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Screening for Total Carotenoids and β-Carotene in Some Widely Consumed Vegetables in Nigeria

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ABSTRACT: Ten different locally grown and widely consumed vegetables were selected for the screening of total carotenoids and β-carotene contents. The pigments were extracted by solvent extraction and the concentrations determined using UV-visible spectrophotometer. Carrot (*Daucus carota*) has the highest values of both the total carotenoids (397.8 ± 2.0 µg/g) and β-carotene (203.0 µg/g). Squash (*C. moschata*) has the lowest concentrations of total carotenoids (20.3 ± 2.0 µg/g) while cabbage has the lowest β-carotene (24.41 ± 9.8 µg/g). These vegetables, if properly processed, may serve as good sources of provitamin A in addition to other nutritional roles. The potentials of these vegetables as candidates for biofortification with β -carotene for the eradication of vitamin A deficiency were discussed.

Keywords: Vegetables, Carotenoids, β-carotene, Vitamin A deficiency

INTRODUCTION

Carotenoids are a family of pigmented compounds that are synthesized by plants and microorganisms but not animals. In plants, they contribute to the photosynthetic machinery and protect them against photo-damage (Alexander, 1999). Carotenoids are notable for their wide distribution, structural diversity, and of various functions (Kimura and Rodriguez-Amaya, 2004). They are especially abundant in yellow-orange fruits and vegetables and dark green, leafy vegetables (Olson and Krinsky, 1995).

Fruits and vegetables constitute the major sources of carotenoid in human diet (Johnson, 2002). They are the most ubiquitous and wide spread class of natural fat-soluble pigments. Carotenoids are present as micro-components in fruits and vegetables and are responsible for their yellow, orange and red colours (Alexander, 1999). Carotenoids are made up of a polyisoprenoid structure, a long conjugated chain of double bond and a near bilateral symmetry around the central double bond, as common chemical features (Briton, 1995).

More than 600 carotenoids have so far been identified in nature. However, only about 40 are present in a typical human diet. Of these 40, about 20 carotenoids have been identified in human blood and tissues. About to 90% of the carotenoids in the diet and human body is represented by β-carotene, α-carotene, lycopene, lutein and cryptoxanthin (Gerster, 1997).

Vitamin A deficiency presents a serious public health problem in many parts of the world, with South East Asia being the most afflicted area (WHO, 1999). Vitamin A deficiency is a major cause of premature death in developing nations particularly among children (Briton *et al.*, 1995). Carotenoids are widely known as provitamin A. Dietary β-carotene and other provitamin A carotenoids such as α-carotene and cryptoxanthin can be obtained from a number of fruits and vegetables (Mangels *et al*; 1993). There is an increasing interest in the role of carotenoids as antioxidants (Bohm *et al*. 2002). It is estimated that in developing countries 70.9% of the vitamin A intake is derived from plant foods especially vegetables and fruits (FAO/WHO, 1988).

Unfortunately, despite the abundance of vegetables in the tropics vitamin A deficiency is still a problem in Nigeria. Is it that the right plant sources are not yet known or the dietary habit of the people could be responsible?

This study aimed at screening locally grown and consumed vegetables for their carotenoid contents.

MATERIALS AND METHODS

All the chemicals used in this study were of analytical grade.

Vegetable Samples

Edible portion of Carrot (*Duccus carota*), Cabbage (*Brassica perkinensis*), Lettuce (*Brassica oleracea*), Pumpkin (*Curcurbita, maxima*), Punk leaf (*Telferia* *occiditalis*), Red pepper (*Capsicum annuum L.*), Squash (*Curcurbita moschata*), Spinach (*Amaranthus gangeticus*), Tomatoe (*Lycopersicon esculentum*) and Waterleaf (*Talinum triangulare*) were purchased from Sokoto Central market, Sokoto State, Nigeria.

Extraction of Carotenoids

The extraction was carried out as described by Kimura and Rodriguez-Amaya (2004), with slight modifications. The edible portion of the vegetable samples was ground in a mortar and pestle, 4 g of the homogenized sample was transferred to a mortar and 0.3 g of $MgCO_3$ was added. The mixture was ground with 25 ml of cold acetone (refrigerated for about 2 hours). The extract was filtered using a Whatman filter paper.

Total Carotenoid Estimation

Twenty (20ml) of Petroleum ether were pipetted into a separating funnel with Teflon stopcock. Fifteen (15 ml) of the acetone extract were added and allowed to stand for 15 minutes. One hundred and fifty (150) ml of distilled water were added by flowing along the walls of the funnel. The mixture was allowed to separate into two phases, and the aqueous phase was discarded. The petroleum ether phase was washed 4 times with 100 ml of distilled water to remove residual acetone. The petroleum ether phase was collected in a 25 ml volumetric flask by passing the solution through a small funnel containing 7.5 g of anhydrous sodium sulfate to remove residual water. The separating funnel was then washed with petroleum ether and the washing was collected into the volumetric flask by passing it through the funnel with sodium sulfate. The volumetric flask was then made up to volume with petroleum ether and the total carotenoids content were determined from the molar absorptivity β-carotene $E^{1\%}$ = 2590 at λ_{max} 450nm (Ball, 1988) and lycopene $E^{1\%}$ = 3450 at λ_{max} 472nm (Rahway, 1989) derived from the standard plots.

β -Carotene Estimation

Fifteen (15) ml of hexane was pipetted into a separating funnel with Teflon stopcock and 10 ml of acetone extract was added. The mixture was then allowed to stand for 20 minutes. The mixture was then washed with 50 ml distilled water and the lower aqueous phase discarded. The washing with water was repeated thrice. The upper layer was then transferred to a 25 ml volumetric flask containing 4.5 ml of acetone and then diluted to volume with hexane. The β- carotene content was determined from the molar absorptivity (β-carotene) $E^{1\%}$ = 2590 at λ_{max} 450nm derived from a standard plot (Ball, 1988).

RESULT AND DISCUSSION

The result of the total carotenoid of the selected vegetables and that of β-carotene are presented in Table 1. In this research, ten vegetables were selected and analysed for their total carotenoid and β- carotene contents.

Table 1: Total Carotenoid Contents of some Selected Vegetables (μg/g).

Vegetable	Total Carotenoids	β-carotene
Carrots (*D. carrota*)	397.8 ± 2.0*	203.0 ± 2.0*
Cabbage (*B. perkinensis*)	147.1 ± 2.0	24.41 ± 9.8
Lettuce (*B. oleracea*)	156.7 ± 17.7	55.5 ± 6.0
Pumpkin (*C. maxima*)	135.2 ± 8.0	38.6 ± 2.0
Punk leaf (*T. occidiralis*)	25.3 ± 3.9	78.9 ± 2.0
Red pepper (*C. annuum L.*)	33.3 ± 15.7	96.6. ±6.0
Squash (*C. moschata*)	20.3 ± 7.8	27.7 ± 1.0
Spinach (*A. gangeticus*)	390.6 ± 21.6	128.5 ± 3.4
Tomato (*L. esculentum*)	231.0 ± 7.9	50.8 ± 71.6
Water leaf (*T. triangulare*)	260.4 ± 15.8	50.6 ± 2.0

*Values are mean ± standard deviation.

From the results (Table 1), carrots was found to have the highest value of total carotenoids (397.8 ± 2.0 μg/g) followed by spinach (390.6 ± 21.6 μg/g). This is in agreement with the earlier assertion that among root vegetables carrot has the highest contents of carotenoids (Romanclink *et al.,* 1997). Among the leafy vegetables analyzed, spinach has the highest value of total carotenoids. This result is close to that reported by Rock *et al.* (1998). The values of total carotenoids in the other vegetables are however slightly different from what were reported by Rock *et al.* (1998). Tomatoes have a mean value of 231 ± 7.9 μg/g of total carotenoid. This value is lower than that reported by Giovanucci, (1999). The differences could be due to geographical location, climatic condition, and cultivar varieties-factors known to affect the carotenoid contents of plants (Kimura and Rodrigujez-Amaya, 2004). All the analysed vegetables contain high enough concentrations of the carotenoids for pro-vitamin A or other nutritional roles such as inhibition of lipid peroxidation, free radicals scavenging, etc. (Giovannucci, 1999).

The results of β-carotene content of the vegetables show that carrot has the highest value (203.0 ± 12.0 μg/g). This asserts the fact that among root vegetables carrots have the highest levels of carotenoid, and the predominant carotenoid present is β-carotene which constitutes 99% of the colour pigment in carrot (Olson, 1999). The vegetable with significant level of beta-carotene after carrot is spinach (128.5 ± 3.4 μg/g). Among leafy vegetables, spinach has highest level of carotenoids and beta-carotene (Rodriquez-Amaya, 1999). Cabbage has the lowest mean value of beta carotene (24.41 ± 9.8 μg/g), this agreed well with the report of Rock *et al.* (1998).

CONCLUSION

All the vegetables analysed have relatively high levels of total carotenoid and β-carotene contents. Therefore if properly processed, they may serve as good sources of provitamin A and other nutritional roles.

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