EFFECT OF BLANCHING TIME ON OXALATE AND PHYTATE CONTENT OF NON-CONVENTIONAL LOCAL VEGETABLES IN BENUE STATE, NIGERIA

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Abstract: The effect of blanching time on the oxalate and phytate content of five non-conventional green leafy vegetables consumed in Benue State, Nigeria, was investigated. Titrimetric analysis was employed to determine the levels of oxalate and phytate in *Justicia schimperi* (Abushi), *Hibiscus sabdariffa* (Ashwe), *Fiscus sur* ("Tur"), *Cucurbita spp* ("Furum") and *Ocimumgratissimum* ("Kunguleku-Utamen") before and after blanching. The oxalate content of unblanched and blanched samples were compared. The results revealed that the oxalate content of all the studied vegetables decreased with increase in blanching time. The maximum level of oxalate was observed in *Hibiscus sabdariffa* (2189 mg/100g) while the minimum level of oxalate was observed in *Ficus Sur* (759 mg/100g). A general reduction in the phytate content of the vegetables with increasing blanching time was also observed. Blanching at 5 min had the highest reducing effect on the phytate and oxalate content of the vegetables. The reduction is expected to enhance the nutritional value of these green leafy vegetables.

Keywords: Blanching, oxalate, phytate, vegetables, antinutrients, titrimetric

Introduction

Vegetables contain vitamins and minerals which help to build teeth and bones, protect the body from disease and regulate biological processes that promote good health. Vegetable intake in daily diet have been strongly associated with overall good health and vision, reduced risk of some forms of cancer, heart disease, stroke, diabetes, anemia, gastric ulcer, rheumatoid arthritis and other chronic diseases (Joao, 2012). Regular consumption of vegetable diet has undeniable positive effect on human health, however, their anti-nutritional contents should not be ignored, which in high levels may result in health implications that are quite lethal and in extreme cases fatal. Anti-nutritional factors may be defined as those substances generated in natural feed stuff by normal metabolism of species and by different mechanism (e.g. inactivation of some nutrient, reduction of the digestive process or metabolic utilization of feed) which exert effects contrary to optimum nutrition (Santosh *et al*., 2015). Sedentary species (plants, fungi and bacteria) synthesize a range of low and high molecular weight compounds to store nutrients and avoid predation, these compounds with the exception of nutrients are called allelochemicals. These secondary metabolites play a significant role in defense against herbivores, insects, pathogens, or adverse growing conditions. Many of these compounds, depending on the situation, can be beneficial or lethal to organism consuming them. Anti-nutritional factors may be regarded as a class of these compounds (Kumar, 1992). The presence of anti-nutritional factors in vegetables is detrimental to man when their consumption exceeds safety limits. Although the presence of these anti-nutritional factors is always in trace quantities, they have been established to play significant role in the nutritional quality of food (Sharifah, 2013).

Phytates and oxalates can form chelates with di- and trivalent metallic ions such as Cd, Mg, Zn and Fe to form poorly soluble compounds that are not readily absorbed from the gastrointestinal tract thus decreasing their bioavailability and can lead to diseases such as rickets and osteamalicia (Anhwange *et al*., 2014). Oxalate is the conjugate base of oxalic acid which can bind to metal ions such as Ca^{2+} and Mg^{2+} to form precipitates in the body. Consumption of high oxalate-containing foods may result in hyperoxaluria and subsequent formation of insoluble calcium oxalate (CaOx) crystals, a primary component of kidney stones (Al-Wahsh *et al*., 2012).

Anti-nutritional factors in vegetables are evidently advantageous to human and animal health when consumed at the appropriate quantities. Some potential health benefits are antioxidant property, anti-carcinogenic property, reduced risk of cardiovascular diseases, lower cholesterol levels and increased level of protein efficiency (Nkafamiya *et al*., 2010; Yilkal, 2015). Hence it is pertinent to effectively manage the crisis by reducing the anti-nutritional factors to tolerable limits while yet maximizing the nutritional and health benefits of consuming the vegetables (Shimelis, 2008; Soetan & Oyewole, 2009). Blanching is the method used in the cooking of these vegetables by the people in the locality where they are consumed. This is done usually within five minute and one cannot say if this is enough to reduce the antinutritional factors (oxalates and phytates) in such using this method of food preparation. The research thus was focused on evaluating the effect of blanching on the studied vegetables consumed predominantly by the indigenous Tiv people of Nigeria.

Materials and Methods

Study area

This research was conducted in Makurdi town. Makurdi town is the headquarters of Makurdi Local Government Area and capital of Benue State. The town is located between latitude 7°38'N - 7°50'N, and longitude 8°24'E and 8°38'E and 104 meters elevation. It is situated in the Benue valley in the North Central region of Nigeria. It is traversed by the second largest river in the country, the River Benue.

Sample collection

The five local vegetables were obtained randomly within Benue State, Nigeria. They were then taken to the Biological Science Department of the Benue State University for identification. The vegetables collected, identified and studied were; *Justicia schimperi* (Abushi), *Fiscus sur* ("Tur") *Hibiscus sabdariffa* ("Ashwe"), *Cucurbita spp* ("Furum") and *Ocimumgratissimum* ("Kunguleku-Utamen"). The local names of these vegetables are adequately indicated in parenthesis. The vegetables were destalked and washed with distilled water. The fresh leaves were used for the study.

Sample preparation

Each sample was divided into six portions in a 250 ml beaker, one unblanched and the others blanched at different blanching time (1 – 5 min). This was done with the aid of a stop watch. The water was decanted using a basket without pressing the vegetable. The blanched and unblanched samples were dried in the absence of sunlight until they were crispy. The dried samples were then pounded (ground) into fine powder using laboratory pestle and mortar after which they were sieved to fine powder. Chemical analyses were carried out on the fine powdered samples.

Determination of phytate

The method reported by Anhwange *et al.* (2014) was adopted for phytate quantification. 4 g of the powdered sample was soaked in 100 cm^3 of 2% HCl V/V for 3 h and filtered. To 25 cm^3 of the filtrate in the conical flask, 5 cm^3 of 0.3% ammonium thiocyanate solution and 53.5 cm^3 distilled water were added, thoroughly mixed and titrated against standard $FeCl_3$ (containing 0.00195 g Fe^{3+}/cm^3) until a brownish yellow color persisted for 5 min. Blank was titrated in a similar manner and 1 cm^3 which equals 1.19 mg phytin phosphorus was determined and the phytate content was calculated by multiplying by a factor 3.55.

Determination of oxalate

The titration method as described by Day and Underwood (2009) was adopted. 1 g of sample was weighed into a 100 ml conical flask after which 75 ml of 3 m H_2SO_4 was added and stirred for 1 h with the aid of a magnetic stirrer. This was filtered using Whatman No. 1 filter paper. 25 ml of the filtrate was then taken and titrated while hot against 0.05M $KMnO_4$ solution until a pink color persisted for at least 30 seconds. The oxalate content was then calculated by taking 1ml of 0.05M $KMnO_4$ as equivalent to 2.2 mg oxalate.

Results and Discussion

Oxalate content of the studied vegetables

Oxalate has deleterious effects on human nutrition and health mainly by decreasing calcium absorption and aiding the formation of kidney stones. The formation of oxalate crystals is said to take place in the digestive tract (Shivprasad *et al.*, 2012). Comparatively, the concentration of oxalate in Hibiscus sabdariffawas found to be significantly higher among all the vegetables studied (Table 1). This is also clearly exemplified in Fig. 1. Green leafy vegetables blanched for 5 min showed the highest reduction for oxalate as shown in Table 1 and Fig. 1. This can be attributed to the fact that the concentrations of anti-nutritional factors are higher in the superficial layer of vegetables and blanching may rupture this layer (Udousoro *et al*., 2013).

Table 1: Oxalate content of unblanched and blanched vegetables (mg/100g)

Vegetables	Unblanched	1 min	2 min	3 min	4 min	5 min
Justicia schimperi	13.75	12.32	9.35	7.81	6.27	5.72
Hibiscus sabdariffa	21.80	20.46	19.14	18.04	16.50	13.42
Cucurbita spp	10.56	5.39	5.28	5.17	4.84	3.74
Ficus sur	7.59	6.93	5.39	4.51	4.18	3.74
Ocimumgrastissimum	11.55	8.25	7.26	6.49	4.73	3.96

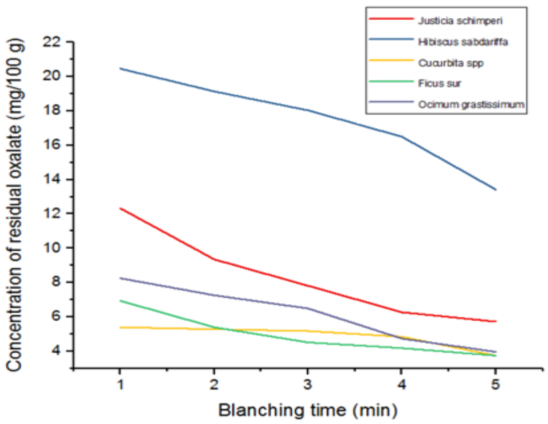

Fig. 1: Residual oxalate concentration versus blanching time

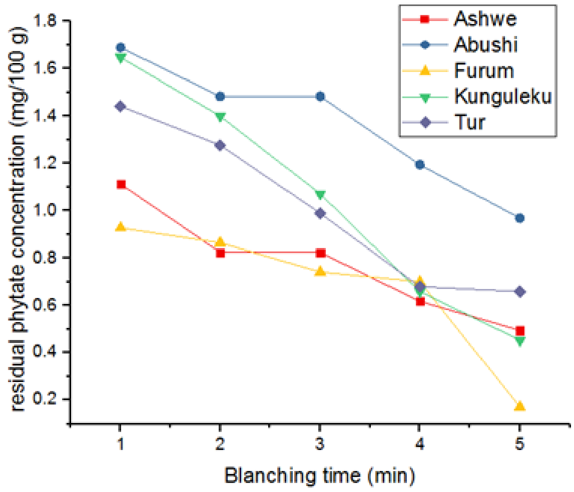

Fig. 2: Residual phytate concentration against blanching time

The oxalate content of the studied vegetables was found to be in the range as reported by Amalraj and Pius. On the contrary, the oxalate content of the studied vegetableswas found to be less than those reported by Radek and Savage (2008) for solution and total oxalate content of 11 leafy vegetables consumed in India. If high oxalate food were to be consumed in conjunction with low calcium diet, then the consumer may be at risk of hyperoxaluria and stone formation. In general, the levels of oxalate in these vegetables are too low to significantly interfere with nutrition utilization. They are below the established toxic level of 2 to 30 g for humans (Nkafamiga *et al.*, 2010). The percentage reduction of oxalate in the studied vegetables is presented in Fig. 3. It can be clearly observed that the percentage reduction of oxalate increases with corresponding increase in blanching time.

Table 2: Phytate Content of Unblanched and Blanched Vegetables (mg/100g)

Vegetables	Unblanched	1 min	2 min	3 min	4 min	5 min
Ashwe	1.3180	1.1121	0.8238	0.8238	0.6178	0.4943
Abushi	2.1830	1.6887	1.4828	1.4828	1.1945	0.9679
Furum	1.2357	0.9267	0.8650	0.7414	0.7002	0.1697
Kunguleku	1.7711	1.6476	1.4004	1.0709	0.6590	0.4531
Tur	1.7505	1.4416	1.2769	0.9885	0.6796	0.6590

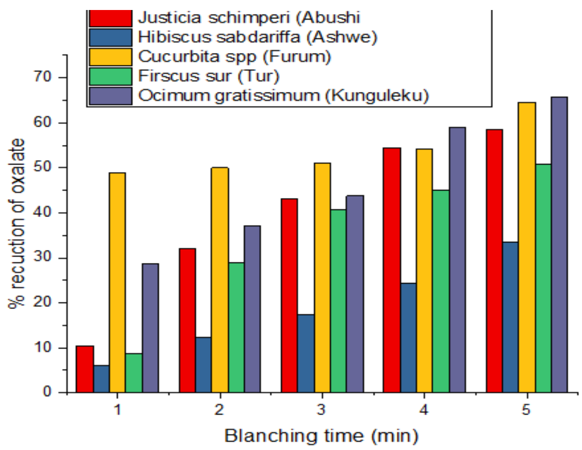

Fig. 3: Percentage reduction of oxalate against blanching time

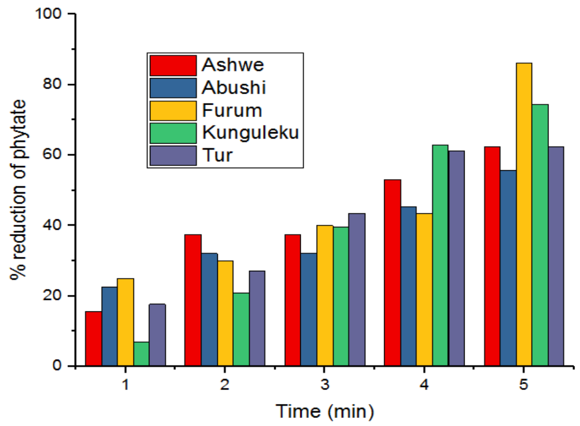

Fig. 4: % reduction of phytate against blanching time

Phytate content of the studied vegetables

Similarly, a general reduction in the phytate content of the studied vegetables with increasing blanching time was observed. The trend can be clearly seen in Table 2 and Fig. 2. The phytate content of *Hibiscus Sabdariffa* (*Ashwe*) decreased considerablyafter blanching for 5 min. *Cucurbita spp* (*Furum*) showed a reduction of its phytate content from 1.2357 mg/100g in the unblanched sample to 0.1697 mg/100g after blanching for 5 min, respectively. The phytate content of *Ficus sur* (*Tur*), *Ocimumgrastissimum* (*Kunguleku-Utamen*), *Justicia schimperi* (*Abushi*) decreased from 1.7505, 1.7711 and 2.1830 to 0.6590, 0.4531 and 0.9679, respectively all in mg/100g after blanching for 5 min. These values are different from those obtained by Agbaire (2011), Nupo *et al*. (2013). The phytate content of all the studied vegetable samples were below the toxic level of 25 mg/100g as reported by Ramiel (2013). The percentage reduction of phytate in the studied vegetables is presented in Table 2. It can be clearly seen that, the percentage reduction of phytate increases with corresponding increase in blanching time. The trend can also be observed in Fig. 4. The percentage reduction of phytate in *Justicia schimperi* (Abushi) for example, increased from 22.643% at 1 min to 55.662% at blanching time of 5 min while that of *Fiscus sur* (Tur) increased from 17.646% at blanching time of 1 min to 62.354% at blanching time of 5 min.

Conclusion

The results obtained from the chemical analyses of the vegetables revealed the presence of phytates and oxalatsat varying concentrations in all the studied vegetables. However, the concentrations were found to be within the permissible limit for phytate content. The oxalate and phytate content of studied vegetables decreased with increase in blanching time. The percentage reduction of oxalate and phytate increased with increase in blanching time, hence the deduction further validates the fact that blanching generally reduced the phytate and oxalate content of the studied vegetables.

Conflict of Interest

Authors declare that there is no conflict of interest reported on this work.

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