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B-CAROTENE EXTRACTION FROM *Daucus carota* (CARROT) UNDER DIFFERENT CONDITIONS OF TEMPERATURE AND SOLVENTS

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ABSTRACT

Carrots are common sources of β carotenes which are known for their therapeutic benefits such as their roles as antioxidants, prevention against cardiovascular diseases and cataracts. This research is aimed at extracting β-carotene from carrots under different conditions of temperature and solvents. Ethanol, 2-propanol and chloroform were used as solvents to extract β -carotene from the root of carrots (*Daucus carota L.*) and the yields were evaluated at different temperatures 20°C, 40°C and 60°C and time. Results revealed that the yield of carotene from carrot depends on temperature and solvent while time duration didn't make any significant ($p \leq 0.05$) change in the yield of carotenoids from carrots. There was increase in the yield of β - carotene from 60 mins to 240 mins but, a drop in concentration was observed at 300 mins. The temperature that gave the highest yield in all the solvents used was 60°C and the best solvent for the extraction was 2-propanol. In conclusion, 2-proponol was the most suitable solvent used for β -carotene extraction and the best extraction efficiency of 1hour to 4 hours.

Keywords: Carrot 2-propanol Temperature β-carotene

INTRODUCTION

Carrot (*Daucus carota L.*) is a nutritious root vegetable usually orange in colour, but also exist in purple, black, red, white and yellow. Carrot is a good source of beta carotene, fiber, vitamin KI, potassium and antioxidants (Baranska *et al*., 2005). Fast growing cultivars mature within three months (90 days) of sowing the seed while slower maturing cultivars takes a month longer (120 days). The roots of *Daucus carota L*. contain high quantities of alpha and beta carotene (Iorizzo *et al*., 2020). They are valuable to the food industry as they are used as natural food colorants to provide wide range of pigments , from yellow to red (Tan and Norhaizan, 2019). β-carotene has pro-vitamin A properties. It protects the body from cell damage by free radicals. β- carotene is cleaved into half by the enzyme carotene deoxygenase , thus it displays vitamin A activity. (Nogueira *et al*., 2016). Xanthophyii carotenoids such as β-cryptoxanthin and kutein / zeaxanthin are beneficial for maintaining healthy bones and eyes, respectively (Krugger *et al*., 2019). Carrots are the second richest source of β-carotene after dehydrated pepper (Nath *et al.*, 2016). In carrots, 80% of carotenes found consist of β-carotene bounded to proteins. The β- carotene in carrots provides more amount of absorbed Vitamin A compared to other vegetables that have inferior absorption of β-carotene (Berman *et al*., 2015).

Carotenes consist of long unsaturated hydrocarbon chains making them nonpolar. They are soluble in organic solvents such as petroleum ether and hexane (Kruger *et al*., 2019). Xanthophyiis are oxygenated carotenoids, making them more polar than carotenes. They lack pro-vitamin A activity due to the presence of hydroxyl groups present on either one or both ends of the xanthopyii structure.

There are no commonly established carotenoids extraction procedures or standard methods (Honda *et al*., 2019). However, most of the extraction methods involve the releasing of desired carotenoid components by disrupting tissues of food matrices, followed by removing undesirable components and a liquid- solid or liquid – liquid extraction (Amorim *et al*., 2014).

The high water content of carrots is considered a negative factor for an efficient carotenoid extraction. Thermal-based extraction methods such as heating, oven or microwave drying could cause heat degradation of carotenoids (Murtaza *et al*., 2018).

Solvent extraction is the most widely used method due to its simplicity, efficiency and affordability. The degradation of carotenoids is prevented with solvent extraction and use of minimal temperature that gives optimum yield. The selection of appropriate solvent depends on the polarity and chain length of the target.

The aim of this study was to determine the effect of solvents, temperature and time duration on extraction of carotenoids from carrots.

MATERIALS AND METHODS

The materials used were Spectrophotometer, separating funnel, 96% ethanol, chloroform and petroleum ether. All other reagents used were of analytical grade. Roots of carrots were purchased at random from a market in Zaria Local Government Area of Kaduna State.

Processing and Extraction of Roots of *Daucus carota L.*

The roots of *Daucus carota L*. were cut to slices (width 2 mm, length 1cm). The extraction was performed according to the method described by Duta *et al*., 2005.The extraction yield of β-carotene was observed at different temperatures (20° C, 40°C and 60° C) using ethanol , chloroform and 2-propanol as solvents. Exactly 25 g of the sliced carrot was added to 100 ml of 96 % ethanol, chloroform and 2- propanol, respectively and then heated in water bath at different temperatures 20° C, 40°C and 60° C. Exactly 5 ml sample was taken and mixed with 20 ml petroleum ether at every hour interval of extraction. Water was added to the separation phases after which the petroleum-ether-carotenoid phase was made up to 50 ml.

Determination of Carotenes

The concentration of β-carotene in the petroleum ether extract was determined spectrophotometrically at absorbance of 450

nm. The concentration of carotenes was expressed in mg / 100 ml using the response factors as below:
B - carotene = A × d × V/ E × W
Where:
A = Absorbance
d = dilution
E = Coefficient of absorbance (2592 for petroleum ether)
W = Weight of sample (g)
V = Volume (ml).

Statistical Analysis
All analysis were conducted in triplicate. Results were expressed as mean ± standard deviation. The mean values of each extract were compared using student T – test and Dunkan Multiple Range Test. Values of P ≤ 0.05 were considered significantly different.

RESULTS AND DISCUSSION
It was observed that the yield of β-carotene extracted from carrots using ethanol at 20°C and 40°C had yields of 1.65 mg ± 0.0015 /100g and 2.06 mg ± 0.04 /100g, respectively in 240 minutes. The highest yield of β-carotene using ethanol was at 60 °C with yields of 3.9 mg ± 0.043 in 120 minutes (Table 1). This finding conforms with the report of Fikselova *et al*. (2008) which stated that optimal time for β-carotene extraction is between 120 minutes to 24 minutes.
Table 2 showed the yield of β-carotene extracted from carrots using 2-propanol at 20°C and 40°C and 60°C. The highest yield was 5.29 mg ± 0.025 at 60°C in 240 mins. There was significant ($p \leq 0.05$) increase in the yields of β-carotene with increase in temperature which is in conformity with the findings Rafjlovska *et al*. (2007) which stated that increase in temperature positively influences the mass transfer processes.
Table 3 showed that the highest yield of β-carotene extracted from carrots using chloroform was 3.54 mg ± 0.043 at 60°C in 240 mins , 2.04 mg ± 0.02 in 240 mins and 1.37 mg ± 0.02 in 240 mins. This agrees with the findings of Dutta *et al.* (2005) where the highest solubility of carotenes was found to be at 60°C. Heat treatment enhances the release of carotenoids bound by protein and render them easily extractable.
It is observed that the higher the temperature the more the concentration of carotenoids extracted (Tables 1, 2 and 3). This finding agrees with the report of Martina *et al*. (2008). Temperature can be said to be a significant factor in determining the carotenoids yield from carrots. There was increase in carotenoid yield extracted by ethanol, 2-propanol and chloroform from 60 mins to 240 mins but a decrease in the carotenoid concentration was observed at 300 mins in all the solvents used.

Table1: β - Carotene Yield from Carrot using Ethanol at 20 °C, 40 °C and 60 °C at Different Time Duration

Time of Extraction (mins)	Yield at 20°C (mg /100 g)	Yield at 40°C (mg /100 g)	Yield at 60°C (mg /100 g)
60	1.55 ± 0.02^{a1}	1.96 ± 0.02^{a2}	3.88 ± 0.09^{a3}
120	1.57 ± 0.04^{a1}	1.97 ± 0.03^{a2}	3.9 ± 0.04^{a3}
180	1.61 ± 0.02^{b1}	2.02 ± 0.02^{a2}	3.8 ± 0.06^{a3}
240	1.65 ± 0.02^{c1}	2.06 ± 0.04^{b2}	3.81 ± 0.05^{a3}
300	1.60 ± 0.01^{b1}	2.02 ± 0.08^{a2}	3.75 ± 0.09^{a3}

Values with different superscripts alphabets (a-c) across the column and numbers (1-3) down the row are significantly different at $p \leq 0.05$.

Table 2: β - Carotene Yield from Carrot using 2-Propanol at 20 °C, 40 °C and 60 °C at Different Time Duration

Time of Extraction (mins)	Yield at 20° C (mg/100g)	Yield at 40° C (mg/100g)	Yield at 60° C (mg/100g)
60	1.54 ± 0.05^{a1}	2.23 ± 0.05^{a2}	5.11 ± 004^{a3}
120	1.63 ± 0.03^{b1}	2.27 ± 0.09^{a2}	5.17 ± 0.018^{b3}
180	1.61 ± 0.03^{b1}	2.30 ± 0.05^{b2}	5.20 ± 0.124^{c3}
240	1.69 ± 0.09^{c1}	2.29 ± 0.03^{c2}	5.29 ± 0.3^{e3}
300	1.60 ± 0.07^{b1}	2.37 ± 0.03^{d2}	5.18 ± 0.03^{e3}

Values with different superscripts alphabets (a-e) across the column and numbers (1-3) down the row are significantly different at $p \leq 0.05$.

Table 3: β - Carotene Yield from Carrot using Chloroform at 20 °C, 40 °C and 60 °C at Different Time Duration

Time of Extraction (mins)	Yield at 20°C (mg /100g)	Yield at 40°C (mg /100g)	Yield at 60°C (mg /100g)
60	1.24 ± 0.21^{a1}	1.90 ± 0.25^{a2}	5.11 ± 004^{a3}
120	1.27 ± 0.09^{a1}	1.94 ± 0.19^{a2}	5.17 ± 0.018^{b3}
180	1.34 ± 0.03^{b1}	2.00 ± 0.02^{a2}	5.20 ± 0.124^{c3}
240	1.37 ± 0.02^{b1}	2.04 ± 0.02^{b2}	5.29 ± 0.3^{e3}
300	1.33 ± 0.03^{a1}	1.93 ± 0.041^{d2}	5.18 ± 0.03e3

Values with different superscripts alphabets (a-e) across the column and numbers (1-3) down the row are significantly different at $p \leq 0.05$.

CONCLUSION
In conclusion, 2-propanol gave the highest β-carotene concentration in carrots at 60° C. The best solubility time for carotenoid extraction is 60 mins – 240 mins. It is recommended that 2-propanol be used in extracting β-carotene from carrots.

REFERENCES
Amorim- carrilho K.T. , Cepeda A., Fente C., Regal P. (2014) . Review Methods for Analysis of Carotenoids. *Anal Chemistry*. 56: 49-73.

Baranska M., Schulz H., Baranski R. (2005). In situ Simultaneous Analysis of Polyacetylenes, Carotenoids and

Polysaccharie in Carrot Roots. *Journal of Agricultural and Food Chemistry*. 53 (17) : 6565-6571.

Berman J., Zorrillla- lopez U., Farre G., Zhu C., Sandmann G.,Twyman R.M.,Capell T., Christou P.(2015). Nutritionally Important Carotenoids as Consumer Products. *Phytochemiistry Review* 14 : 727-743.

Dutta D., Raychaudhuri U., Chakraborty R. (2005). Retention of β-carotene in Frozen Carrotsunder Varying Conditions of Temperature and Time of Storage . *African Journal of Biotechnology*. 4: 102-108.

Fikselova M., Silhar S., Marecek J., Francakova H. (2008). Extractionnof Carrot (Daucus carota L.). Carotenes Under Different Conditions . *Czech Journal of Food Science*. 26:268-274.

Honda M., Kageyama H., Hibino T., ZhanzY., Diono W., Kanda H., Yamaaguchi R., Takemura R., Fukaya T., Goto M. (2019). Improved Carotenoid Processing with Susttainable Solvents Utilizing Z-isomerization- induced Alteration in Physicoshemical Properties: A Review and Future Directions . *Molecules* . 24: 2149.

Iorizzo M., Curaba J., Pottorf M., Ferruzzi M.G., Simon P. Cavagnaro P.F. (2020). Carrot Anthocyanins Genetics and Genomics: Status and Perspective to Improve its Application for the Food Colorant Industry. *Genes* . 11 (8): 906.

Kruger J., Stuetz W., Frank J. (2019). Iron, Catechin and Ferulic Acid Inhibit Cellular Uptake of β- carotene by Reducing Micellization. *Journal of Agriculture and Food Chemistry*. 67: 5792-5800.

Martina F., Stansilar S., Jan M., and Helena F. (2008). Extraction of Carrot (*Daucus carota*) Carotenes Under Different Conditions. 26 (4) : 268: 274.

Murtaza A., Muhammad Z., Iqbal A., Ramzan R., Liu Y., Pan S., Hu W. (2018). Aggregation and Conformational Changes in Native and Thermally Treated Polyphenol Oxidase from Apple Juice (*Malus domestica*). *Frontier Chemistry*. 6: 1-10.

Nath P., Kaura C., Rudra S.G., Varghese E. (2016). Enzyme-Assisted Extraction of Carotenoid- Rich Extract from Red Cazpsicum (*Capsicum annum*). *Agriculture Research*. 5:193-204.

Nogueira M., Berry H., Nohl R., Klompmaker M., Holden A., Fraser P.D. (2016). Subchromoplast Fractionation for Different Solanaceae Fruit Species. *Bioprotocol*. 6: 1861**.**

Rafajlovska V., Slaveska-raicki R., Koleva-gudeva L., Klopceska J. (2007). Spice Paprika oleoresin Extraction under Different Conditions involving Acetone and Ethanol. *Journal of Food , Agriculture and Environment*. 5: 65-69.

Tan B.L., Norhaizan M.E. (2019). Carotenoids: How Effective are they to PreventAge-related Diseases? *Molecules.* 24: 1801.