EFFECT OF DOMESTIC HANDLING METHODS ON THE ASCORBIC ACID AND MINERAL COMPOSITION OF SELECTED GREEN LEAFY VEGETABLES

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Abstract

Leafy vegetables are important food crops because they provide adequate amounts of many vitamins and minerals for humans. They are highly perishable and require special processing treatments to prevent post harvest losses. The fresh leaves of Vernonia amygdalina (bitter leaf), Moringa oleifera (drum stick), Occimum gratissicum (scent leaf) and Telfairia occidentalis (fluted pumpkin) were subjected to various domestic processing methods namely hot water blanching, sun drying and squeeze washing. Ascorbic acid and mineral contents of the samples were determined using standard analytical methods. The results obtained from the analysis showed that all the unprocessed (fresh) samples had the highest value of ascorbic acid. The ascorbic acid of unprocessed leaves are 75.5mg/100g for fluted pumpkin leaf, 56.4 mg/100g for bitter leaf, 42.8 mg/100g for scent leaf and 228.7 mg/100g for drum stick leaf while that of processed leaves ranged from 31.2 – 45.2mg/100g for fluted pumpkin, 23.4 – 56.4mg/100g for bitter leaf, 17.8 – 42.8g/100g for scent leaf and 90.2 – 228.7mg/100g. Mineral contents of the unprocessed samples ranged from 4.2 – 31.8 mg/100g for iron, 53.0 – 411.4 mg/100g for calcium, 24.6 – 212.3 mg/100g for magnesium, 42.6 – 201.1 mg/100g for potassium and 35.1 – 181.3 mg/100g for sodium. From the analysis carried out in this work, the various domestic processing methods caused significant decrease ($P < 0.05$) in the ascorbic acid and mineral contents of the samples except for the sun drying that gave results that compared favourably with the unprocessed samples. These results revealed that sun drying was the best out of the domestic handling methods studied.

Keywords: Domestic handling; Ascorbic acid; Mineral composition; Vegetable

Introduction

Vegetables are herbaceous plants whose part or parts are eaten as supporting food or main dishes and they may be aromatic, bitter or tasteless. Green leafy vegetables constitute an indispensable constituent of human diet (Awogbemi and Ogunleye, 2009). The utilization of leafy vegetables is part of Africa's cultural heritage and they play important roles in the customs, traditions and food culture of the African household. Nigeria is endowed with a variety of traditional vegetables and different types are consumed by the various ethnic groups for both culinary and medicinal reasons. Some green leafy vegetables could be consumed fresh or unprocessed, however others are consumed as cooked complements to the major staples such as cassava, millet, maize and rice (Oguche, 2011). They are reportedly inexpensive and easy to cook and rich in vitamins and provide roughage (Sobowale, 2010). They play an important role in human nutrition, especially as a source of vitamins (A, B, C and E), minerals (especially iron and calcium) and dietary fibre. They are also rich in carotenoids. Vegetables play crucial roles in alleviating hunger and food security by contributing bulk of the nutritional components in diets of people where animal products are scarce (Sobowale, 2010).

It has been estimated that perhaps over sixty species of green vegetables are used in Nigeria alone (Aletor and Abiodun, 2013). Some of these green leafy vegetable are fluted pumpkin (*ugu*), bitter leaf (*ewuro*), scent leaf (*efinrin*), drum stick (*ewe iye*), amaranths (*tete*), celosia (*sokoyoto*), corchurus (*ewedu*), sorrel (*isapa*), *Talinum* (*gure*), basella (*amunu-tutu*) and many others. They are in abundance shortly after the raining season but become scarce during the dry season when the previously cultivated ones are used (Mepba *et al.*, 2007).

In Nigeria, leafy vegetables are rarely processed, presumably due to the general lack of basic preservation facilities for freezing, canning or dehydration which are reported to be the best methods in terms of nutrient retention and storability. Traditionally, boiling, squeeze-washing and sun-drying are some of the domestic handling and postharvest methods practiced by the people of the developing countries, including Nigeria. (Ejoh *et al.,* 2007). These methods are used to improve their palatability and sometimes storability. However, some of these practices cause losses of some essential and important nutrients that are required for the body's metabolic processes and general wellness (Amic *et al.*, 2003).

Minerals are very important and essential ingredients of diet required for normal metabolic activities of body tissues. Among the plants, vegetables are excellent sources of minerals and contribute to the recommended daily allowance (RDA) of these essential nutrients. They are constituents of bones, teeth, blood, muscles, hair, nerve cells and act as catalyst for many biological reactions within the human body (Rumeza *et al.,* 2006). Minerals are vital to all mental and physical processes and total well being of the body. They are very important in keeping the blood tissue fluids from either becoming too acid or too alkaline and allow other nutrients to pass into the blood stream, and aid in transporting nutrients to the cells. No single mineral can function alone since they are synergistically related. A correct balance of minerals in the body ensures proper assimilation of vitamins e.g. calcium is needed for vitamin C utilization, magnesium for B complex vitamins (Awogbemi & Ogunleye, 2009).

Vitamins are organic compounds occurring in natural foods especially in vegetables as utilizable precursors. They are needed for vision, reproduction, blood clotting and maintenance of skin, mucous membranes, bones, teeth and hair. They are also essential for the metabolism of macromolecules (Rumeza *et al.,* 2006). In homes, cooking has been known to have quite a significant effect on the ultimate nutrient delivery to the consumer particularly that of the labile water soluble ascorbic acid (Davey *et al*, 2000). The vitamin C in vegetables might not be readily available due to various processing methods they undergo such as blanching, boiling, squeeze-washing and sun drying. Therefore, the purpose of this study was to determine the most effective domestic handling method that can be used for preserving the ascorbic acid and mineral contents of some leafy green vegetables thereby promoting their shelf-life and year round availability.

Materials and Methods

Source of materials: Four types of indigenous leafy vegetables; *Vernonia amygdalina* (bitter leaf)*, Moringa oleifera* (drum stick*), Occimum gratissicum* (scent leaf) and *Telfairia occidentalis* (fluted pumpkin) were harvested in a garden at Ilorin, Kwara State. Ilorin is on latitude 8.5^0E and longitude^{0}N. The research was done during the rainy season (around May). The ambient temperature used was 28 ± 2^0C.

Sample Processing Methods

Sun drying: This was carried out according to the method of Ogbadoyi *et al*, (2011) with some modifications. The leaves were weighed separately and spread in clean trays. These trays were covered with cheesecloth to prevent them from dust, insects and rodents and dried in the sun. The vegetables were turned occasionally in the container while in the sun until they are properly dried. Samples were dried for two days. The dried samples were used for the required analysis.

Hot Water Blanching: Hot water blanching was carried out according to the method of Adeboye and Babajide, (2007). Ten grams of destalked vegetable was cut into pieces and blanched in 80ml water at 100^0C for about 5 minutes. The leaves were then rinsed with 100mls of clean water and excess water was drained from the blanched vegetables.

Squeeze Washing: Squeeze washing was carried out following the method of Adeboye and Babajide (2007). Ten grams of destalked vegetables were cut into pieces and squeezed thoroughly between the palms with 80ml of water for 5 minutes. The squeezed vegetables were then rinsed with 100 ml of water and the vegetables were drained to remove excess water.

Ascorbic Acid Determination: This was carried out according to the method described by Chopra and Kanwar (2007). Five grams of sample was soaked in 50ml of 3% HPO_3 (auto-phosphoric acid). 5ml of sample was put in 3% HPO_3 and titrated with 50 mg of sodium salt of 2,6-dichlorophenol indophenol which had been made to 200ml in a standard flask. The solution was titrated with the dye solution to a pink end point which persisted for 15 seconds. The dye factor was determined by putting 5ml of standard ascorbic acid in a conical flask and adding 5 ml of HPO_3 to it. The solution was then titrated with the dye solution to pink colour end-point that persisted for 15 seconds.

Dye factor = Mg of ascorbic acid per ml of dye = 0.5/ titre.

Calculation:

Mg of ascorbic acid in 100g or 100ml

$$= \frac{\text{Titre x dye factor x volume made up}}{\text{Volume of extract taken for titration x weight of sample}} \times 100$$

Mineral Determination: Mineral determination was carried out by Aqua-ragia method of AOAC, (2005). One gram of sample was weighed into the Kjedahl flask; 3ml of nitric acid (HNO_3) and 1ml of hydrochloric acid (HCl) were added to the content in the flask. Heat was applied until the sample was properly digested giving a clear solution. The solution was finally taken for the atomic absorption spectrophotometer for mineral analysis.

Statistical Analysis: The data collected was subjected to Analysis of Variance (ANOVA) and the completely randomized design (CRD) was used. The differences between means were assessed by Duncan (1955) multiple range test using the statistical package stats graphics (2000) at $P < 0.05$.

Results and Discussion

Table 1 shows the effect of domestic handling methods on vitamin C content of the four vegetables studied in this research. The vitamin C content of the processed vegetables reduced significantly ($P < 0.05$) as compared to the fresh samples. The vitamin C contents of the fresh vegetables are; fluted pumpkin leaf (75.5 ± 1.1mg/100g), bitter leaf (56.4 ± 0.8mg/100g) scent leaf (42.8 ± 1.0mg/100g) and drum stick leaf (228.7 ± 1.1mg/100g). These values were within

the range reported by Oboh (2005) for some tropical green leafy vegetables (43.5-148 mg/100g). However, the various domestic handling methods caused significant decrease ($P< 0.05$) in the vitamin C contents of the vegetables. This loss in vitamin C could be as a result of its high solubility in water as it has been reported by Oboh, (2005) that vitamin C is not stable at high temperature, thus local processing methods with or without high temperature may lead to the destruction of this important vitamin. Generally, the loss of vitamin C in green leafy vegetables is a function of the processing method used for its preparation. Vitamin C has been noted for its antioxidant activity, helps fight off free radicals in the body, warding off inflammation, infections and viruses. It has proved to be useful in breaking down some kinds of oxidized fat and prevent atherosclerosis. It also protects the body against cancer of the oesophagus, oral cavity and stomach (Oboh, 2005). Deficiency diseases associated with this vitamin include hair loss, gum disease, tiredness e.t.c.

Sun drying had the highest values of vitamin C for all the vegetables because they do not have contact with water and the temperature of the sun is not as high as that of the temperature used for blanching. It had little effect on the vitamin C of the vegetables (Ejoh *et al.*, 2007). This could be as a result of vitamin C being temperature dependent. Similar result was obtained by Babalola *et al.*, (2010) who observed that sun drying had the least effect on vitamin C content when compared with other processing methods in Indian spinach.

During squeeze washing, ascorbic acid was lost because the process involved cutting, tearing apart and crushing of the components of the vegetables. This process exposed the cells contained within the vegetables to oxidation by the oxidase enzymes as well as leaching of the vitamin C into the processing water. These caused great damage and loss of vitamin C. It was also observed that squeeze washing led to more loss than blanching. This was also reported by Ejoh *et al.*, (2007) in a similar work on some vegetables.

The reduction in the ascorbic acid observed in the blanched samples may be due to thermal degradation, temperature of the blanching water and water solubility (Oboh, (2005); and Awogbemi and Ogunleye, 2009). Blanching in hot water causes the inactivation of the oxidase enzymes that destroys vitamin C. It also removes field soil and destroys microorganisms present (Adetuyi *et al*, 2008).

Tables 2, 3, 4 and 5 show the effect of domestic handling methods on the mineral content of the four vegetables used. The mineral contents of all the vegetables ranged from 4.2 – 31.8 mg/100g for iron, 53.00 – 411.40 mg/100g for calcium, 24.60 – 212.30 mg/100g for magnesium, 42.60 – 201.10 mg/100g for potassium and 35.10 – 181.32 mg/100g for sodium. The fresh and the sun dried samples were not significantly different ($P< 0.05$). There was significant reduction in the mineral contents of the vegetables that were subjected to blanching and squeeze washing. The sun dried samples had the highest value of mineral because they do not have contact with water and there was no leaching. The blanched samples were next to the sun dried sample. The squeezed washed samples had the lowest mineral contents because the process involves the tearing apart of the leaf samples. During this process, the mineral contents were leached into the water. The trend of the increase in mineral content in relation to domestic handling methods is thus sun dried > blanched > squeeze washing (Yakubu *et al.,* 2012). Other factors that can affect mineral content of vegetables include soil condition, planting condition and post harvest handling methods Mepba *et al,* (2007). The loss of mineral nutrients in blanched and squeeze washed samples agrees with the work of Akindahunsi and Oboh, (1999).

Table 1: Effect of domestic handling methods on the ascorbic acid of vegetables

Sample	Fresh (mg/100g)	Blanched (mg/100g)	Sundried (mg/100g)	Squeezed Wash (mg/100g)
Bitter leaf	56.4 ± 0.8^{a}	28.5 ± 1.2^{c}	55.7 ± 1.0^{b}	23.4 ± 1.0^{d}
Scent leaf	42.8 ± 1.0^{a}	21.1 ± 0.8^{c}	41.3 ± 0.7^{b}	17.8 ± 0.1^{d}
Drum Stick leaf	228.7 ± 1.1^{a}	124.6 ± 0.6^{c}	219.8 ± 1.0^{b}	90.2 ± 0.7^{d}

Values are triplicate determinations; means within rows having different superscripts differs significantly ($P < 0.05$) for each vegetable.

Table 2: Mineral content of processed fluted pumpkin leaf

Methods	Iron	Calcium	Magnesium	Potassium	Sodium
Fresh (Control)	8.1 ± 0.01^{a}	411.0 ± 0.01^{a}	212.1 ± 0.10^{a}	201.1 ± 0.01^{a}	181.3 ± 0.01^{a}
Blanched	5.4 ± 0.01^{c}	71.1 ± 0.01^{c}	130.0 ± 0.01^{c}	71.1 ± 0.01^{c}	52.1 ± 0.01^{c}
Sun dried	7.9 ± 9.01^{b}	402.6 ± 0.10^{b}	203.2 ± 0.10^{b}	190.1 ± 0.01^{b}	178.3 ± 0.01^{b}
Squeeze washing	4.2 ± 0.10^{d}	63.1 ± 0.01^{d}	60.0 ± 0.01^{d}	62.1 ± 0.01^{d}	41.3 ± 0.10^{d}

Values are triplicate determinations; means along columns having different superscripts differs significantly ($P < 0.05$).

Table 3: Mineral content of processed drum stick leaf

Methods	Iron mg/100g	Calcium mg/100g	Magnesium mg/100g	Potassium mg/100g	Sodium mg/100g
Fresh (Control)	16.0 ± 0.01^{a}	66.8 ± 0.10^{a}	59.0 ± 0.01^{a}	70.2 ± 0.10^{a}	51.1 ± 0.01^{a}
Blanched	14.0 ± 1.00^{b}	64.2 ± 0.10^{b}	57.0 ± 1.00^{b}	66.2 ± 0.01^{b}	49.1 ± 0.01^{b}
Sundried	15.2 ± 0.01^{ab}	66.8 ± 0.01^{a}	59.0 ± 0.01^{a}	70.1 ± 0.01^{a}	51.1 ± 0.01^{a}
Squeeze washing	11.0 ± 1.00^{c}	56.4 ± 0.01^{c}	52.0 ± 1.00^{c}	61.2 ± 0.01^{c}	43.0 ± 0.01^{c}

Values are triplicate determinations; means along columns having different superscripts differs significantly ($P < 0.05$).

Table 4: Mineral content of processed scent leaf

Methods	Iron mg/100g	Calcium mg/100g	Magnesium mg/100g	Potassium mg/100g	Sodium mg/100g
Fresh (Control)	20.6 ± 0.01^{a}	61.2 ± 0.10^{a}	83.5 ± 0.01^{a}	80.4 ± 0.01^{a}	80.02 ± 0.01^{a}
Blanched	16.9 ± 0.01^{b}	58.0 ± 1.00^{b}	43.6 ± 0.10^{b}	70.1 ± 0.01^{b}	41.4 ± 0.10^{b}
Sundried	20.6 ± 0.10^{a}	61.2 ± 0.01^{a}	83.5 ± 0.01^{a}	80.4 ± 0.01^{a}	80.0 ± 0.01^{a}
Squeeze washing	15.0 ± 1.00^{c}	53.0 ± 1.00^{c}	24.6 ± 0.10^{c}	52.1 ± 0.01^{c}	40.0 ± 1.00^{c}

Values are triplicate determinations; means along columns having different superscripts differs significantly ($P < 0.05$).

Table 5: Mineral content of processed bitter leaf

Methods	Iron mg/100g	Calcium mg/100g	Magnesium mg/100g	Potassium mg/100g	Sodium mg/100g

Fresh (Control)	31.8 ± 0.10[a]	60.3 ± 0.10[a]	271.1 ± 0.01[a]	129.2 ±0.01[a]	40.5 ± 0.01[a]
Blanched	28.0 ± 1.00[b]	58.4 ± 0.01[b]	54.0 ± 1.00[b]	51.4 ± 0.10[b]	38.1 ± 0.01[b]
Sundried	31.6 ± 0.10[a]	60.3 ± 0.01[a]	271.1 ± 0.01[a]	129.2 ±0.01[a]	40.5 ± 0.01[a]
Squeeze washing	27.5 ± 0.10[c]	54.0 ± 1.00[c]	21.8 ± 0.10[c]	42.6 ± 0.10[c]	35.1 ± 0.10[c]

Values are triplicate determinations; means along columns having different superscripts differs significantly ($P < 0.05$).

Conclusion

Sun drying of vegetables had little effect on the ascorbic acid content of the four types of vegetables when compared to blanching and squeeze washing. The mineral contents of the vegetables were not destroyed by sun but other domestic methods had effect on the mineral contents. Sun drying however, was the best method for preserving the nutrients.

Recommendation

If vegetables are not obtained in their fresh state, they can be consumed in their sun dried state since some of the essential nutrients are preserved by this method. Though some nutrients were lost during processing, but sun drying still had the highest value of ascorbic acid and minerals. It is therefore recommended that future research work should be directed towards the evaluation of sun drying on the sensory properties of vegetables.

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