RESEARCH ARTICLE OPEN ACCESS

Quantification Of Some Antioxidant Compounds In Raw Sweet Potato By Spectrophotometric Method

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ABSTRACT
The Objective Of This Study Was To Estimate The Level Of Some Antioxidant Compounds (Total Carotenoids Content, Total Vitamin C Content) In Several Sweet Potato Korean Varieties, Cultivated At Research And Development Center For Plant Growing On Sands Dabuleni. Spectrophotometry Analysis Were Used To Identifying And Comparing Carotenoids Content Quantitatively And Qualitatively In Orange, Yellow And White Sweet Potatoes Flesh Tuber. Vitamin C (A Spectrophotometric Method, L Ascorbic Acid Test Kit, Megazyme, Bioreba) Was Determined On Fresh Tissues. The Results Of This Study Showed That The Highest Total Carotenoid Content Was In Orange Sweet Potato Followed By Yellow And White Sweet Potato. Carotenoids Were Found In All Samples Of Sweet Potato Ranging From 11.50±3.482 Mg/100g DW In White Sweet Potato To 34.94±2.461 Mg/100g DW In Orange Sweet Potato. The Highest Level Of L Ascorbic Acid Total Content Had The Samples From The KSP1 Variety (25.3±2.080 Mg/100g FW). Another Cultivar That Had High Values Of Vitamin C Content (20.7±1.539 Mg/100g FW) Was Juhwangmi. Total Carotenoids And Vitamin C Content Vary Between The Flesh Tissues Of These Sweet Potato Varieties. The Results From This Study Could Be Useful For The Pharmaceutical, Food And Cosmetic Industries Market.

Keywords **-** Antioxidant Activity, Carotenoids, Spectrophotometry, Sweet Potato, Vitamin C

Date of Submission: 10-04-2018 Date of acceptance: 24-04-2018

I. INTRODUCTION

Sweet Potato (*Ipomoea Batatas* L.) Continues To Be Of Remarkable Economic Value As The Sixth Most Plentiful Food Crop In The Earth [1, 2, 3]. Sweet Potato Is A Vegetable Rich In Carotenoids, Especially B-Carotene (Pro-Vitamin A). Carotenoids Are Commonly Found In Fruits And Vegetables And Are Responsible For Yellow, Orange, And Red Pigmentations. Carotenoids And L Ascorbic Acid Are Antioxidants Compounds With Pharmaceutical And Medicinal Benefits. Carotenoids Such As A-Carotene And B-Carotene React As Pro-Vitamin A In The Human Body, While Lutein And Zeaxanthin Are Two Major Components Of The Macular Pigment Of The Retina. L Ascorbic Acid Is Particular Important Because It Can Reduce The Chelating Effect That Compound Phytic Acid Has On Iron, Increasing Its Bioavailability.

Vegetable Pigments Are Natural Substances That Determine The Color Of Flowers, Fruits, Leaves, Pollen, Tubers, And Other Plant Tissues And Organs. Carotenoid Are Among The Most Abundant Naturally Occurring Pigments That Are Found In Plants And Plant Foods [4]. From A Biochemical Point Of View, Vegetable Pigments Perform Many Fuctions: They Form Oxidation-Reducing Systems, Give The Taste, Flavor And Color Of Some Food, Indirectly Contribute To The Pollination And Spreading Of Seeds And Fruits (By Varied Color Of Flowers And Fruits That Attract Insects And Animals) Play An Essential Role In The Photosynthesis Process (Chlorophyll Pigments), They Take Part In Numerous Metabolic Processes [5].

Carotenoids Are Among The Most Valuable Food Constituents In Terms Of Food Quality And Human Health Effects. As Natural Pigments, They Confer The Color Of Many Fruits, Vegetables, Egg Yolk, Crustaceans, And Some Fish. The Principal Carotenoids Found In Foods Are B-Carotene, A-Carotene, B-Cryptoxanthin, Lycopene, Lutein, And Zeaxanthin. These

Carotenoids Are Also The Most Commonly Found In Human Plasma And Have Been The Most Studied In Terms Of Health Benefits. Orange-Fleshed Sweet Potatoes With Considerable Amounts Of B-Carotene Are Available And Have Been Shown To Improve The Vitamin A Status Of Children. B-Carotene Predominates In Sweet Potato. In The Carotenoid Compositions Of Sweet Potato Roots A Wide Variations Between-Variety Was Observed [6].

Sweet Potatoes Are An Excellent Source Of Vitamin A (In The Form Of Beta-Carotene). They Are Also A Very Good Source Of Vitamin C, Manganese, Copper, Pantothenic Acid And Vitamin B6. Additionally, They Are A Good Source Of Potassium, Dietary Fiber, Niacin, Vitamin B1, Vitamin B2 And Phosphorus. Sweet Potatoes Contains Large Amounts Of Vitamin C (Around 60 Percent Of Our Recommended Daily Allowance Per Large Potato). Most People Know That Vitamin C Aids Collagen Production And Exhibits Anti-Aging Benefits, But It Also Prevents Cholesterol From Oxidizing (Which Can Protect Us From Heart Disease) And Helps Stabilize Blood Cholesterol Levels. This Makes Sweet Potatoes A Great Choice For Those Of Us Suffering From Cardiovascular Conditions.

For Animal Organisms, Carotenoids Play The Role Of Provitamins A (In The Lining Of The Small Intestine, Two Carotene Molecules Of Beta-Carotene Produce 2 Molecules Of Vitamin A). One Large Sweet Potato Contains A Whopping 34.590 International Units Of Vitamin A, Which Is 692

Percent Of Our Recommended Daily Allowance. Though Vitamin A Performs Many Functions In The Body, Including Supporting The Immune System, Its Most Notable Role Is Maintaining Eye Health [7].

Sweet Potatoes Gain Most Of Their Antioxidant Properties From Their Significant Polyphenol Content. Polyphenols Are Essential Phytochemicals Which Aid In The Prevention Of Cardiovascular Diseases, Cancers, And Osteoporosis And Plays A Role In The Prevention Of Neurodegenerative Diseases And Diabetes Mellitus [7, 8, 9, 10, 11, 12, 13, 14, 3]. Since Sweet Potatoes Are One Of The Richest Sources Of Polyphenols, Eating More Of Them Can Help Shield Us From These Serious Diseases.

As Humans Are Unable To Synthesize Carotenoids, They Have To Depend On Plants For These Essential Products. Studies Have Shown The Superior Ability Of Sweet Potatoes To Raise Blood Levels Of Vitamin A [15, 16]. The Consumption Of Diets Containing Mostly Plant Sources Of B-Carotene, The Primary Source Being Sweet Potato, Increased Serum Retinol Concentrations In Children Marginally Deficient In Vitamin A.

II. MATERIAL AND METHODS

2.1. Biological Material

Five Sweet Potato Varieties Were Chosen For This Study (Fig. 1). This Biological Material Included The Following Korean Varieties Very Appreciated For Their Nutritional Quality (Data Not Show): Hayanmi And Yulmi (White Flesh); KSP1 And KSC1 (Yellow Flesh); Juhwangmi (Orange Flesh).

Fig. 1 Flesh Colour Of The Five Studied Sweet Potato Varieties

Sweet Potato Tubers Were Obtained On The Sandy Soils Of Southern Romania, With A Reduced Natural Fertility, And Soil Ph Values Ranging Between 5.64-6.98. Table 1 Shows The Evolution Of Climatic Conditions During The Growing Season. 2017 Was A Year Marked By Higher Air Temperature Values, With Peaks Above 40 ^{O}c And Very Low Air Humidity (25-30%) During Root Tuberization (Table 1), Whitch Affected The Accumulation Of The Dry Substance [17].

Table 1. Climate Conditions Recorded At The Weather Station From R&DCAPS Dabuleni During The Sweet Potato Growing Season

Period/Climate Parameters		May	June	July	August	September	Avegaire (%)	Σ %M m
2017	Monthly Average Temperature (°c)	17.8	24	24.8	24.8	20.2	22.32	3435
	Maximum Monthly Temperature (°c)	29.0	41.2	40.8	40.4	36.9		
	Rainfall (Mm)	78.6	17.4	120.8	28.8	18.2		263.8
Multiannual (1956-2017)	Monthly Average Temperature (°c)	16.8	21.6	23.1	22.4	17.8	20.32	3109
	Rainfall (Mm)	62.12	69.30	53.15	37.28	41.81		263.66

Source: Draghici Et Al. (2017)

The Climatic Conditions In The Sandy Soils Area, With High Temperatures In The Air Up To 40 ^{O}c, With Soil Surface Temperatures Of 65 ^{O}c

2.2. Sample Preparation

Tubers Were Hand-Peeled With A Potato Peeler, Cut For Reduce The Surface And Flesh Tissues Were Freeze-Dried (Scanvac Coolsafe 55-9 Pro Freeze Dryer, Denmark) For 60 Hours, Ground To A Fine Powder (Using A Coffee Grinder) And Stored To -20 ^{O}c Until Further Analysis.

2.3. Total Carotenoids Content (TCC)

Total Carotenoids Was Determined According To Burgos Et Al. (2009) Without Alkaline Hydrolysis. Extraction Of TCC From 0.5 G Of Powdered Skin Or 2 G Of Powdered Flesh Was Sequentially Carried Out In Triplicate With Acetone Using 10.7 And 5 Ml Volumes Shaking In 50 Ml Polypropylene Tubes At 10000 Rot/Min For 15 Minutes. The Supernatants Were Combined And 5 Ml Of Petroleum Ether And 20 Ml Of Pure Water Added. The Tubes Were Shaken Vigorously By Hand And Centrifuged At 10000 Rot/Min For 1 Minute To Separate The Aqueous And Organic Phases. The Top Organic Phase Was Removed Using A Pasteur Glass Pipette And Washed With 40 Ml Pure Water, Separating Both Phases As Described Above. The Top Organic Phase Was Again Removed And A Tip Of Spatula Of Sodium Sulphate Anhydrous Added To Absorb Minor Quantities Of Water At The Bottom Of The Tubes. The Extracts Were Transferred To Tarred Polypropylene Tubes (50 Ml), Washing The Sodium Sulphate Precipitate With Around 0.5 Ml Of Petroleum Ether In Triplicate. The Tubes Containing The Extract Were Weighed And The Absorbance Of An Aliquot Was Measured At 450 Nm Against Petroleum Ether Using A UV VIS Spectrophotometer Spectronic Genesys 5 (Milton Roy). TC Content Was Calculated As Follow:

(1) $C_s\,(Mg/G) = A \cdot 10 \cdot (0.65 \cdot 2500)^{-1}$

Where Cs Is The Concentration Of Carotenoids In The Extract, A The Absorbance Measured, 10 The Concentration Of A Solution 1% (Mg/Ml), 0.65 Is The Density Of Petroleum Ether (G/Ml) And 2500 Is The Absorbance Of A 1% Solution (1).

(2) $TC\,(Mg/Kg\ DW) = C_s \cdot 1000 \cdot W_e \cdot W_s^{-1}$

Where TC Is Total Carotenoids Content, DW Is Dry Weight, Cs Is The Concentration In Solution Calculated Above (Mg/G), 1000 Is The Conversion Factor From Grams To Kilograms, W_e Is The Weight Of The Extract Calculated By Difference Between The Tubers With And Without The Extract (G) And W_s Is The Initial Weight Of The Sample (G) (2).

And Minimum Air Humidity At 25% Act As Stressful Factors On The Plants, Which Dehydrate Through The Very Pronounced Foliar Sweating [17].

2.4. Vitamin C Analysis

Dry Matter (Thermoventilated Oven At 105 ^{O}c), Vitamin C (A Spectrophotometric Method, L Ascorbic Acid Test Kit, Megazyme, Bioreba) Were Determined On Fresh Tissues. We Choosed A Representative Sample Of Tubers Per Lot. The Sample For These Analysis Were Choosed From Each 2 Tubers (2 Tubers/Sample). The Characteristics Determination Was Made In 3 Repetitions [19].

2.5. Antioxidant Activity (AA) Analysis

Antioxidant Activity Was Determined Following The Method Presented By Goupy Et Al., 1999 And Valcarcel Et Al., 2015. Trolox Solutions With Different Concentration (Ranging From 0.01 To 0.04 Mm) Were Prepared In Ethanol. A Solution Of DPPH (1, 1-Diphenyl-2-Picrylhydrazyl) 0.238 G L^{-1} In Ethanol Was Prepared 2 H Before The Experiment And Stored At 4 ^{O}c. This Solution Dilute 1:5 Was Made And 0.5 Ml From This Was Pipetted In Tubes Containing Blank, Standard Or Sample Extract Solutions. The Tubes Were Vortex Mixed And Placed In The Dark For 30 Minutes. The Absorbance Of Each Solution Was Determined Against Air At 515 Nm Using A UV VIS Spectrophotometer Spectronic Genesys 5 (Milton Roy). Antioxidant Activity Was Expressed As Milligrams Trolox Per 100 G DW Of The Sample And Was Calculated By Dividing The IC_{50} Of The Trolox By That Of Each Sample. Higher Values Of This Results Corresponded To Samples With Good Antioxidant Activity.

III. RESULTS AND DISCUSSION

The Total Carotenoids Content (TCC), Total L Ascorbic Acid Content (TLAA), Dry Weight (DW) And Antioxidant Activity (AA) Was Determined On Fresh Tissues Of Five Sweet Potato Varieties With Different Flesh Colour And The Results Are Presented In Table 2. Carotenoids Have Long Been Recognized As Essential Nutrients And Important Beneficial Compounds For Good Health. The Highest Total Carotenoid Content Was In Orange Sweet Potato (Juhwangmi) Followed By Yellow (KSP1 And KSC1) And White Sweet Potato (Yulmi And Hayanmi). Carotenoids Were Found In All Samples Of Sweet Potato Ranging From 11.50±3.482 Mg/100g DW In White Sweet Potato To 34.94±2.461 Mg/100g DW In Orange Sweet Potato.

Table 2. Total Carotenoids Content, Total L Ascorbic Acid Content, Dry Matter And Antioxidant Activity Of The Biological Material Tested

Variety	Flesh Colour	Characteristics			
		TCC (Mg/100g DW)	TLAA (Mg/100g FW)	DW (G/100g FW)	AA (Mg Trolox/100g DW)
Yulmi	W	10.57	20.4	24.2	533.42
		17.08	17.4	25.1	700.28
		9.28	20.8	24.8	624.02
		12.31±4.381	19.5±1.858	24.70±0.458	619.23±83.542
Hayanmi	W	10.42	16.1	23.8	333.44
		8.68	13.8	24.6	457.07
		15.39	15.2	23.6	492.48
		11.50±3.482	15.0±1.159	23.33±1.439	427.64±83.486
KSC1	Y	12.38	18.5	24.4	487.01
		18.08	16.2	23.8	578.36
		13.16	13.8	23.6	423.12
		14.54±3.090	16.2±2.350	23.93±0.436	495.56±79.068
KSP1	Y	19.52	26.8	24.2	624.64
		11.38	22.1	23.6	527.06
		15.29	27.1	22.4	489.28
		15.40±4.071	25.3±2.080	23.40±0.917	546.97±69.855
Juhwangmi	O	34.87	22.4	21.8	976.36
		37.44	20.3	24.6	1048.32
		32.52	19.4	23.7	910.56
		34.94±2.461	20.7±1.539	23.37±1.428	978.41±68.903

Abbreviation: FW= Fresh Weight; DW = Dry Weight; TCC=Total Carotenoids Content; TLAA= Total L Ascorbic Acid Content; AA= Antioxidant Activity; W= White; Y= Yellow; O=Orange.

The Highest Level Of L Ascorbic Acid Total Content Had The Samples From The Variety With Yellow Flesh KSP1 (25.3±2.080 Mg/100g FW). Another Cultivar That Had High Values Of Vitamin C Content (20.7±1.539 Mg/100g FW) Was Juhwangmi, This One Having Orange Color Of Flesh Tissue.

Free Radicals Contribute To The Occurrence Of Many Degenerative Diseases Which Can Be Prevented By The Presence Of Antioxidants [22]. There Are Two Main Types Of Antioxidants Namely Primary And Secondary Antioxidants Which Differ In Their Mechanisms Of Action [23, 22]. In This Study, The Orange Fleshed Sweet Potato Variety (Juhwangmi) Showed The Highest Antioxidant Activity (978.41±68.903), Followed By Yulmi Variety, With A White Coloured Storage Roots (619.23±83.542) And KSP1, Which Has Yellow Fleshed Storage Roots (546.97±69.855). The White Fleshed Sweet Potato Variety Hayanmi, Showed The Lowest Antioxidant Activity (427.64±83.486). Is Interesting That, Although Yulmi And Hayanmi Varieties Have The Same Flesh Colour, They Still Show A Different Antioxidant Activity. In A Study Conducted By Teow Et Al. (2007), The Purple Fleshed *Ipomoea Batatas* Storage Roots Showed The Highest Antioxidant Activity Followed By Orange Coloured Storage Roots While The Yellow And White Fleshed Storage Roots Showed The Lowest Antioxidant Activity.

Depending On Flesh Colour, Sweet Potato Contains A Host Of Plant Bioactive Componds, Including Carotenoids, Anthocyanins, Phenolic Acids, Other Flavonoids And Vitamin C [25, 26]. Hwang Et Al., 2014 Investigate The Amounts Of Vitamin C In 22 Sweet Potato Cultivars Cultivated In Korea. Methods For Determining Vitamin C Was Validated By Determining Linearity, Specificity, Limit Of Detection (LOD), Limit Of Quantification (LOQ), Precision, And Accuracy Using HPLC. The Average TA Levels Were Also Dependent On Flesh Color, Whish Was Significantly Higher In General Sweet Potato And Orange Sweet Potato Than In Purple Sweet Potato. Pacheco Et Al., 2014 Developed A Micro Scale Extraction Method For Analysis Of Carotenoids In Vegetable Matrices. Quantification Of The Total Carotenoids Was Made By Spectrophotometry. Carotenoid Concentrations And Total Carotenoid Content Obtained By Commonly Used And Microscale Extraction Methods Were Determined. For Orange Pulp Sweet Potato, Based On The Two Methods, The Following Values Were Obtained: Trans-B-Carotene 85 Mg/G; A-Carotene 4 Mg/G And Total Carotenoid 95 Mg/G Respectively. Huang Et Al., 2014 Investigated The Carotenoid Contents Of Five Sweet Potato Varieties With Different Pulp Colors (Purple, White And Orange). The B-Carotene Content Varied Depending On The Variety, The Values Being: 7.275, 1.075, 47.2, 40.45, And 99.95 Mg Per Gram Tissue, Respectively.

IV. CONCLUSIONS

Total Carotenoids And Vitamin C Content Vary Between The Flesh Tissues Of These Sweet Potato Varieties. As We Expect, The Orange-Colored Sweet Potato Had A Higher Content Of Carotenoids Than The Sweet Potatoes Of Other Flesh Colors. Also, The Orange Sweet Potato Variety Has Obtained The Best Results In Terms Of Antioxidant Activity Compared To The Other Varieties With Different Flesh Colours (White And Yellow). Varieties Contained Antioxidants That Are Beneficial To The Human Body. Hence, The Sweet Potato Variety Juhwangmi Used In This Study Can Be Suggested As A Suitable Source Of Natural Antioxidants. The Results From This Study Could Be Useful For The Pharmaceutical, Food And Cosmetic Industries Market.

ACKNOWLEDGMENTS

This Work Was Supported By The Research Project ADER 2.2.2.

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Cioloca Mihaela "Quantification Of Some Antioxidant Compounds In Raw Sweet Potato By Spectrophotometric Method " International Journal of Engineering Research and Applications (IJERA) , vol. 8, no. 4, 2018, pp41-46