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LEVELS OF VITAMIN A FORTIFICATION IN FLOUR AND VEGETABLE OILS SOLD IN KANO METROPOLIS

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ABSTRACT

This paper assessed the levels of compliance with vitamin A fortification by the manufacturers of flour and vegetable oils. This was carried out by the determination of vitamin A in the flour and vegetable oil samples which were purchased from retail outlets in Kano metropolis. The levels of vitamin A were determined colorimetric ally at 620nm after extraction. The levels of vitamin A in the flour samples ranged from 4125-8000 iu/kg and the levels in vegetable oils ranged between 4688 and 14250 iu/kg. The recommended value for flour is 25000 iu/kg and for vegetable oil it is 20000 iu/kg. It can be concluded that the degree of compliance in vitamin A fortification in flour and vegetable oil is low and more effort has to be put by the authorities concerned to ensure strict compliance by the manufacturers of these products.

Keywords: *β-carotene, plasma retinol binding protein (pRBP), retinol, Vitamin A.*

INTRODUCTION

Animals require not only carbohydrates, fat, protein and water to live, but also require vitamins. These substances originally were thought to be amines, that is, vital amines, thus the term vitamins. Although many of them are not amines, they are vital constituents of the diet and are organic in nature. Only small amounts of vitamins are required (Annino and Giese, 1975).

In 1913, researchers found a substance that made one grow and see better. McCollumn and Davis (1913) described the substance as fat 'Soluble A', later; they gave the substance the name Vitamin A. Since then, researchers have continued to unravel the biochemical importance of this unique substance in metabolism (Akanya, 2004). This occurs in many forms, such as retinol (alcohol), retinal (aldehyde), retinyl acetate or palmitate (esters) and provitamin A carotenoids (β-carotene, α- Carotene, etc). Preformed retinol is found only in foods of animal origin such as liver, egg yolk, butter and whole milk (Sebrel and Harris, 1967). Dark green vegetables are generally good sources of pro-vitamin A carotenoids (Devlin, 1992). In developing countries, 80% or more of the potentially available vitamin A is from carotenoids (Bender, 1992). β-carotene is a pro-vitamin A that is efficiently converted to retinol than other carotenoids. α-carotene and β-cryptoxanthin are converted only half as efficiently as β-carotene (Olson *et al., 2000*).

All-trans retinol; a polyisoprenoid compound containing a cyclohexenyl ring, is the parent compound in the vitamin A group. It is a precursor of: retinal (plays a critical role in vision) and retinoic acid (serves as an intracellular messenger that affects transcription of a number of genes). β-carotene is a major carotenoids that can be converted to vitamin A within the intestine and other tissues (Olson *et al.,*2000).

About 70-90% of dietary retinol is absorbed, this falls slightly even at high intakes (Bender, 1992). Preformed vitamin A is well absorbed and used efficiently by the body than that from plants (USDA, 2004). The combined action of bile and pancreatic esterases hydrolyses the esters of retinol in the small intestine. It is then transported in micellar form across the epithelial cells of the villus (Ong, 1994). Hepatic vitamin A in a well-nourished individual normally represents over 90% of the total reserve of the vitamin (Goodman, 1984). Other storage sites are the kidneys, adrenals and the pigment epithelium of the retina of the eye (Blaner and Olson, 1994).

Vitamin A must be transported to target tissues, since retinol is a fat-soluble molecule and not readily soluble in aqueous environment, a binding protein is required to solubilise retinol in the aqueous plasma and intracellular fluids, thus enabling the vitamin to reach tissue cells, while at the same time affording some protection against oxidation (Akanya, 2004). The combination of retinol and plasma retinol binding protein (pRBP) protects and stabilises the vitamin making it soluble and transportable in plasma and protect tissues from the toxicity of free retinol (Bashor *et al.,* 1973; Ong and Chytil, 1975). The plasma concentration of retinol-binding protein in normal subject is 50µg/ml (Smith *et al.*, 1970) however the younger the child, the lower the pRBP. In Northern Nigeria, the level of pRBP in children ranged between 25µg/ml and 35µg/ml (James *et al.,* 1984). However, the plasma concentration of retinol in normal subjects is 30µg/100ml (IVACG, 1976), this level may vary depending on age and sex. Other transport proteins for retinol metabolism include; cellular retinol binding protein, cellular retinoic acid binding protein (Ong and Chytil, 1975) and cellular retinyldehyde binding protein (Futterman *et al.*, 1977; Saari *et al.*, 1982).

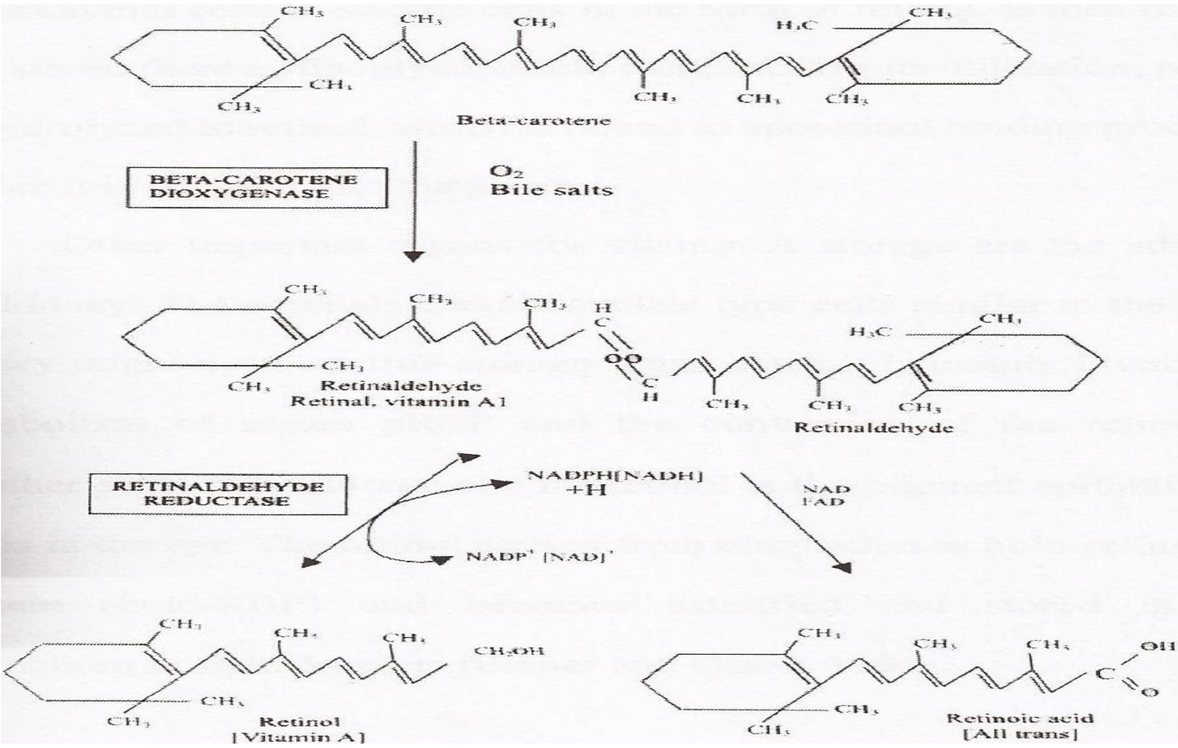

Figure 1 Conversion of β-carotene to vitamin A compounds

Vitamin A has a number of functions in the body. β-Carotene and some other carotenoids have recently been shown to play an important role as antioxidants. At the low oxygen tensions prevalent in the body, β-carotene is a very effective antioxidant and might be expected to reduce the risk of those cancers initiated by free radicals and other strong oxidants (Akanya. 2004).

Vitamin A deficient animals have been shown to be more susceptible to both infections and cancer. The decreased resistance to infections is thought to be due to the keratinization of the mucosal cells lining the respiratory, gastrointestinal, and genitourinary tract. Under these conditions, fissures readily develop in the mucosal membranes, allowing microorganisms to enter. Some evidence suggests that vitamin A deficiency may impair the immune system (Ross and Hammerling, 1994). The protective effect of vitamin A against many forms of cancer probably results from the antioxidant potential of β-carotene and the effects of retinol and retinoic acid in regulating cell growth.

Deficiencies of this vitamin can develop only over prolonged periods of inadequate uptake since it is stored by the liver. Mild vitamin A deficiencies are characterized by follicular hyperkeratosis (rough keratinized skin resembling goose bumps), anaemia (biochemically equivalent to iron deficiency anaemia, but in the presence of adequate iron intake), and increased susceptibility to infection and cancer. Night blindness is also an early symptom of vitamin A deficiency. Severe vitamin A deficiency leads to progressive keratinization of the cornea of the eye known as xerophthalmia in its advanced stages. In the final stages, infection usually sets in, with resulting haemorrhaging of the eye and permanent loss of vision (Devlin, 1992). Large amounts of this vitamin over prolonged periods of time can be toxic. The four major adverse effects of hypervitaminosis A are birth defects, liver abnormalities, reduced bone mineral density that may result in osteoporosis, and central nervous system disorders (Bendich and Langseth, 1989)

Food fortification is a nutritional intervention programme with a specifically defined target population, and its effectiveness is measured by whether or not the fortified food is accepted, purchased and consumed by that population. Food fortification is one of the four strategies (viz: supplementation, dietary diversification, primary health care and food fortification) outlined by the World Health Organization (WHO), United Nations International Children Education Fund (UNICEF), and Government of various countries of the world in order to eliminate vitamin A deficiency (VAD) as a public health problem. The success of food fortification programme is measured by whether or not the nutrition and health status of the targeted population has been improved.

In February 2000, the Nigerian Government, due to the recommendations of the National Agency for Food and Drug Administration and Control (NAFDAC), Standard Organization of Nigeria (SON), universities and research institutes as well as UNICEF and Micronutrients Initiative enacted a law for mandatory fortification of wheat and maize flour, vegetable oil and sugar. These products were selected on the basis of their importance in the national food market and food consumption habits of the population. Vitamin A fortification of wheat/maize flour as well as vegetable oil started in 2002. Food fortification is the most cost effective option, it is technically feasible, and cost of fortification with vitamin A is marginal for the industries and consumers (Akanya, 2004).

In Nigeria, enforcement of compliance started in September 2002, two years after the law for mandatory fortification of foods with vitamin A has been enacted; however compliance has been extremely low. Survey conducted in October 2003 by NAFDAC sampling flour and vegetable oil products indicated only 5% compliance (Akanya, 2004).

Vitamin A fortification of wheat/maize flour as well as vegetable oil started in 2002, while the fortification of sugar started in April 1, 2004. Enforcement of compliance started in September 2002 but compliance has been extremely low. Survey conducted in October 2003 by NAFDAC sampling flour and vegetable oil products indicated only 5% compliance. Food fortification is the most cost effective option, it is technically feasible, and cost of fortification with vitamin A is marginal for the industries and consumers.

This research measured the degree of compliance in flour and vegetable oils and to see if this vitamin reaches the consumers at the required level during storage and sales.

SAMPLE SOURCES AND COLLECTION

The food items were purchased from retail outlets in Kano metropolis. These include: Four samples of wheat flour purchased by the measure. These were designated Flour 1, 2, 3 and 4. Three different brands of packaged vegetable oil designated as Oil 1, 2 and 3.

Colorimetric Estimation of Retinol in Foods:

The method used is as described by Adamu (1979). With the aid of hand gloves and a spatula, 1 gram of the sample was weighed out and transferred into a glass stoppered test tube. Mixture of diethylether ($5cm^3$) and butylhydroxytoluene ($100µg/cm^3$) was then added and hand shaken until thorough mixing was achieved. It was then kept overnight in a refrigerator. The tube was again shaken by hand and allowed to stand for few minutes in a refrigerator. With the aid of a fine tipped Pasteur pipette, the supernatant was carefully transferred to another tube. An aliquot ($0.2cm^3$) was removed to another tube and dried under nitrogen gas at room temperature. The extract was then re-dissolved in hexane ($2cm^3$).

A standard calibration curve was prepared by dissolving 1 gram of the standard vitamin A in $100cm^3$ hexane, from which the working standards were produced. The various vitamin A concentrations of the samples were determined from the standard calibration curve.

RESULTS

After extraction and estimation of retinol in various food samples, the results obtained are as presented in Figures 2 and 3.

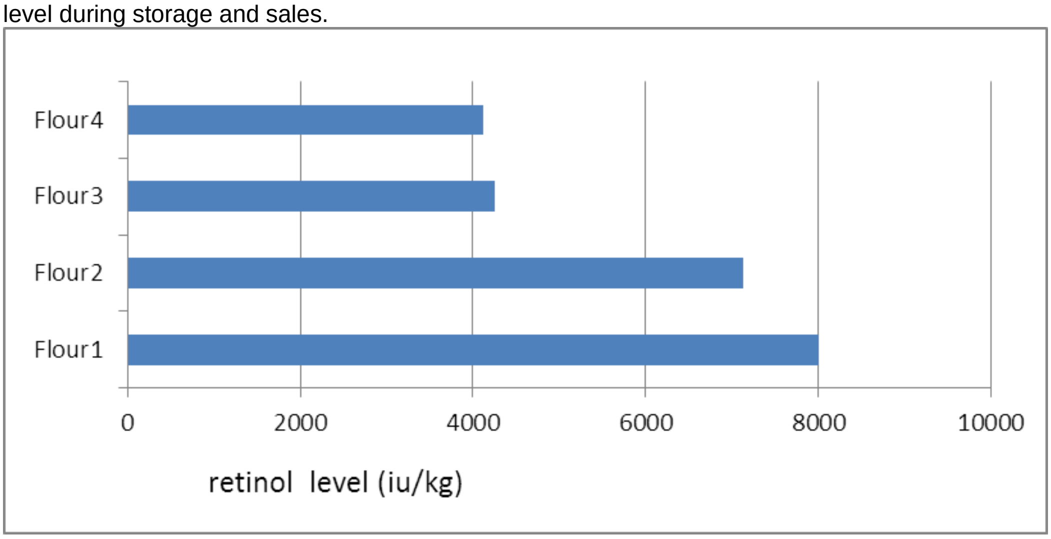

Figure 2: Concentration of Retinol in Flour Samples (iu/kg)

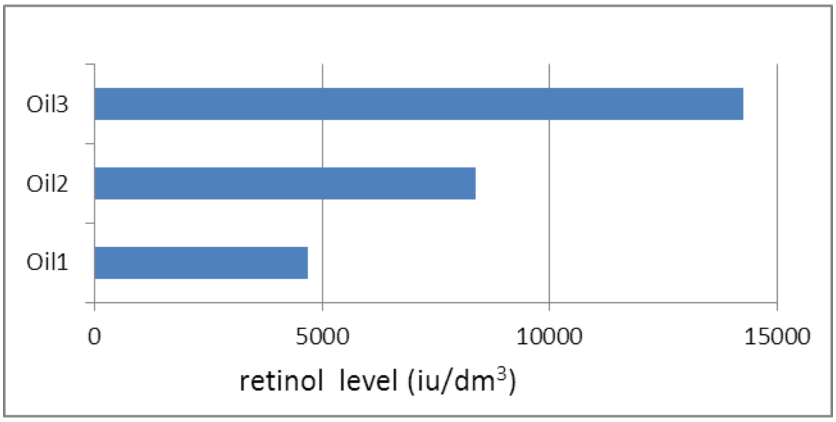

Figure 3: Concentration of Retinol in Vegetable Oil Samples

DISCUSSION

The level of retinol in the flour samples, expressed in international unit (iu), ranges from 4125 – 8000 iu/kg (Fig 2) which is much lower than the required level of fortification (i.e. 30,000 iu/kg). Since the samples were obtained by the measure, it may be due to long term exposure of the food item by the retailers to air, light and heat, thus destabilizing the vitamin, since vitamin A is relatively unstable under normal storage conditions particularly in harsh environments. The instability is mostly due to its chemical structure, which contain many double bonds susceptible to degradation (www.unu.edu/unupress). However, since the level of retinol in the flour samples is less than 27% of the recommended value; the low level may be as a result of lack of compliance in fortification to the required level, and not just due to air, light and heat during storage.

In the vegetable oil category (Fig 3), only Oil 3 showed a high level of compliance in vitamin A fortification (i.e. 14,250 iu/kg) to near the required level (20,000 iu/kg), since the level of retinol is about 71% of the required level. Analysis showed that Oil 1 and Oil 2 contain low level of vitamin A (i.e. 4688 iu/kg and 8375 iu/kg respectively), with a percentage of 23% and 42% of the required level respectively, indicating lack of compliance in their fortification. The National Agency for Food and Drug Administration and Control (NAFDAC) has sealed a flour mill and four oil mills and has since banned the importation of some vegetable oils accusing them of deception over vitamin A fortification illegality and threat to human health and for non-compliance with all the rules and regulations of production, fortification and hygienic requirements (Anon, 2007). The companies manufacturing Oil 1 and Oil 2 were included.

CONCLUSION

Five years after the enforcement of compliance in fortification of foods with vitamin A in 2002, it can be concluded that the degree of compliance is still low, since most of the samples that were analyzed in this research contain lower amounts of the vitamin A as compared with the mandatory level of fortification as set by NAFDAC and SON.

RECOMMENDATIONS

Although the Government represented by the National Agency for Food and Drug Administration and Control (NAFDAC), is doing a good job, but a lot still needs to be done in order to make the program of food fortification a success. One of the recommended ways is to ensure proper packaging of all the fortified food products, because packaging assumes great importance and should be a major factor to consider. Another way of ensuring proper retainment of the vitamin is through public enlightenment to the retailers and general public on how to handle fortified foods by keeping them away from light and air, so as to reduce oxidation of the vitamin.

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Table 1: Amended Nigerian food standards-mandatory fortification of cereals, sugar, and oils and milk. Nigerian Industrial Standard (NIS) (www.sightandlife.org)

Product	Mandate	Levels/kg
Wheat flour	NIS 121:2000	30,000iu
Sunflower oil	NIS 90:2000	20,000iu
Coconut oil	NIS 387:2000	20,000iu
Soya beans oil	NIS 392:2000	20,000iu
Rape seed oil	NIS 394:2000	20,000iu
Palm kernel oil	NIS 289:2000	20,000iu
Cotton seed oil	NIS 389:2000	20,000iu
Palm oil	NIS 230:2000	20,000iu
Groundnut oil	NIS 388:2000	20,000iu
Sesame seed oil	NIS 393:2000	20,000iu
Sugar refined white	NIS 90:2000	25,000iu
Sugar refined brown	NIS 438:2000	25,000iu
Margarine	NIS 243:2000	26,000 – 33,000iu
Millet maize product	NIS 295:2000	20,000iu
Milk		21,000 – 25,000iu