

EFFECT OF VARIOUS PROCESSING METHODS ON BETA-CAROTENE AND ASCORBIC ACID CONTENTS OF SOME GREEN LEAFY VEGETABLES.

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ABSTRACT

The effect of different processing methods on the β carotene and ascorbic acid contents of *Celosia argentea*, *Solanum incanum* and *Talium triangulare* were investigated. *Celosia argentea* was boiled in water with salt for 5 minutes, *Solanum incanum* was squeezed with salt for 3 minutes and rinsed thrice, while *Talium triangulare* was oven dried at 59°C overnight. After processing, the vegetables were homogenized. The β carotene and ascorbic contents were determined using standard methods. The various studied processing methods caused significant decrease ($P < 0.05$) in the β carotene and ascorbic acid contents of the green leafy vegetables. Combination of these leafy vegetables with other foodstuffs is recommended to satisfactorily meet the RDA.

KEYWORDS: Green leafy vegetables, β carotene, Ascorbic acid, and Micronutrients

INTRODUCTION

Micronutrient malnutrition is a major global public health problem affecting more than a third of the world population, with developing countries being the most hit (Haas and Miller, 2006). These deficiencies are determining and aggravating factors for health status and quality of life as they play major roles in optimizing health and prevention or treatment of disease (Field *et al.*, 2002; Diaz *et al.*, 2003). This stems partly from the increase in knowledge and understanding of the biochemical functions of these nutrients (Shenkin, 2006). Amongst these micronutrients, deficiencies of beta carotene and ascorbic acid are two nutritional problems that have frequently serious consequences.

Provitamin A activity is the most widely and well-understood nutritional role for carotenoids notably beta-carotene (Barua and Olson, 2000, Evangelina *et al.*, 2001). Vitamin A deficiency constitutes one of the major health problems in Nigeria and indeed Africa. Deficiency of vitamin A, particularly in the third world countries accounts for blindness in 250,000 to 500,000 children a year according to estimates by the World Health Organization (Minsante/UNICEF, 2001). The protective effects of carotenoids against serious disorders such as heart disease, cancer and degenerative eye disease have been recognized. Its role in vision and growth regulation has made the public health officials to look for urgent and rapid methods of combating the problem (Ejoh *et al.*, 2007). The prevalence of ascorbic acid deficiency in developing countries is rather low compared to other developed countries as evidenced by the prevalence of scurvy. This low prevalence may be attributed to the consumption of leafy vegetables which constitutes a major ingredient in the diets (Erukainure *et al.*, 2010).

Leafy vegetables have been reported to play significant role in human nutrition, especially as a source of vitamins (A, B, C, E), minerals and dietary fibre (Aletor and Adeogun, 1995). Vegetables in conjunction with fruits and nuts is known to contribute about 91% of Vitamin C and 48% of vitamin A (Obboh, 2005a). In Nigeria, green leafy vegetables are usually subjected to various methods of processing such as blanching, soaking, abrasion with or without salt in order to improve their palatability and to remove the bitter taste and some of the acids present in the vegetables (Obboh, 2005a). These various processing techniques had been reported to alter both the nutrient, antinutrient and antioxidant property of some commonly consumed plant foods in Nigeria (Obboh and Akindahunsi, 2004; Obboh 2005b). Amongst these vegetables are *Celosia argentea*, *Solanum incanum* and *Talium triangulare*.

Celosia argentea is a traditional food plant in Africa with potentials to improve nutrition, boost food security, foster rural development and support sustainable landcare (NRC, 2006). Popularly called Lagos spinach, it is

one of the main boiled greens in Nigeria, where it is known as *soko yòkòtò* by the Yorubas or *farar áláyyafó* by the Hausas (Grubben and Denton, 2004). *Solanum incanum* is a species of nightshade that is native to northwestern Africa and the Middle East (USDA, 2006). Commonly known as *igbo* among the Yorubas of western Nigeria, all parts of the plant are considered useful. The leaves are consumed as leafy vegetables, while the fruits are extensively used in Kenya for the treatment of cutaneous mycotic infections and other pathological conditions (Beaman-Mbaya and Muhammed, 1976). *Talium triangulare* has been reported to be rich in vitamins and minerals. It is cultivated in West Africa, South Asia, Southeast Asia, and is one of the most important leafy vegetables consumed in Nigeria (USDA, 2003).

This study aims at reporting the effect of different processing methods on the β carotene and ascorbic acid contents of *Celosia argentea*, *Solanum incanum* and *Talium triangulare*.

MATERIALS AND METHODS

Vegetables

The leafy vegetables (*Celosia argentea*, *Solanum incanum* and *Talium triangulare*) were purchased from strategic market locations in Lagos metropolis in Nigeria.

Preparation of Samples

The fresh and healthy vegetables were immediately washed under tap water and excessive water was allowed to drip off. Edible portions (120 g) of the vegetables were cut into small pieces.

Samples Processing

Celosia argentea was boiled in water with salt for 5 minutes. *Solanum incanum* was squeezed with salt for 3 minutes and rinsed thrice. While *Talium triangulare* was oven dried at 59°C overnight.

The processed vegetables were homogenised using a blender for 5 min. The homogenised samples were transferred into an air-tight containers, labeled and kept at $\leq 2^{\circ}\text{C}$ before vitamin analysis.

Determination of Beta Carotene

Beta carotene was determined by the chromatographic method of the association of vitamin (AOVC, 1966). This method is based on the extraction of carotenoids with hexane from the vegetable samples. And subsequently isolation and purification of β carotene on a column absorbent-Alumina (Al_2O_3). The purification process is based on the varying affinities of the absorbent for the different pigment. All samples were carried out in triplicates.

Determination of Ascorbic Acid

Ascorbic acid was determined according to the method described by Adeboye (2008). Ascorbic acid was measured by titration with phenolindo-2, 6-dichlorophenol (DPIP). The sample (0.2 g) was mixed with 4 mL of a buffer solution made up of 1 g L⁻¹ oxalic acid and 4 g L⁻¹ sodium acetate anhydrous. This was titrated against a solution containing 295 mg L⁻¹ DPIP and 100 mg L⁻¹ sodium bicarbonate. The results were expressed as mg/100 g DM. All samples were carried out in triplicates

The processed vegetables were compared to the unprocessed vegetables.

Statistical analysis and scoring of data

Statistical significance of the difference between experimental groups was calculated using the Student's *t*-test (Fisher and Yates, 1963). A $p < 0.05$ was considered significant. One-way ANOVA was also performed.

RESULTS

Effect of processing on beta carotene content of the three vegetables is depicted in figure one. A decrease in the beta carotene content of the processed vegetable was observed, with the unprocessed vegetable having a significant higher ($p < 0.05$) value. Processing of *Celosia argentea* caused a 37.63% decrease in the beta carotene content. No significant difference was observed in processed *Solanum incanum* compared to the unprocessed.

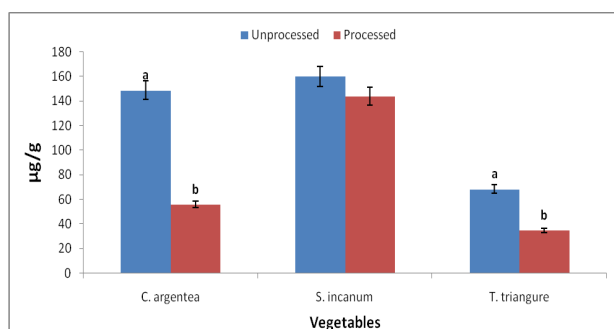


Figure 1: Effect of different processing methods on beta carotene content of selected vegetables. Values = mean $\pm$ SD; n = 3. Superscripts are significantly different with a>b (P<0.05). Processing led to a decrease in the ascorbic acid content of the vegetables as depicted in figure 2. Of the studied processing methods, squeezing with salt for 3 minutes was observed to have no significant effect on the ascorbic acid content. Significant difference (p<0.05) was observed between the ascorbic acid of the unprocessed and processed vegetables, with the unprocessed having a higher value.

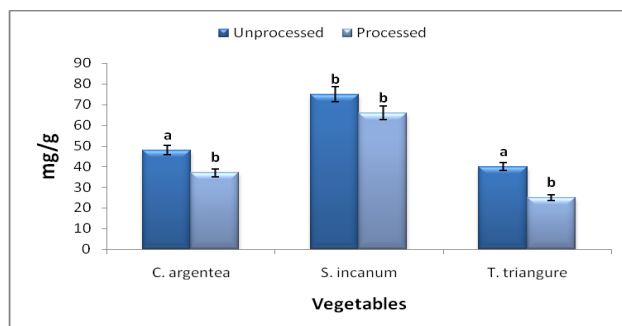


Figure 2: Effect of different processing methods on ascorbic acid content of selected vegetables. Values = mean $\pm$ SD; n = 3. Superscripts are significantly different with a>b (P<0.05)

DISCUSSION

Vegetables play an important role in human diet as they are important sources of minerals and certain vitamins especially vitamin A and C (Obboh, 2005b). Most of the data available on these nutrients refer to the raw materials. It is evident, however, that data relating to the form in which the vegetables are consumed by the population are urgently needed as well as the influence of processing and storage on these nutrients (Rodriguez-Amaya, 1997). This paper reports influence of various processing methods on the beta-carotene and ascorbic acid contents of selected green leafy vegetables.

The protective effects of carotenoids against serious disorders such as heart disease, cancer and degenerative eye disease have been recognized (Ejoh *et al.*, 2007). The various studied processing methods were observed to have significant difference on the β -carotene content of the leafy vegetables as depicted in Figure 1. The 62.37% reduction in β -carotene content of *Celosia argentea* after boiling corresponds to various reports. Dietz *et al.* (1988) reported that boiling for 30 minutes led to 53 and 40% reduction of carotene in lettuce and carrots, respectively. Anjum *et al.* (2008) reported a pronounced reduction in beta-carotene content of selected Indian vegetables. This however, contradicts the report of Granado *et al.* (1992). They reported much higher levels of carotene in cooked vegetables than in the uncooked vegetables after boiling 18 Spanish vegetables for 10 to 38 minutes. These lower retention levels have been attributed to the time lag between preparation, cooking and long cooking (Rodriguez-Amaya, 1997). The observed β -carotene content of *C. argentea* would not be able to meet the Required Dietary Allowance (RDA) for β -carotene estimated at 6mg/day (10,000 IU/day) (Wardlaw, 1999). Drying has been the most popular traditional method of preserving fruits and vegetables in Nigeria and other developing countries. Oven drying of *Talium triangulare* led to 49.12% loss of β -carotene. Rahman *et al.* (1995) evaluated the retention of carotenoids in two leafy vegetables during oven-drying and sun-drying.

They reported an excellent retention (96 to 98%) with oven-drying over the sun dried, indicating its advantage over the traditional method of sun drying. This method however, poses a feasibility problem in rural communities as ovens and other basic amenities are not readily available. The low percentage (10%) loss of β -carotene observed in *Solanum incanum* can be attributed to the processing method. Unlike the other studied vegetables, *S. incanum* did not undergo any heating process which could have adverse effect on carotenoids because trans form change to cis form that are biologically inactive (Hachett *et al.*, 2002), thus signifying its advantage over the other processing method. In addition, the observed β -carotene content of *S. incanum* was estimated to have the highest IU value of 41.66, though it would require several servings per day to meet the estimated RDA for individuals (10,000 IU/day) (Wardlaw, 1999).

Ascorbic acid has been described as a powerful reducing agent, making it a potent antioxidant providing nonspecific protection against oxidative damage (Koolman and Roehm, 2005). As shown in figure 2, processing of the vegetables led to significant reduction ($p < 0.05$) of the ascorbic acid content. This results corresponds to earlier reports by Oboh (2005a); and Oboh and Akindahunsi (2004) that various conventional food processing methods bring about loss in ascorbic acid content of leafy vegetables. The reduction in ascorbic acid content can be attributed to the fact that it is water soluble and at same time not heat stable (Oboh 2005a). Processed *S. incanum* was observed to have the least percentage loss of ascorbic acid content (12%), this could be attributed to the lack of heat applied during processing. Processed *S. incanum* would be able to meet the RDA of ascorbic acid for adolescent and adults (60 mg/day) as its ascorbic content was observed to be 66 mg/g. The ascorbic acid of processed *C. argentea* and *T. triangulare* will also be able to meet the RDA for both adolescents and adults (60 mg/day) when served more than twice a day.

CONCLUSION

The various studied processing methods caused significant decrease ($P < 0.05$) in the beta carotene and ascorbic acid contents of the green leafy vegetables. Combination of these leafy vegetables with other foodstuffs is recommended to satisfactorily meet the RDA.

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