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Food Supplementation with Vitamin A in Nigeria: A Critical Review

Moses Z. Zaruwa
Department of Biochemistry, Adamawa State University, Mubi,
Adamawa State, Nigeria
Contact: *moseszira@yahoo.com*; +2348105152595

ABSTRACT

Researchers have roiled up publications on the therapeutic and prophylactic properties of Vitamin A and its importance for the prevention of millions of deaths from preventable diseases. In Africa, especially Nigeria such publications occupies numerous pages in the dailies, the internet and scientific journals. These positions prompted the Nigerian government into enacting law requiring food-processing industries to supplement their products with Vitamin A with a view to providing the Nigerian populace the daily recommended dietary vitamin A requirement. Therefore, wheat flour, maize flour, vegetable oil, sugar and confectionaries solid in Nigeria are being fortified with vitamin A in compliance to the mandatory fortification requirement by the Standards Organization of Nigeria (SON). However, there are uncertainties surrounding the conventional wisdom of the indiscriminate supplementation of food with this vitamin. To date, none of the Nigerian regulatory agencies have formally evaluated the impact of the supplementation programme on neither health status nor its side effects. The current report examines the effects of vitamin A fortification initiative in foods and call for caution in the irrational supplementation of some foods with vitamin A as a solution to vitamin A deficiency (VAD) problem.

KEYWORDS: Vitamin A Deficiency, food fortification; Hypervitaminosis and toxicity;

Introduction

Improving public health is a great investment in the future of any nation, because a healthy society is a happy and productive society. People in different regions of the world are affected by various forms of malnutrition and nutrition related diseases. High incidence of these deficiency diseases occur mainly in poverty stricken communities, people with lack of access to varieties of foods, inadequate of knowledge of appropriate dietary practices, unhealthy eating habits and lifestyle (Bain *et al*., 2013). The global community have recognized deficiencies of vitamin A, iodine and iron as the three micronutrient malnutrition affecting many communities globally (Bouis, 2000; Griffiths, 2003; Feike and Josette, 2012).

There is no argument that micronutrient deficiencies affect many people in today's society and nutrient shortfalls have health consequences that could impact daily life and overall wellbeing (Dickinson, 2012). Therefore, many regulatory agencies and other stakeholders committed to improving public health have come up with innovative such as food fortification, dietary diversification, dietary

supplementation, nutrition education, and public health measures to combat malnutrition and its associated health effects (Haas and Miller, 2006). In Nigeria, the government in response to the claims on the effects of undernourishment and micronutrient deficiencies, through the Standard Organization of Nigeria (SON) launched a food policy in 2001 with the aim of improving the nutritional status of all Nigerians. In 2002, Nigeria started the implementation of mandatory supplementation of foods namely, wheat flour, maize flour, vegetable oil, sugar and confectionaries with vitamin A and by December, 2004, 100% of wheat flour, 70% of the sugar and 55% of vegetable oil sold in the market were fortified with vitamin A, all flour mills across Nigeria also fortified their products with vitamin A (UNICEF, 2006).

SON claimed many Nigerians were suffering from preventable diseases that resembled that of vitamin A deficiency (Vitamin A is required for the development of children immune and visual system as well as survival). This claim is not conclusive as many Nigerian consume liver, dairy foods, cod liver oil, fish, palm oil, egg yolk, butter, or vegetables containing carotene and these are potent sources of vitamin A.A major concern about the potential toxicity of retinol is the observation that intake of retinol in various physical forms have different thresholds for toxicity, as retinol in water-soluble, emulsified, or solid forms seems to have more acute toxic effects than retinol in foods or oils (Blomhoff *et al.*, 2003). The water soluble form of this vitamin is used in the supplementation of flour, vegetable oil, sugar and confectionaries; this has its own limitations. Therefore, the potential for hypervitaminosis A from supplements and from foods fortified with retinol among Nigerians is high as diets consists of large amounts of preformed vitamin A and retinol-fortified foods with daily intakes which approaches the upper safe limits. Toxic symptoms vitamin A seem to depend on both the amount and duration of exposure.

Metabolism of Different Forms of Vitamin A

Multiple generic forms of vitamin A are available (retinol, retinal, retinyl esters and retinoic acid). Retinal, retinol and retinoic acid are the aldehyde, alcohol and acid forms of vitamin A. The retinoids exist as many geometric isomers due to the unsaturated bonds in the aliphatic chain. Retinoids also exist as retinyl esters such as retinyl propionate, retinyl acetate and retinyl palmitate. Retinyl esters provide pools of vitamin A that are converted into retinol and other retinoids as needed (Kiser, *et al.,* 2014). Dietary vitamin A can be obtained from **preformed vitamin A (retinyl esters)** found in animal foods (liver, milk, kidney, fish oil), fortified foods, and drug supplements or**provitamin-A (carotenoids)** from plant sources, principally carrots and crude palm oil, the body can make use of both preformed vitamins A and provitamin A carotenoid that it converts into vitamin A (retinol).

The use of synthetic vitamin A as supplement in food fortification is of great concern considering the fact it is this form of the vitamin that is used in most countries for food supplementation (TemaNord, 2003; Penniston and Tanumihardjo, 2006). The demerits of using the synthetic form of vitamin A which is water soluble have been investigated by Myhre *et al*.(2003), they found that the synthetic retinol

which is chemically similar to the natural vitamin A was more toxic than the fat soluble natural form and was the implicated cause of birth defects in both humans and animals. Many regulatory agencies cannot systematically differentiate between naturally occurring nutrients and those added to foods at manufacturers' discretion. Likewise, the consumption of fortified foods is not comprehensively assessed during dietary data collection (Sacco and Tarasuk, 2013). This trend has its deleterious effects on the nutritional status of target populations and have contributed to excessive intakes of the fortified nutrients (Mertz, 1997). It's a fact that natural substances containing natural retinoids such as all trans retinoic acid and 13-cis retinoic acid, or synthetic retinoids have different metabolism and toxicity (Penniston and Tanumihardjo, 2006).

Vitamin A Deficiency in Nigeria

It is alarming to note that the preponderance of vitamin A deficiency is increasingly becoming wide spread in Nigeria, considering daily radio, television and newspaper advertisements. It is worthy to note that a recent research observed that over 34%-69% of childhood blindness in Nigeria is caused by corneal opacity, which results mainly from an interplay of vitamin A deficiency, measles, and harmful traditional eye practices (Rabiu and Kyani). The research touched on several causes of what predisposes blindness among Nigerian children and centred on vitamin A deficiency as the root of the problem. Another study earlier carried out in South Western Nigeria had indicated a 6.3% vitamin A deficiency (VAD) in well-nourished children under the age of 3, and 7.8% VAD in malnourished children in the same area. This discovery indicated that everyone is prone to vitamin A deficiency[2]. However, critical scholars have drawn attention to the possibility that the household size of the families from which the subjects were picked could be responsible for this result. This postulation sound very rational thus should be viewed without prejudice as a social hypothesis, which addresses other cases within the context of the study.

In a detached study on the plasma vitamin A and C status of in-school adolescent and associated factors in Enugu State of Nigeria, a team of researchers observed that in spite of the adequate intake of vitamin A (126%-137% of recommended intake) by 600 adolescents studied, "the plasma concentration of vitamin A was low in 40% of the males and 32% of the females (Ene-Obong *et al.*, 2003). These findings which correspond with those of several others, similarly points to the fact that a blanket supplementation of our foods may not be the solution to the problem of vitamin A deficiency in Nigeria. Based on these reports therefore, it would be unsafe to conclude that the supplementation of food with vitamin A will improve or balance the plasma levels in the consumer. It is therefore pertinent to contend that considering the side effects of vitamin A toxicity and otherwise, supplementation of commonly consumed foods in Nigeria would merely end up solving a problem in the interim among a significant few, while creating another on a long term basis for a visible majority. Thus, except the emphasis of health care delivery in Nigeria is on short term remedies, scientific studies as illustrated so far point to the fact that the long term solution to vitamin A deficiency dose not reside in administering vitamin A supplements.

Vitamin A Toxicity

Owing to their ability to accumulate in the body, fat-soluble vitamins have a higher potential for toxicity compared to water-soluble vitamins. Almost 60,000 instances of vitamin toxicity are reported annually to US poison control centres (Mowry *et al.,* 2014). The defined safety levels of vitamin A intake have remained debatable till date. However, a common deduction from available reports is that a high level of vitamin A is harmful to the user (Hathcock *et al*., 1990). To some as much as 25 000 IU (7500 mcg or retinal equivalent) of vitamin A is considered safe, while for those above the age of 65 and individuals who suffer from liver related diseases need not supplement with more than 15 000 IU (4500 mcg) per day. However, less than 10 000 IU (3 000 mcg) per day is generally accepted as safe. Whether the average individual would benefit from vitamin A supplementation remains unclear, especially when considering that many Nigerians use one or more of the natural sources of vitamin A (directly or indirectly) daily (Akinyinka *et al*., 2001; Ene-Obong *et al*., 2003). With universal vitamin A food fortification and the increasing availability of fortified foods and supplements, most individuals will be exposed to more than necessary daily quantities of synthetic vitamin A. resulting in a large percentage of the population with preformed vitamin A intakes higher than recommended.

Consuming natural sources of vitamin A rarely results in toxicity as the cleavage of provitamin A carotenoids to retinal is a highly regulated step. In contrast, absorption and hepatic storage of preformed vitamin A occur very efficiently until a pathologic condition develops. Some studies have concluded that vitamin A is one of the vitamins among others that substantial number of cases of toxicity has been reported (TemaNord, 2003). Toxicityof vitamin A is becoming a growing concern, because intake from preformed sources of vitamin A often exceeds the recommended dietary allowances (RDA) for adults

In a study in the New England Journal of Medicine, middle aged and pregnant women were advised to take less than 10 000 IU (3 000 mcg) per day of vitamin A to avoid the risk of birth defects due to the teratogenic effect of mega dose of vitamin A (Rothman *et al*., 1995)**.** Other studies attributed excessive dietary intake of vitamin A to about 20 reported cases of birth defects in a 30year period (Biesalki, 1989; Azais-Braesco and Paschal, 2000)**.** Presently, the level at which vitamin A supplementation may cause birth defects varies for reasons that are still not clear, though combined human and animal data suggests that 25 000 IU (7500 mcg) per day may be considered safe (Wigand *et al*., 1998).

In children, vitamin A supplementation studies are inconclusive. The fact that it supports immune function and prevents infection has been proved to be conditional. This is because vitamin A was observed to increase the risk of infections. A study explicitly showed that vitamin A supplementation was beneficial mainly to children who were severely malnourished, while those who were not suffered increased risk of diarrhoea when compared with the placebo group. Among children who received the vitamin A supplements, 67% showed increased risk of coughing and rapid breathing, and clinical signs of further lung infection or damage (Fawzi et al., 2000). In another African trial, the children fared poorly in terms of both the risk of diarrhoea and the risk of continued lung problems. Hence vitamin

A provided no benefit to the well-fed children. The nourished children report inferred that, it makes sense not to give vitamin A supplements to children unless there is a special reason to do so (Petel*et al*., 1998; Hathcock *et al*., 1990).

The indiscriminate supplementation of foods with vitamin A for well-nourished children is uncalled for and not beneficial to the children. A controlled clinical trial showed that people who took 25 000 IU of vitamin A per day for a median of 3.8years had an 11% increase in triglycerides, a 3% increase in total cholesterol and 1% decrease in high density lipoprotein compared to those who did not (Cartmel *et al*., 1999). This is a clear indication that people at risk for cardiovascular disease would be concerned about long term dietary vitamin A supplementation.

A study by Melhus *et al*., (1998) spanning a period of 30 years showed that vitamin A supplementation was associated with bone loss and risk of hip fracture as a result of its interference with the cells that produce new bone and interfere with vitamin D, which helps the body maintain normal calcium level. This study recommended that just 3000 IU for men and 2 300 IU for women, which is easily supplied by a healthy diet. The study suggested that vitamin A consumption of more than 1.5 mg (1 500 000 IU) is injurious and that most people should not take vitamin A supplements nor do they need dietary extras. Similarly, data test tube, animal and human studies, showed an accelerated bone loss and inhibit formation of new bone (risk of osteoporosis) after excessive vitamin A intake. In humans, the effects were observed after 85 000-125 000 IU per day intake (Binkley and Krueger 2000).

It is not enough to draw a conclusion, as done in some circles that vitamin A toxicity cannot or could hardly be attained because of the quantity added to foods. The fact that additions are made to more than one food item is enough to suspect a possibility of bioaccumulation of the vitamin within the body or an over stretching of the system responsible for the vitamin metabolism. This in effect could lead to any of the aforementioned ailments. There are however, no good or bad vitamins, just good or bad uses (Andrew, 1997). A study of people with retinitis pigmentosa, in which participants received 15 000 IU of vitamin A per day over a 12-year period showed no sign of adverse effects or toxicity (Rabiu and Kyani 2002). Another survey showed that taking vitamin A and iron together helps overcome iron deficiency more effectively than iron supplementation alone, or in combination with zinc or both elements, vitamin A status improved among children at high risk for deficiency of the three nutrients (Mejia and Chew 2000; Munoz *et al.,* 2000). A research deduced that, the risks of ailments like stroke are reduced by diets high in vegetables and fruits. Though the components in the vegetables and fruits which confer the protection against stroke is not known, people wishing to be on the safe side are advised to rely primarily on fruits and vegetables, rather than taking vitamin supplements (Rodriguez *et al.,* 1998; Jospura *et al.,* 1999).

Monitoring of Vitamin A Status of Nigeria

As the availability of fortified foods expands, very little effort have been devoted to monitoring risk of excessive nutrient intake; considering that the human body needs only very small amounts of micronutrients (Dwyer *et al.,* 2015). Ideally,

vitamin A status is monitored as part of public health programs to prevent the occurrence of both subclinical deficiency and toxicity (Penniston and Tanumihardjo 2006). The deleterious effects of vitamin A deficiency are known, however in trying to prevent it through fortification monitoring of vitamin A status of the population is required to ascertain the effects of fortification on overall health and well-being of the population.

Conclusion

The current report outlines some of the changes to the health status of Nigerians in relation to its vitamin A food fortification initiative. Going by recent findings, it is clear that indiscriminate dietary supplementation with vitamin A may cause more harm than good to the consumers on long-term basis. It would be of immense benefit to policy advisers and Nigerians, if balanced diet using fresh and natural foods is advocated for instead of spending huge amounts on vitamin A supplements, which will add to the already high prices of those commodities that are going beyond the reach of average Nigerians.

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