of both catechin and epicatechin show different physiological and biological effects. (+)-catechin has antibacterial and antifungal activities whereas (−)-catechin, shows phytotoxic effects [27].

It is necessary to note, that epicatechin in analysed carrot hybrids practically was not detected (Fig. 4).

The higher catehcin content was found in hybrids 'Maestro' and 'Forto' – 24.16 and 26.40 ± 0.92 mg/100g (in dry matter) respectively.

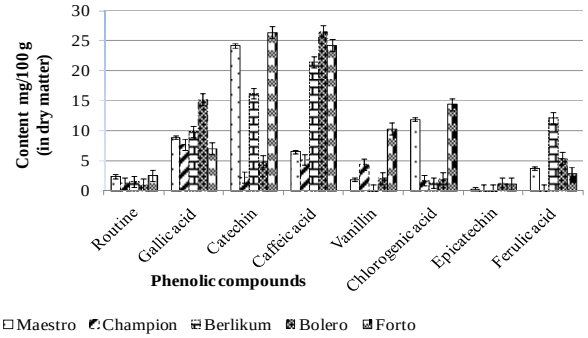

Fig. 4 Polyphenols content in "Nante" cultivar carrot hybrid dry matter

Caffeic acid is a naturally phenolic compound and traditionally is presented in coffee, olive oil, white wine, cabbage etc. Caffeic acid and its modifications, ethyl ester and phenethyl ester, act as carcinogenic inhibitors and they also show antiradical-scavenging activity *in vitro*. Moreover, chitosan oligomers show antioxidant activity which is not shown in polymer formation [28].

Very similar content of caffeic acid was detected in hybrids 'Berlikum', 'Bolero' and 'Forto' – 21.46 ± 4.61, 26.52 ± 1.44 and 24.17 ± 1.23 mg/100g (in dry matter) respectively. Therefore, antiradical-scavenging activity *in vitro* for described carrot samples could be typical. Unfortunately, lower antiradical-scavenging activity could be characterised in carrot hybrids 'Maestro' and 'Champion' – 6.49 ± 1.78 and 5.17 ± 1.14 mg/100g (in dry matter) respectively.

A few studies on the antioxidant properties of vegetables suggested that vegetables are excellent dietary sources of natural antioxidants. Vegetables, including broccoli, carrot, potato, and tomato are rich in phenolic compounds, and all of their 50 % MeOH extracts suppressed lipid oxidation in lower density lipoproteins. In scientific literature, data are reported that the juices of selected vegetables including carrot, potato and tomato purchased from a supermarket in Italy had inhibitory effect against lipid oxidation in rat liver microsome. These data suggest the presence of antioxidants in commonly consumed vegetables and the potential influence of growing locations on their antioxidant properties [29].

No relevant differences ($p > 0.05$) was not found in total antioxidant capacity (DPPH) between tested carrot hybrids 'Bolero', 'Chempion' and 'Maestro' as 22.33 ± 0.25 % DPPH, 22.16 ± 0.09 % DPPH and 22.84 ± 0.16% DPPH respectively. Different antioxidant capacity was detected in carrot hybrids 'Forto' and 'Berlikum', as 24.28 ± 0.45 % DPPH and 23.12 ± 0.39 % DPPH respectively. Acquired results are close to in scientific literature found, for example, antioxidant capacity of the cold-pressed carrot is ~38 % DPPH [30].

IV. Conclusion

In the present research after comprehensive chemical composition evaluation of in Latvia cultivated late-bearing variety 'Nante' hybrid carrots 'Nante/Berlikum', 'Nante/Maestro', 'Nante/Forto', 'Nante/Bolero' and 'Nante/Champion' for fresh-cut salad production as more applicable could be recommended hybrids 'Nante/Forto' and 'Nante/Berlikum' – mainly because its higher nutritive value, as higher total phenolic compounds and polyphenols (especially caffeic acid), its pronounced antioxidant capacity, yet carrot hybrids 'Nante/Forto' and 'Nante/Berlikum' yellowness and firmness values, and carotenoid content was not so pronounced.

Acknowledgment

The research and publication has been prepared within the framework of the ESF Project "Formation of the Research Group in Food Science", Contract No. 2009/0232/1DP/ 1.1.1.2.0/09/APIA/VIAA/122.

References

[1] S. T Talcott, L. R.Howard, C. H Brenes "Factors contributing to taste and quality of commercially processed strained carrots," *J. Food Research International*, vol. 34, Iss. 1, pp. 31-38, 2001.

[2] R. Baranski, C. Allender, M. Klimek-Chodacka "Towards better tasting and more nutritious carrots: Carotenoid and sugar content variation in carrot genetic resources," *J. Food Research International*, in press.

[3] C.-W. Hsieh', W.-C. Ko "Effect of high-voltage electrostatic field on quality of carrot juice during refrigeration," *J. LWT - Food Science and Technology*, vol. 41, iss. 10, pp. 1752-1757, December, 2008.

[4] A. Rodríguez-Bernaldo de Quirós, H. S. Costa "Analysis of carotenoids in vegetable and plasma samples: A review," *J. Food Composition and Analysis*, vol 19, iss. 2-3, pp. 97-111, March-May, 2006.

[5] M. Sun, F. Temelli "Supercritical carbon dioxide extraction of carotenoids from carrot using canola oil as a continuous co-solvent," *J. Supercritical Fluids*, vol.37, iss. 3, pp. 397-408, May, 2006.

[6] S. Smoleń, W. Sady "The effect of various nitrogen fertilization and foliar nutrition regimes on the concentrations of sugars, carotenoids and phenolic compounds in carrot (*Daucus carota* L.)," *J. Scientia Horticulturae*, vol.120, iss. 13, pp. 315-324, May, 2009.

[7] D. Marinova, F. Ribarova, M. Atanassova "Total phenolics and total flavonoids in Bulgarian fruits and vegetables," *J. of the University of Chemical Technology and Metallurgy*, vol 40, iss. 3, pp. 255-260, 2005.

[8] E .M. Gonçalves, J. Pinheiro, M. Abreu, T. R. S. Brandão, C .L .M. Silva "Carrot (*Daucus carota L.*) peroxidase inactivation, phenolic content and physical changes kinetics due to blanching," *J. Food Engineering*, vol. 97, iss. 4, pp. 574-581, April, 2010.

[9] Y. Tsukakoshi, S. Naito, N. Ishida, A. Yasui "Variation in moisture, total sugar, and carotene content of Japanese carrots: Use in sample size determination," *J. Food Composition and Analysis*, vol. 22, iss. 5, pp. 373-380, August, 2009.

[10] M. Rashidi "Modeling of carrot firmness based on water content and total soluble solids of carrots," *J. Agricultural and Biological Science*, vol. 6, No. 8, pp. 62-65, August, 2011.

[11] A. K. Biswas, J. Sahoo, M. K. Chatli "A simple UV-Vis spectrophotometric method for determination of β-carotene content in raw carrot, sweet potato and supplemented chicken meat nuggets," *J. LWT - Food Science and Technology*, vol. 44, iss. 8, pp. 1809-1813, October, 2011.

[12] V. Lima, E. Mélo, M. Maciel, F. Prazeres, R. Musser, D. Lima "Total Phenolic and Carotenoid Contents in Acerola Genotypes Harvested at Three Ripening Stages," J. *Food Chem.isgtry*, vol. 90, iss. 4, pp. 565–568, 2005.

[13] T. Rakcejeva, K. Rusa, L. Dukalska, G. Kerch "Effect of chitosan and chitooligosaccharide lactate on free lipids and reducing sugars content and on wheat bread firming," *J. European Food Research and Technology*, vol. 232, no.1, pp.123-128, 2010.

[14] N. G. Baydar, O. Sagdic, G. Ozkan, S. Cetin "Determination of antibacterial effects and total phenolic contents of grape (*Vitis Vinifera* L.) seed extracts," *J. Food science and technology*, vol. 41, iss. 7, pp. 799-804, August, 2006.

[15] I. Berregi, J. I. Santos, G. del Campo, J. I. Miranda "Quantitative Determination of (-)-Epicatechin in Cider Apple Juice by HNMR," *J. Talanta*, vol. 61, iss. 2, pp. 139-145, October, 2003.

[16] A.L.K. Faller, E. Fialho "Polyphenol content and antioxidant capacity in organic and conventional plant foods," *J. Food Composition and Analysis*, vol. 23, iss. 6, pp. 561-568, September, 2010.

[17] V. A. McGlone, R. B. Jordan, R. Seelye, P. J. Martinsen "Comparing density and NIR methods for measurement of Kiwifruit dry matter and soluble solids content," *J. Postharvest Biology and Technology*, vol. 26, iss. 2, pp. 191-198, September, 2002.

[18] E. Roca, B. Broyart, V. Guillard, S. Guilbert, N. Gontard "Predicting moisture transfer and shelf-life of multidomain food products," *J. Food Engineering*, vol. 86, iss. 1, pp. 74-83, May, 2008.

[19] Y. Peng, R. Lu "Analysis of spatially resolved hyperspectral scattering images for assessing apple fruit firmness and soluble solids content," *J. Postharvest Biology and Technology*, vol. 48, iss.1, pp. 52-62, April, 2008.

[20] R. Baranski, C. Allender, M. Klimek-Chodacka "Towards better tasting and more nutritious carrots: Carotenoid and sugar content variation in carrot genetic resources," *J. Food Research International*, in press.

[21] H. D.Belitz, W. Grosch, P. Schieberle *Food Chemistry*. Springer, 2004, pp. 238-239.

[22] D. Hornero-Méndez, M. I. Mínguez-Mosquera "Bioaccessibility of carotenes from carrots: Effect of cooking and addition of oil," *J. Innovative Food Science & Emerging Technologies*, vol. 8, iss. 3, pp. 407-412, September, 2007.

[23] P. Karnjanawipagul, W. Nittayanuntawech, P. Rojsanga, L. Suntornsuk "Analysis of β-Carotene in Carrot by Spectrophotometry," *J. Pharmaceutical Science*, vol. 37, iss. 1-2, pp. 8-16, 2010.

[24] D. P. Singh, J. Beloy, J. K. McInerney, L. Day "Impact of boron, calcium and genetic factors on vitamin C, carotenoids, phenolic acids, anthocyanins and antioxidant capacity of carrots (*Daucus carota*)," *J. Food Chemistry*, in press.

[25] D. Hervert-Hernández, O. P. García, J. L. Rosado, I. Goñi "The contribution of fruits and vegetables to dietary intake of polyphenols and antioxidant capacity in a Mexican rural diet: Importance of fruit and vegetable variety," *J. Food Research International*, vol. 44, iss. 5, pp. 1182-1189, June, 2011.

[26] J. Gil-Longo, C. González-Vázquez "Vascular pro-oxidant effects secondary to the autoxidation of gallic acid in rat aorta," J. *Journal of Nutritional Biochemistry*, vol. 21, iss. 4, pp. 304-309, April, 2010.

[27] A. Ghassempour, S. Mollayi, M. Farzaneh, A. Sharifi-Tehrani, H. Y. Aboul-Enein "Variation of Catechin, epicatechin and their enantiomers concentrations before and after wheat cultivar-*Puccinia triticina* infection," *J. Food Chemistry*, vol. 125, iss. 4, pp. 1287-1290, April, 2011.

[28] A. O. Aytekin, S. Morimura, K. Kida "Synthesis of chitosan–caffeic acid derivatives and evaluation of their antioxidant activities," *J. Bioscience and Bioengineering*, vol. 111, iss. 2, pp. 212-216, February, 2011.

[29] K. Zhou, L. Yu "Total phenolic contents and antioxidant properties of commonly consumed vegetables grown in Colorado," *J. LWT - Food Science and Technology*, vol. 39, iss. 10, December, 2996.

[30] L. L. Yu, K. K. Zhou, J. Parry "Antioxidant properties of cold-pressed black caraway, carrot, cranberry, and hemp seed oils," *J. Food Chemistry*, vol. 91, iss. 4, pp. 723-729, August, 2005.

Tatjana Rakcejeva, Dr.sc.ing, and associated professor was born in Dobele at 1977 in Latvia. She has received her Dr., degree in Food science at 2006, and elected in associated professor's post in Latvia University of Agriculture at 2010. Main scientific directions are: alternative processes and technologies for processing of meat, fish, berries and vegetables *(especially dying possibilities in vacuum microwave drier)*, development of new food

products and its quality evaluation, prolonging possibilities of food shelf-life and food shelf-life prediction. She has about 39 published scientific articles.

Ingrida Augspole, Mg.cib.hyg., and senior laboratory assistant in Latvia University of Agriculture, Faculty of Food Technology, Department of Chemistry was born in Madona at 1972 in Latvia. She has received her Mg., degree in Food Hygiene in Latvia University of Agriculture at 2010. Main scientific directions are: wild berries, apples, honey and potatoes quality evaluation and processing. She has about 4 published scientific articles.

Lija Dukalska, Dr.habilit.sc.ing, and professor was born in Riga district at 1934. She has received her Dr., degree in Food science and technology at 1972, Dr habilit. sc. ing at 1997 and elected in professor's post in Latvia University of Agriculture at 1998. Scientific direction is studies of the novel and environmentally friendly biodegradable food packaging material application for food packaging technologies. She has about 180 published scientific articles, and 4 published books, EC expert in Brussels, reg. N°EE19981A03785. Participated in EU financed International projects *EcoPac*, QLRT-2001-01823 and *PackTeck*, N G1RTC-CT-2002-05068.

Fredijs Dimins, Dr.sc.ing., and assistant professor was born in Riga at 1973 in Latvia. He has received his Dr., degree in Food science at 2006, and elected in assistant professor's post in Latvia University of Agriculture, Faculty of Food Technology, Department of Chemistry at 2011. Main scientific directions are: wild berries, apples, honey and potatoes. He has about 35 published scientific articles.