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Provitamin a Yellow Cassava: A key Strategy to Alleviating Vitamin A Deficiency in the Tropics

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Abstract

The significance of biofortification β-Carotene-biofortified cassava produced through plant breeding as a sustainable agronomic approach to alleviate vitamin A deficiency. VAD is observed to be prevalent in tropical regions of the world where cassava is a staple crop and forms a major component of the daily food intake Therefore, cassava biofortification intervention focused on alleviating VAD in rural areas has advantages over supplementation and fortification because the provitamin A biofortified yellow cassava can provide a sustainable source of β-carotene, a potent precursor of vitamin A which is easily converted to retinol in vivo in humans thus improving their vitamin A status. It is hope that with the much-needed support from governmental and donor agencies as well as increase research attention, the provitamin A biofortified cassava remains a viable alternative in addressing VAD in the tropics.

Keywords: Vitamin A deficiency; Biofortification; Provitamin A yellow cassava

Introduction

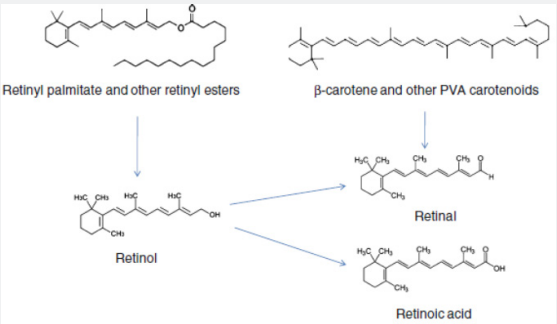
Vitamin A deficiency disease (VAD) remains a public health challenge in developing countries. VAD primarily affects preschool children and women with an estimated 3.3 million preschool children in Africa affected each year. Reports have shown that over 10% of affected children become either partially or totally blind [1-4]. The requirement for vitamin A in women increases in pregnancy, and at present over 20 million pregnant women in developing countries are vitamin A deficient. Approximately 6 million vitamin A-deficient women show clinical signs of night blindness and close to 600,000 mortality cases in pregnancy have been attributed to VAD annually [4,5]. Vitamin A deficiency (VAD) impairs human vision and damages the immune, respiratory, and reproductive systems. Consequently, individuals suffering from VAD are characterized by weak immune systems and are at a more considerable risk of dying from measles, diarrhoea or malaria [6].

Vitamin A plays a fundamental role in supporting growth, reproduction, and embryonic development, as well as in regulating cell differentiation and proliferation, and maintains an important function in the immune system. Vitamin A is an essential nutrient in mammalian nutrition. It occurs in several forms including retinol, retinal, retinoic acid and the provitamin A carotenoids (Figure 1). These variable forms of vitamin A are collectively called retinoids. In the process of vision, retinal combines with the protein opsin to form rhodopsin which is the light-absorbing molecule [7]. In plants, vitamin A occurs as provitamin A carotenoids (precursors of retinol), which are converted into retinol in vivo. There are over 600 naturally occurring carotenoids of which only 3 are important precursors of vitamin A in humans. These include, α-carotene, β-carotene and β-cryptoxanthin [8]. β-carotene, aside being the most abundant carotenoid in foods, is nutritionally the most potent precursor of vitamin A [9]. These provitamin A carotenoids are found in green leafy vegetables (including spinach, amaranth; yellow vegetables including pumpkins, squash, and carrots; and yellow and orange non-citrus fruits including mangoes, apricots, and papaya [1].

Mammals lack the capacity to synthesize vitamin A de novo thus the daily requirement by the body to meet physiological needs and functions must be obtained from the diets. However, low intake vitamin A could result in vitamin A-deficiency with its attendant health implications [3].

Several intervention strategies have been advanced to addressing the devastating consequences of VAD in children and women [10]. As part of these efforts, the yellow-fleshed provitamin A-biofortified cassava was introduced recently as a sustainable strategy to increasing the dietary intake of vitamin A especially in rural communities where supplementation has not been successful. The provitamin A cassava cultivars have been genetically modified using the traditional plant breeding tools to

accumulate high levels of pro-vitamin A and other pro-vitamin A carotenoids [6,11-13]. These new cassava varieties are 25% higher in β-carotene and are capable of providing up to 40% of vitamin A recommended daily allowance (RDA) for children who are vulnerable to VAD [10,14,15]. It has also been established that provitamin A biofortified cassava is capable of retaining a large proportion of its provitamin A content and thus providing 100% more β-carotene than the indigenous white sweet cassava (unpublished data) (Figure 1).



Source: Bai et al. [16]

Figure 1: Bioconversion of the major retinoids in humans.

Since its introduction in 2005 in Nigeria, efforts have been geared towards aggressive advocacy and education by extension workers on the nutritional and health benefits of these new cassava varieties. Stem cuttings of the provitamin A cassava varieties are distributed freely to local farmers. It is hope that this approach will offer a cost-effective, renewable means to reduce micronutrient deficiencies as opposed to vitamin A supplementation [12]. Overall, biofortification is expected to have a far-reaching health implication across the different strata of the society, including children and women who are most susceptible to VAD [10].

Results on the experimental validation of the effectiveness of provitamin A cassava in improving the vitamin A status of volunteers have been impressive. In a study by Talsma et al. [17] daily consumption of β-carotene biofortified cassava fed as porridge to Kenyan schoolchildren with marginal vitamin A status was observed to produce modest increase in serum retinol concentration and large increases in β-carotene concentration compared with children fed white cassava. However, increase research attention is required to bring to limelight the potential nutritional and health-promoting attributes of this novel cassava varieties.

In conclusion, provitamin A biofortified cassava offers a feasible and viable strategy of improving the vitamin A status of VAD of the poor and vulnerable women and children in very remote rural communities in the tropical regions of the world where cassava is a staple crop and forms a major component of the daily food intake.

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