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SHORT COMMUNICATION

Comparative Study of Beta-Carotene Content of Egg Yolk of Poultry

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ABSTRACT

In view of the fundamental role of antioxidants such as beta carotene in human nutrition, this study was designed to determine the concentrations of this antioxidant in chicken egg yolks of the preponderant poultry breeds in Nigeria. Among the strains studied include Harco, White Leghorn, and Local chickens. Again, due to instability of beta carotene resulting from enzymatic and the photochemical destruction, storage duration on the beta-carotene contents of the eggs yolk of these poultry breeds was also studied. A spectrophotometer was used to determine the beta-carotene concentrations of the egg yolks at 450 nm. The results indicate that eggs from Black Harco breed had the highest concentration of beta-carotene when fresh but were most unstable upon storage, while those from local breed had the most stable concentration of beta-carotene upon storage.

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INTRODUCTION

The quest for man to be nutritionally balanced is a topical issue that can never be overemphasized. The consequence of such a quest is to resort to the consumption of various kinds of food substances which may belong to any of the six classes of nutrients viz. Carbohydrate, proteins, vitamins, mineral salts, fats and oil, and water.

Numerous health benefits are associated with consumption of antioxidants such as alpha-tocopherol and beta-carotene (Jiang *et al*., 1994). According to the authors, among these benefits include playing key role as a precursor of vitamin A, preventing macula degeneration (macula – an area of the retina that provides the best central vision), protecting the body cells from damage by free radicals (by quenching free radicals), promoting proper cell communication thereby reducing the cause of overgrowth of cells (including cancer), and supporting reproductive health. Although its exact function in female reproduction has not yet been identified, it is known that the corpus luteum has the highest concentration of beta-carotene than any other organ in the body (Thomas, 2006).

Vitamin A, otherwise called retinol, with molecular formula $C_{20}H_{29}OH$, is a crystalline solid insoluble in water but soluble in fat and various fatty solvents (organic solvents). It is pale yellow in colour and readily destroyed by oxidation upon exposure to air and light.

Vitamin A is known to be essential for good night vision, normal development of bones and teeth, for healthy skin and mucous membrane. Its deficiency can cause low resistance to infection, poor night vision, blindness due to ulcers on the cornea, poor growth in children, weak bones and teeth, inflamed eyes, diarrhoea, and poor appetite (Coultate, 1996; Joseph, 1987).

Vitamin A is present as precursors or provitamins in the form of certain carotenoids. Carotenoids have orange, yellow or red colours. Carotenoids may be divided into two main categories: carotenes (hydrocarbon class) and xantophylls (oxygenated class). The later includes lutein, cryptoxanthin and zeaxanthin, most of which cannot be converted to vitamin A but are useful as anti-oxidants, anti-radicals, singlet oxygen quenchers, and may participate in gap junction communication. The carotenes consist of alpha-carotene, beta-carotene and gamma-carotene. Of all the carotenes: beta-carotene is the most important as it forms the major source of vitamin A for animals. It has a melting point of 184.5^0C and exists in both the cis- and the trans- isomeric forms, with the latter being more stable than the former (Olson, 1996; Taylor *et al.*, 1996).

Conversion of beta-carotene to vitamin A occurs in cells of the intestinal mucosa, and to some extent, in the liver. The beta-carotene molecule is a double retinal structure and theoretically should give rise to two molecules of retinal. Biologically however, the activity of beta-carotene is only about half that of retinal. The enzyme responsible for beta-carotene cleavage to retinal is called β-carotene-15, 15^1 –monooxygenase and is known to split the two central carbon atoms of beta-carotene in the presence of molecular oxygen to yield two molecules of retinal. The retinal so produced is converted to retinol by retinaldehyde reductase for which Nicotinamide Adenine Dinuclceotide Hydrogen (NADH) can serve as a co-factor (Taylor *et al*., 1996).

Beta-carotene can be found in egg yolk, butterfat, carrots, squash, broccoli, sweet potatoes, apricots, and leafy greens (in which they usually have their colours frequently masked by chlorophyll).

Conversion of carotenoids to retinol is rarely 100% so that the vitamin A potency of various foods is expressed in terms of retinol equivalents: 1RE equals 1mg retinol, 6mg beta-carotene, and 12 mg of other Pro-vitamin A carotenoids. It could also be expressed in International Units (I.U.) per kilogram of body weight. 1 I.U. equals 0.6 µg of all-trans beta-carotene, 1.2 µg of Pro-vitamin A carotenoids, and 5000 I.U. equals 3 mg of beta-carotene, which is the Recommended Dietary Allowance (RDA). The normal clinical value of carotenoids in the blood is 0.8 - 4.0 mg/ml (Maynard *et al.*, 1979).

Metabolism and absorption of beta-carotene

The rapid increase in hepatic retinol concentration after administration of beta-carotene to mammals, and the apparent failure of this conversion when beta-carotene was given to persons with severe liver disease, suggests that the liver is also a site of formation of retinol from beta-carotene although the intestinal mucosa is actually the major locus of conversion (Coultate, 1996).

The first step in the utilization of beta-carotene is absorption. Absorption of beta-carotene takes place (though with much difficulty) in the uppermost part of the small intestine known as the duodenum. The process of absorbing beta-carotene takes several days and is made more efficient with the intake of fat. The lining of the small intestine stores some of the beta-carotene absorbed from a meal to compensate for the possibility of not getting more beta-carotene later. If the lining of the small intestine is irritated and the lining sloughs off, the beta-carotene is lost.

Some of the beta-carotene absorbed into the lining of the intestinal wall is quickly converted into vitamin A. The rest of the beta-carotene absorbed into the bloodstream "hitches a ride" on Very Low-Density Lipoprotein (VLDL cholesterol). This form of cholesterol is slowly broken down into Low-Density Lipoprotein (LDL cholesterol) and High-Density Lipoprotein (HDL cholesterol). Riding through the bloodstream on cholesterol, beta-carotene may be stable in the human body for as long as 4 or 5 months.

Stability of beta-carotene

Enzymatic destruction of beta-carotene requires oxygen, is greatest at high temperatures and ceases after complete dehydration. The photochemical action increases with decreasing moisture content. In storage, both the enzymatic and the photochemical destruction must be controlled to produce foods rich in beta-carotene (Geoffrey, 1998).

The long partially unsaturated hydrocarbon chains in beta-carotene are easily oxidized to by-products that have no vitamin potency. Hence, this study aims at determination of the effect of prolonged storage, as well as chicken breed on the beta-carotene content of egg yolk.

MATERIALS AND METHODS

The apparatus and materials utilized for this study include spectrophotometer (wavelength = 450nm), cuvettes, weighing balance (Mettler's), retort stand, separating funnel, filter funnel, absorbent cotton wool, Whatman's no. 4 filter paper, boat tray, mortar, pestle, spatula, a pair of forceps, 25ml standard flask, measuring cylinders. The reagents include cold acetone, petroleum ether, sodium sulphate, distilled water.

A total of three hundred and sixty eggs were procured from reputable poultry farms in Anambra State, Nigeria. One hundred and twenty eggs were collected from each breed namely Local breed, White Leghorn and Black Harco breeds at different duration (within 2 hours, 7 days, 14 days and 21 days after the eggs were laid). Liquid-liquid extraction method as adopted by Okonkwo (2009) was employed to extract beta carotene and the assay was done using spectrophotometer. The concentration of beta carotene was calculation as follows:

$$\text{Conc. (mg/g)} = \frac{A \times \text{Volume (ml)} \times 10^4}{A^{10}\,\%\ 1\text{cm} \times \text{sample weight}}$$

Where A = absorbance

A^{10} % 1cm = 2592 to beta carotene (as a constant)

Volume = 25ml

Sample weight = weight of egg yolk

Data obtained were subjected to Analysis of Variance under a completely randomized design and SPSS (2002) statistical package was used.

RESULTS AND DISCUSSION

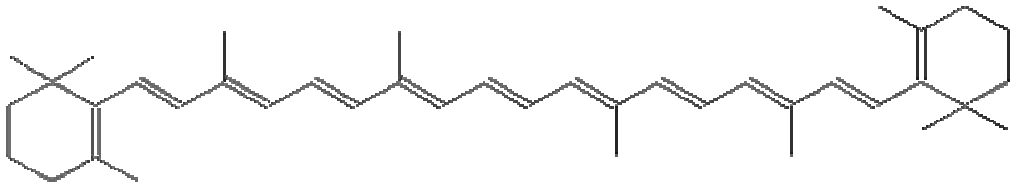
Table 1 shows the mean concentrations in mg/g of beta-carotene for each chicken breed studied at various intervals.

Table 1: Mean concentrations in mg/g of beta-carotene for each chicken strain studied at various intervals

Duration	Chicken Strain			
	Harco Strain	White Leghorn Strain	Local Strain	SE
2 Hours	0.090^b	0.070^a	0.070^a	0.002
7 Days	0.042^a	0.056^b	0.064^c	0.002
14 Days	0.024^a	0.037^b	0.050^c	0.003
21 Days	0.001^a	0.005^b	0.035^c	0.001

*Means bearing the same superscripts on the same row are significantly different ($p<0.05$)

Black harco had the highest concentration of beta-carotene at 2 h after the eggs were laid, and declined as time goes on. This is similar to the finding of Okonkwo (2009) who reported the value of 0.80 mg/g of beta



Structure of beta-carotene

carotene in freshly laid harco egg and 0.000 mg/g after 21 days. The White Leghorn on the other hand, had a moderate concentration of beta carotene at 2 h after the eggs were laid, but the rate of decline as time goes on was rather slow. The same is true for local strain.

From the results thus presented, it can be deduced that with time, the value of beta-carotene that can be obtained from the consumption of eggs depreciates upon prolonged storage, chicken breed notwithstanding. But the stability of concentration values obtained varies with breed of chicken used. Hence, the local breed presents us with the most stable beta-carotene within a storage period of 21 days, while the Black Harco eggs which had the highest concentration value at 2 h after laid, was most unstable and yielded a zero value concentration after three weeks.

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