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VALORISATION OF CARROT AND PUMPKIN WASTES, THROUGH ACHIEVING OF FUNCTIONAL INGREDIENTS WITH HIGH NUTRITIONAL VALUE AND ANTIOXIDANT CAPACITY

Monica CATANĂ[1], Luminița CATANĂ[1], Enuța IORGA[1], Monica-Alexandra LAZĂR[1], Anda-Grațiela LAZĂR[1], Răzvan Ionuț TEODORESCU[2], Adrian Constantin ASĂNICĂ[2], Denisa-Eglantina DUȚĂ[1], Nastasia BELC[1]

[1]National Research and Development Institute for Food Bioresources, IBA Bucharest, 6 Dinu Vintila St., District 2, Bucharest, Romania
[2]University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd., District 1, Bucharest, Romania

Corresponding author email: lumi_catana@yahoo.co.uk

Abstract

Valorisation of vegetable waste from food industry is of real interest because of its high content in nutrients and biologically active compounds, as well as in terms of the protection of the environment. Carrot and pumpkin wastes resulting from juice extraction have a complex biochemical composition, distinguished by protein, sugars, minerals, phenolic compounds, carotenoids and fibre content. At the same time, these vegetable wastes have antioxidant capacity. In this paper are presented results of the performed research to achieve some functional ingredients (powders) from carrot and pumpkin wastes, resulted after juice extraction. Functional ingredients were sensory, physic-chemical and microbiologically analysed. Powder achieved from carrot and pumpkin wastes is characterized by total dietary fibre (29.12...51.67%), total sugar (5.05…16.85%), β-carotene (5.45…13.65 mg/100 g), vitamin C (8.04…15.63 mg/100 g), potassium (668.55...825.45 mg/100 g), calcium (76.85…86.39 mg/100 g), magnesium (25.85…34.56 mg/100 g), iron (2.49…3.85 mg/100 g), zinc (1.54…2.44 mg/100 g) and total polyphenol content (119.85… 295.85 mg GAE/100 g). At the same time, powder achieved from carrot and pumpkin wastes has antioxidant capacity (47.28...103.23 mg TE/100 g). Due to its complex biochemical composition and antioxidant capacity, the functional ingredient achieved from carrot and pumpkin wastes can be used to fortify bakery and pastry products.

Key words: *carrot, pumpkin, waste, β-carotene, dietary fibre.*

INTRODUCTION

At present, the exponential growth of plant waste production in the agro-food industry is a critical global issue in terms of storage, disposal, impact environment and potential health risks. Numerous *in vitro* and *in vivo* studies support the involvement of phytochemical compounds in fruits and vegetables as well as the waste resulting from their processing in the prevention and/or diet therapy of chronic oxidative stress related diseases, such as cancer and cardiovascular diseases (Attanzio et al., 2018). Thus, valorisation of plant wastes through achieving of functional ingredients that increase nutritional quality and antioxidant potential of food products is of real interest.

Carrot (*Daucus carota*) is an important source of β-carotene, vitamins (thiamine, riboflavin, folic acid, etc.), fibres (especially soluble fibres) and minerals. Carrot is an important root vegetable which is used for juice production. The juice yield in carrots is about 60–70% and the carrot pomace is about 30–40% (Sharma et al., 2012). It is worth noting that about 80% of the β-carotene content of the carrots processed are found in the resulting wastes (Kumar & Kumar, 2011).

Carrot wastes are an important source of dietetic fibres (soluble and insoluble), carotenoids and minerals (calcium, copper, magnesium, potassium, phosphorus, iron) (Nagarajaiah & Prakash, 2015). For the purpose of preservation of nutrients and bioactive compounds, carrot pomace is generally dried (at maximum 50°C) and milled to obtain carrot pomace powder. According to research conducting by Kohajdova et al. (2012), the chemical composition of carrot pomace powder was the following: moisture - 9.13% d.m.; ash - 1.39% d.m.; fat - 2.10% d.m.; proteins - 6.73% d.m.; total dietary fibre- 55.70% d.m.; total carbohydrates - 24.95% d.m. Research performed by Gull et al. (2015) highlighted for carrot pomace powder (10.30% moisture) higher content for ash (7.03%) and carbohydrates (68.89%), but lower for crude fibre (11.66%) and fat (1.42%). Also, carrot pomace is a good source of antioxidant components: total carotenoids - 5,456µg/100g and β-carotene - 607 µg/100g (Nagarajaiah & Prakash, 2015).

Due to sensory and nutritional qualities, carrot pomace powder can be used for fortification of coventional and gluten-free bakery and pastry products.

Prakash and Mishra (2015) fortified the rolls with carrot pomace powder using the following levels of fortification: 2.5, 5, 7.5 and 10%. The fortification process led to an increase of their nutrional value: increase in protein content (6.8-7.56%), in lipids (15.51-16.78%) and increase in total ash (0.71–1.18%). Rolls with a level of fortification of 2.5% were the most apreciated from a sensory point of view (the texture, colour, taste and aroma of the product were evaluated). Also, Nagarajaiah & Prakash (2015) have fortified a pastry product (cake) with carrot pomace powder, applying 3 levels of fortification: 4, 8, and 12% (in parallel, the control sample was also made). Fortification of the cake with the functional ingredient obtained from the carrot wastes resulted in an increase of the content of soluble fibre (2.34–4.54%), insoluble fibre (2.64–5.64%), ash (1.18–1.45%), total carotenoids (1,278-3,076 µg/100g) and β-carotene (126-333 µg/100g), compared to the control sample. Using the 12% fortification level affects the sensory characteristics of cake and consumer acceptability.

Pumpkin (*Cucurbita moschata)* is rich in carotenes, vitamins, minerals, pectin and dietary fibre. Pumpkin processing is achieved as puree, juice and pumpkin seed oil, resulting in a large amount of by-products. The pumpkin pomace powder is distinguished by carotenoids content – 35.55 mg/100 g d.w. (Kampuse et al., 2015). Also, the pumpkin pomace powder has high content of cellulose (19.6 %), hemicellulose (3.5%), pectin (5.4%) and minerals (Calcium: 90 mg/100g; Phosphorus: 14 mg/100g) (Derkanosova et al., 2018). Pumpkin pomace powder can be used for fortification of bakery and pastry products. Kampuse et al. (2015) achieved wheat bread enriched with pumpkin by-products (fresh pumpkin pomace and pumpkin pomace powder). In the case of fresh pumpkin pomace, fortification levels were 10, 15, 20, 30, 40 and 50%, and in case of pumpkin pomace powder, were 5, 10 and 20%. Initial growth of pumpkin by-products caused an increase in loaf volume, which started to decrease at higher amounts. Also, after the sensory analysis it was found that wheat bread enriched with pumpkin by-products, is highly appreciated by consumers, except sample with 50% pomace addition. To achieve wheat bread fortified with pumpkin pomace, with superior sensory qualities and high nutritional value, the study authors recommend 5 and 10% fortification levels in case of pumpkin pomace powder and more than 30% of pumpkin pomace (calculated per 100 kg of flour).

In this paper are presented the results of the research performed to achieve functional ingredients (powders) from carrot and pumpkin wastes resulting in juice industry.

MATERIALS AND METHODS

Samples

Carrot and pumpkin pomaces resulted by carrot and pumpkin processing into juice within the Pilot Experiments Plant for Fruits and Vegetables Processing in IBA Bucharest, using a juicer extractor (Philips). Within experiments were used carrots and pumpkin, purchased from Romanian farmers. Carrot and pumpkin pomaces were subjected to dehydration process in a convection dryer at temperature 50ºC to a moisture which allows their milling and conversion into flours and, at the same time, their stability in terms of quality. Milling of dried semi-finished products was performed by using Retsch mill. The achieved functional ingredients (powders) were packed in glass containers, hermetically sealed, protected by aluminum foil against light and stored at 4-8 ºC, till to the sensory, physic-chemical and microbiological analysis. In Figure 1 are presented the carrot pomace powders and in Figure 2, the pumpkin pomace powders, respectively.

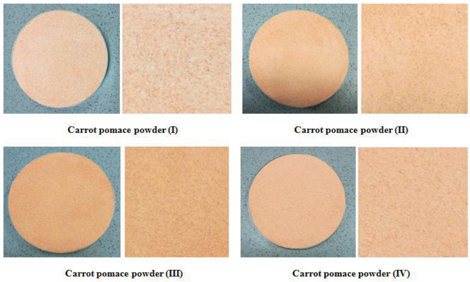

Figure 1. Carrot pomace powders

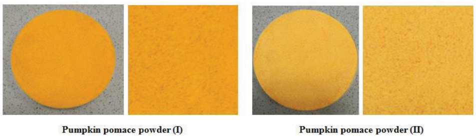

Figure 2. Pumpkin pomace powders

Methods

Sensory analysis

Sensory analysis (appearance, taste and smell) was performed by descriptive method.

Physic-chemical analysis

Measurement of the colour parameters of samples was performed at room temperature, using a CM-5 colorimeter (Konica Minolta, Japan), equipped with SpectraMagic NX software, to register CIELab parameters (the Commission Internationale de l'Eclairage - CIE), *L**, *a** and *b**: *L** - colour luminance (0 = black, 100 = white); *a** - red-green coordinate (-a = green, +a = red); *b** - yellow-blue coordinate (-b = blue, +b = yellow).

Moisture determination was performed with Ohaus Moisture Analyzer MB45 at temperature 105°C.

Protein content was determined by the Kjeldahl method with a conversion factor of nitrogen to protein of 6.25 (AOAC Method 979.09, 2005).

Fat content was determined according to AOAC Method 963.15, and ash content according to AOAC Method 923.03 (AOAC, 2005).

In order to determine minerals samples were mineralized by calcination, with the addition of hydrochloric acid and hydrogen peroxide. The minerals sodium (Na), potassium (K), calcium (Ca), magnesium (Mg) and zinc (Zn) were determined by Atomic Absorption Spectrophotometer (type *AAnalyst* 400, Perkin–Elmer). Iron (Fe) was determined by Graphite Furnace Atomic Absorption Spectrophotometer (type *AAnalyst* 600, Perkin–Elmer).

Total sugar content was determined according to Schoorl method.

Total dietary fibre (TDF) was determined by enzymatic method using the assay kits: K-TDFR ''Total dietary fibre'' (AOAC Method 991.43).

Determination of vitamin C content was performed by high performance liquid chromatography (Accela, Thermo Scientific) coupled with high resolution mass spectrometry (LTQ Orbitrap XL Hybrid Ion Trap-Orbitrap Mass Spectrometer, Thermo Scientific) using hippuric acid as internal standard (Catană et al., 2017).

Determination of β-carotene content was performed by high-performance liquid chromatography (HPLC-DAD).

Total polyphenol content

Total polyphenol content was conducted according to Horszwald and Andlauer (2011) with some modifications (concerning extraction media, time and mode of extraction, extract volumes of the used sample and reagents, using UV-VIS Jasco V 550 spectrophotometer), based on calibration curve of gallic acid achieved in the concentration range 0 to 0.20 mg/mL. The extraction of phenolic compounds was performed in methanol: water 50:50, and the absorbance of the extracts was determined at a wavelenght λ = 755 nm. Results were expressed as mg of Gallic Acid Equivalents (GAE) per g carrot pomace powder and per g pumpkin pomace powder, respectively.

Antioxidant capacity

The DPPH scavenging radical assay was conducted according to Horszwald and Andlauer (2011) with some modifications (concerning extract volumes of the used sample and reagents, using UV-VIS Jasco V 550 spectrophotometer). The reaction was performed in dark for 30 min (at ambient temperature) and after this time the absorbance was read at 517 nm. It was achieved the calibration curve Absorbance = f(Trolox concentration), in the concentration range 0-0.4375 mmol/L and the results were expressed as mg Trolox Equivalents per g carrot pomace powder and per g pumpkin pomace powder, respectively.

Microbiological analysis

The water activity (*A*w) was determined by an instrument Aquaspector AQS-2-TC, Nagy. The measurements were performed at 25ºC. Yeasts and molds were determined by the method SR ISO 21527-1:2009. *Enterobacteriaceae* were determined according to the SR EN ISO 21528-1:2017
method and *Escherichia coli* by SR ISO 16649-2:2007 method. *Salmonella* was determined by the method SR EN ISO 6579-1:2017.

RESULTS AND DISCUSSIONS

Sensory analysis

After sensory analysis it was found that the obtained powders have specific characteristics. Powders obtained from the carrot waste have colours from light orange to orange and show characteristic pleasant taste and smell. Also, the powders obtained from the pumpkin waste have colours ranging from yellow-orange to intense orange and show characteristic pleasant taste and smell.

Following instrumental colour analysis (Figure 3), it was found that carrot pomace powder (III) is the darkest, recording the minimum luminance value (L* = 77.50), while carrot pomace powder (I) is the lightest (L* = 82.06). Also, the minimum positive values of parameter a* (red colour coordinate) and parameter b* (yellow colour coordinate) were recorded in case of carrot pomace powder (I) (a* = 14.26 and b* = 20.08).

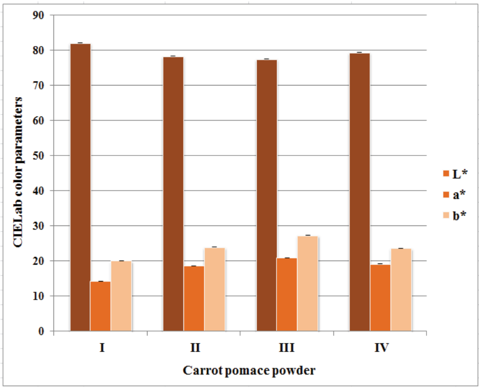

Figure 3. Colour parameters of the powders achieved from carrot pomace

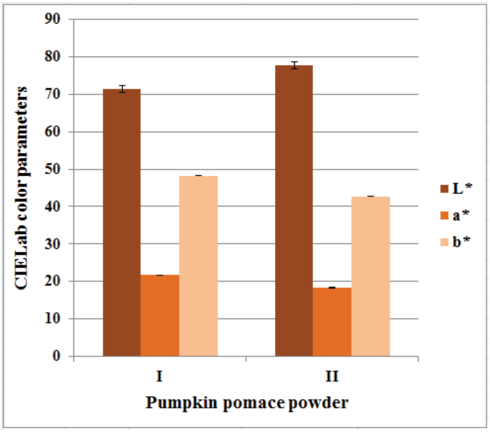

Figure 4. Colour parameters of the powders achieved from pumpkin pomace

The pumpkin pomace powder (I) is the darkest, recording the minimum luminance value (L* = 71.39) (Figure 4). Also, the minimum positive values of parameter a* (red colour coordinate) and parameter b* (yellow colour coordinate) were recorded in case of pumpkin pomace powder (II) (a* = 18.31 and b* = 42.72).

Physic-chemical analysis

Composition of the powders achieved from carrot and pumpkin wastes is presented in Table 1. Water content of carrot and pumpkin pomace powders are higher than those reported by Turksoy and Özkaya (2011): 6.80% for carrot pomace powder and 6.24 for pumpkin pomace powder. Also, Derkanosova et al. (2018) reported in case of pumpkin pomace powder, a lower value for water content (5.3%).

Table 1. Physic-chemical composition of powders achieved from carrot and pumpkin wastes

Functional ingredient	Water (%)	Ash (%)	Protein (%)	Fat (%)	Total sugar (%)	Total fibre (%)
Carrot pomace powder (I)	7.12±0.18	7.28±0.09	6.89±0.06	1.46±0.016	16.85±0.050	48.24±0.90
Carrot pomace powder (II)	7.55±0.19	6.84±0.08	6.55±0.06	1.55±0.017	13.65±0.040	49.12±0.91
Carrot pomace powder (III)	7.28±0.18	7.09±0.08	6.75±0.06	1.78±0.020	15.91±0.048	47.80±0.89
Carrot pomace powder (IV)	7.42±0.18	6.96±0.08	6.67±0.06	1.60±0.018	14.25±0.043	51.67±0.96
Pumpkin pomace powder (I)	7.65±0.19	5.10±0.06	8.35±0.07	0.90±0.010	5.05±0.015	29.12±0.54
Pumpkin pomace powder (II)	7.48±0.18	5.48±0.06	9.21±0.08	1.26±0.014	5.86±0.018	31.27±0.58

Ash content of carrot pomace powders varied in the range 6.84–7.28% (the minimum value was recorded in case of carrot pomace powder (II), and the maximum one in case of carrot pomace powder (I)). Ash content of carrot pomace powder is comparable with that reported by Gull et al. (2015) (7.03±0.73%), but higher than that presented by Nagarajaiah & Prakash (2015) (5.12±0.05%) and Kırbașet et al. (2019) (6.32±0.35). Ash content of pumpkin pomace powders is lower than that of the functional ingredient obtained from carrot wastes but higher than that reported by Turksoy and Özkaya (2011) (4.78±0.68% dry basis). The protein content of carrot pomace powders is lower than that of pumpkin pomace powders, but higher than that reported by Majzoobi et al. (2016) (6.54±0.09%, respectively, 6.48±0.04%). Functional ingredients obtained from carrot and pumpkin pomace have low lipids content, in the range 0.90–1.78%, comparable witht hat reported by Kausaret et al. (2018), in case of carrot pomace powder (1.80±0.01%). It is noted the high content of total sugar (expressed as % invert sugar) of carrot pomace powders, obtained from experiments. Values obtained for this chemical parameter varied within the range (13.65-16.85%). The carbohydrate content of the carrot pomace powder is represented in particular by simple sugars such as glucose and fructose (Sharma et al., 2012).

Instead, the pumpkin pomace powders have a lower sugar content of 5.05% and 5.86%, respectively. Carrot and pumpkin pomace powders are important sources of dietary fibre. The total fibre content varied in the range 29.12–51.67% (the minimum value was recorded in case of pumpkin pomace powder (I) and the maximum one in case of carrot pomace powder (IV). Fibre content of the functional ingredients obtained within this experimental study was higher than that reported by Nagarajaiah & Prakash (2015), in case of carrot pomace powders (44.75%) and comparable to that reported by Derkanosova et al. (2018), in case of pumpkin pomace powder (28.5%). Kırbaş et al. (2019) reported for carrot pomace powder a significantly higher total fibre content compared to that obtained in this experimental study (83.91±0.6%). Difference can be explained by the fact that moisture of carrot pomace powder, obtained by them is about 2.5 times less than that obtained for this functional ingredient in this study. Dietary fibre intake in Western countries is of 18g per person per day, but, according to the World Health Organization, population's fibre intake should increase to 30g a day (British nutrition fundation, 2015). Raman et al. (2018) have highlighted the importance of dietary fibre, as the cornerstones for cardiovascular diseases treatment. The dietary fibre determines the decrease of atherogenic lipoprotein levels and degree of oxidation, thrombogenesis, and concentrations of some relevant factors (homocystein), preventing cardiovascular diseases and coronary heart disease. The intake of dietary fibre in the diet determines weight loss, increased satiety, reduced postprandial glucose response, and hypercholesterolemia effects, and gut microbiome, contributing to prevention of cardiovascular diseases and coronary heart disease.

The powders achieved from carrot and pumpkin wastes are an important source of minerals (K, Ca, Mg, Fe, and Zn). Their content in minerals is presented in Figures 5, 6, 7 and 8.

The results obtained in this study are consistent with those reported by Nagarajaiah & Prakash (2015) which mention that the dried carrot pomace is an important source of fibre (10-20%), antioxidants and minerals, including calcium, copper, magnesium, potassium, phosphorus, and iron, with beneficial effects on health.

Carrot pomace powders have high potassium content in the range 668.55–704.73 mg/100g, (the maximum value being recorded by sample I), of 1.4–1.5 times higher than that of apple pomace powder, reported by Catană et al. (2018) (450.12–508.45 mg/100g). Potassium is the most abundant cation in the intracellular fluid and plays a vital role in maintaining normal cell functions. Both oxidative stress and potassium imbalance can cause different diseases, such as neurodegenerative diseases (Udensi & Tchounwou, 2017). Based on the study performed, Ndanuko et al. (2017) have shown that for weight loss and to improve BP control, it is necessary to decrease in the diet sources of sodium and to increase sources of potassium.

Sodium content of the functional ingredient achieved from carrot waste was 4.4–4.8 times lower compared to potassium content.

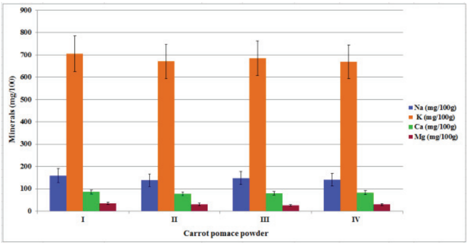

Figure 5. Mineral content (Na, K, Ca, and Mg) of the powders achieved from carrot pomace

The calcium content of the powders achieved from carrot pomace varied in a small range (76.85–86.39 mg/100g), being comparable to that obtained by Catană et al. (2018), in case of apple pomace powders (76.32–92.44 mg/100g). Carrot pomace powders have magnesium content in the range 27.86–32.56 mg/100g, being significantly lower than that reported by Catană et al. (2017), in case of black grape seed flour and black grape pomace flour (146.55-223.75 mg/100g).

Iron content of the powders achieved from carrot pomace varied in the range 2.49–2.97 mg/100g, being comparable to that reported by Catană et al. (2018), in case of apple pomace powders (2.31–2.73 mg/100g). Also, zinc and copper content of carrot pomace powders achieved within this study, is comparable to that obtained by Catană et al. (2018), in case of apple pomace powders.

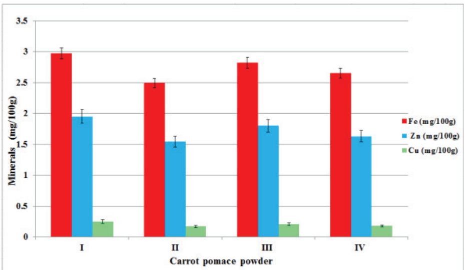

Figure 6. Mineral content (Fe, Zn, and Cu) of the powders achieved from carrot pomace

Ca, Mg and Cu content of functional ingredient achieved from pumpkin pomace is comparable to that obtained from carrot pomace. Conversely, K, Zn and Fe content are 1.17–1.30 times higher than that of carrot pomace powders.

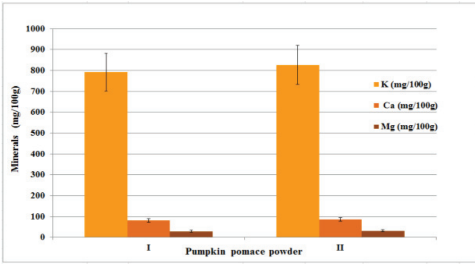

Figure 7. Mineral content (K, Ca, and Mg) of the powders achieved from pumpkin pomace

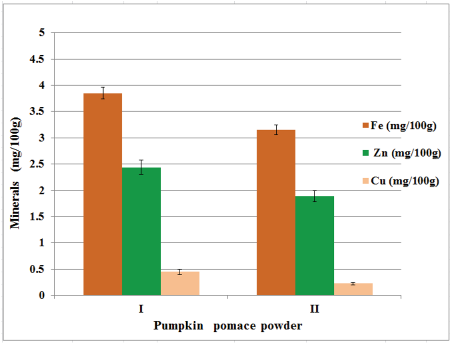

Figure 8. Mineral content (Fe, Zn, and Cu) of the powders achieved from pumpkin pomace

The calcium content of pumpkin pomace powders achieved within this experimental study is comparable to that obtained by Derkanosova et al. (2018), in case of dried pumpkin pomace (90±3.6 mg/100g).

Carrot and pumpkin pomace powders are important sources of β-carotene and vitamin C (Table 2). β-Carotene content of carrot pomace powders varied in the range 10.70–13.65 mg/100g, being higher than that reported by Goyal (2004) for dried carrot pomace (9.87–11.57 mg/100).

Table 2. β-Carotene and vitamin C content of powders achieved from carrot and pumpkin wastes

Functional ingredient	β-Carotene (mg/100g)	Vitamin C (mg/100g)
Carrot pomace powder (I)	10.70±0.45	13.85±0.46
Carrot pomace powder (II)	12.75±0.54	15.05±0.50
Carrot pomace powder (III)	13.65±0.70	15.63±0.52
Carrot pomace powder (IV)	11.85±0.50	14.45±0.47
Pumpkin pomace powder (I)	7.82±0.33	9.18±0.30
Pumpkin pomace powder (II)	5.45±0.23	8.04±0.27

The differences obtained for the content of this bioactive compound can be explained by the carrot varieties used, the conditions for the preservation and dehydration of fresh carrot pomace, and storage conditions of carrot pomace powder. β-Carotene can be chemically degraded and isomerized when exposed to heat, light, and oxygen (Knockaert et al., 2012; Chen & Zhong, 2015).

β-Carotene content of pumpkin pomace powders is comparable to that reported by Das & Banerjee (2015) (7.30 mg/100g) and, respectively, by Kļava et al. (2018), in case of dehydration of pumpkin waste in convective hot air dryer at 50°C (5.42 mg/100g dry matter).

Consumption of food containing β-carotene is important for maintaining human health, because this carotenoid is enzymatically converted to retinol (vitamin A) in the human intestine by the β-carotene 15,15'-monoxygenase (Haskell, 2012; Álvarez et al., 2014). Thus, β-carotene has beneficial effects on the human body: has antioxidant activity (Kasperczyk et al., 2014), prevents and reduces the risk of type 2 diabetes (Sluijs et al., 2015), lower prevalence of the metabolic syndrome in middle-aged and elderly adults (Liu et al., 2014), improve immune system performance and reduce the risk of cardiovascular diseases (Tanaka et al., 2012).

Carrot pomace powders have a vitamin C content comparable to that reported by Goyal (2004), but about 1.7 times higher comparable to that of pumpkin pomace powders. Also, the pumpkin pomace powders achieved in this study had a vitamin C content of about 1.6 times higher comparable to that reported by Kļava et al (2018), in case of dehydration of pumpkin waste in convective hot air dryer at 50°C (5.63 mg/100g).

Vitamin C is an important antioxidant. Thus, vitamin C reacts with free radicals, reducing reactive oxygen species to protect against the oxidation of lipids, proteins, and DNA. It also functions as a cosubstrate for a series of enzymes, including those involved in collagen synthesis (Gerald et al., 2017). To provide antioxidant protection a recommended dietary allowance of 90 mg day^{-1} for adult men and 75 mg day^{-1} for women has been established. Also, the increased risk of chronic diseases, including coronary heart disease, cancer and cataracts, is associated with low intake or low plasma concentration of vitamin C (Czyzowska, 2016).

Total polyphenol content

The powders achieved from carrot and pumpkin wastes are also noted by total polyphenol content (Figure 9). Total polyphenol content of carrot pomace powders varied in the range 265.14-295.85 mg GAE/100g, being, however, significantly lower than that obtained by Catană et al. (2018) in case of apple pomace powders (17.83-38.8 mg GAE/g). Total polyphenol content of pumpkin pomace powders was 124.55 mg GAE/100g (sample I) and 119.85 mg GAE/100g (sample II), respectively, consistent with that obtained by Kļava et al. (2018), in case of dehydration of pumpkin waste in convective hot air dryer at 50°C (112.79 mg GAE/100g dry matter).

Various studies have demonstrated roles of phenolic compounds in the reduction of risk factors of cardiovascular diseases. Thus, based on in *vitro* antiplatelet activity of a number of fruits and vegetable extracts, it has been shown that phenolic compounds have action on the prevention of atherothrombosis (Torres-Urrutia et al., 2011; Fuentes et al., 2012).

Thus, phenolic compounds may be considered natural inhibitors of platelet aggregation, contributing to reducing the individual risk of developing of cardiovascular diseases which causes thrombosis (Lutz et al., 2019).

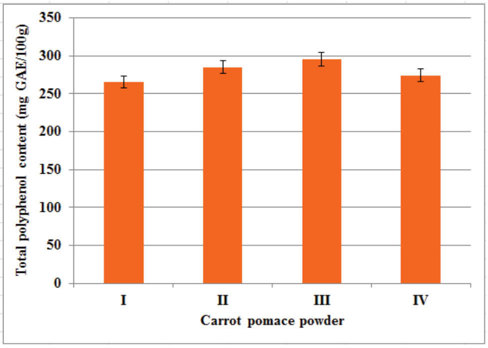

Figure 9. Total polyphenol content of the powders achieved from carrot pomace

There are also studies that demonstrate that higher dietary phenolic compounds intakes are associated with anti-inflammatory effects, in the human body (Cassidy et al., 2015).

Antioxidant capacity

Due to their content in phenolic compounds carrot and pumpkin pomace powders have antioxidant capacity (Figure 10). Antioxidant capacity of carrot pomace powders varied in the range 95.54-103.23 mg Trolox Equivalents/100 g, being about 2 times higher than that of pumpkin pomace powders. Antioxidant capacity of functional ingredients achieved in this study, from carrot and pumpkin wastes is significantly lower than that reported by Catană et al. (2018) in case of the functional ingredients obtained from apple waste (1.77......5.12 mg Trolox Equivalents/g).

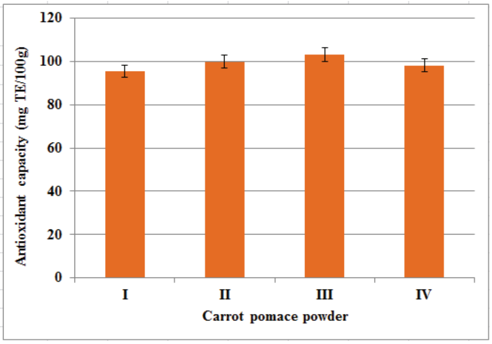

Figure 10. Antioxidant capacity of the powders achieved from carrot pomace

For the powders achieved from carrot and pumpkin pomace between the total polyphenol content and antioxidant capacity it is a linear correlation, regression coefficient R^2 being 0.9987 (Figure 11).

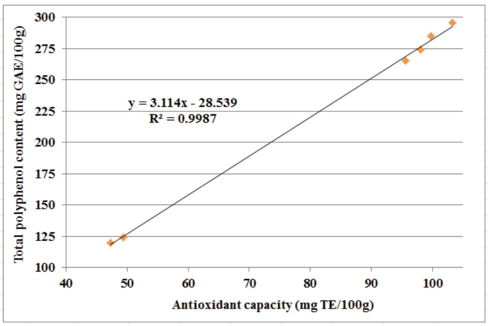

Figure 11. Correlation between the total polyphenol content and antioxidant capacity in case of powders achieved from carrot and pumpkin pomace

The results presented are consistent with those reported by Rana et al. (2015) and Catană et al. (2018), which also obtained a linear correlation between the total polyphenol content and the antioxidant capacity values.

Microbiological analysis

Results of the microbiological analysis of the powders achieved from carrot and pumpkin pomace are presented in the Table 3. Microbiological analysis shown that the achieved powders are in the frame of the provisions of the legislation into force.

These powders show low values of water activity (0.308-0.347), which give them microbiological stability.

Table 3. Microbiological analysis of powders achieved from carrot and pumpkin wastes

Functional ingredient	Yeast and mold (CFU/g)	*Enterobacteriaceae* (CFU/g)	*Escherichia coli* (UFC/g)	*Salmonella* (in 25 g)	Water activity (Aw)
Carrot pomace powder (I)	< 10	< 10	< 10	absent	0.308
Carrot pomace powder (II)	< 10	< 10	< 10	absent	0.339
Carrot pomace powder (III)	< 10	< 10	< 10	absent	0.325
Carrot pomace powder (IV)	< 10	< 10	< 10	absent	0.330
Pumpkin pomace powder (I)	< 10	< 10	< 10	absent	0.347
Pumpkin pomace powder (II)	< 10	< 10	< 10	absent	0.335

CONCLUSIONS

Powders achieved from carrot and pumpkin pomace are important sources of minerals (K, Fe, Mg, Ca, and Zn), dietary fibres and bioactive compounds.

Thus, carrot and pumpkin powders are important sources of β-carotene (5.45-13.65 mg/100g). The powders achieved in this study, are noted for their content in polyphenols (119.85 mg-295.85 mg GAE/100g) and vitamin C (8.04-15.63 mg/100g). Also these powders have antioxidant capacity (47.28-103.23 mg Trolox Equivalents/100 g), being beneficial in a healthy diet for prevention of diseases caused by free radicals.

On the other hand, carrot and pumpkin powders are characterized by high dietary fibre content (29.12–51.67%) being important sources to increase the fibre content of foods (bakery products, pastry products, etc.). Increase of the fibre content in case of the sweet flour products is very important because

it reduces their glycemic impact on the human body, thus preventing the development of diabetes mellitus and obesity. Also, dietary fibre have an important role in promoting feeling of satiety.

Powders achieved from carrot and pumpkin wastes can be regarded as functional ingredients and can be used to fortify food products (bakery and pastry products, especially) in order to increase the nutritional value and their antioxidant capacity.

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