EXCELLENT PUBLISHERS

International Journal of Current Research in Biosciences and Plant Biology

ISSN: 2349-8080 Volume 2 Number 5 (May-2015) pp. 101-107

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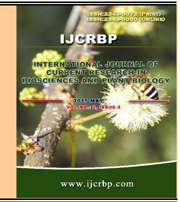

Original Research Article

Effect of Traditional Processing Methods on the Nutrients and Phytochemical Contents in *Lasianthera africana* Leaf Residue

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Abstract

Lasianthera africana leaves ("afia" variety) were cut (2mm width), shared into four equal portions of 1kg each and subjected to different debittering treatments. The treatments were blending in water (1:3w/v), blanching (100°C for 3 min) and blending in water (1:3w/v), blending in 0.50% solution of unripe plantain peel ash (1:3w/v) and blanching (100°C for 3 min) and blending in 0.50% solution of unripe plantain peel ash (1:3w/v). Each of the samples was sieved and residue dried at 50°C for 36 h. The effects of the treatments on the nutrients and phytochemical contents in the leaf residues were determined. Results showed that all the residues had lower protein, minerals, vitamins and phytochemical compounds than the raw leaf. Residues from the unblanched samples that were blended either in water or 0.50% ash solution retained higher protein, minerals, vitamins and phytochemicals than residues from the blanched and blended samples. Residue from the ash solution blanched and blended sample had higher protein, crude fibre and minerals but lower levels of vitamins and phytochemicals than residue from the hot water blanched and blended sample. The losses notwithstanding, the leaf residues still contained appreciable levels of nutrients and health protecting phytochemicals and low levels of anti-nutrients.

Keywords

Blanching
Blending
Lasianthera africana
Leaf residue
Nutrients
Phytochemicals

Introduction

Green leafy vegetables occupy an important place among the food crops as they provide adequate amount of many minerals and vitamins for humans. They are rich sources of carotene, ascorbic acid, riboflavin, folic acid and minerals like calcium, potassium, magnesium, sodium, iron and phosphorus (Fasuyi, 2006). They are also high in dietary fibre which helps in digestion and prevention of colon cancer (Saldanha, 1995). In addition, they contain anti-nutrients such as oxalate and phytic acid which reduce the bioavailability of some essential minerals (Grosvernor and Smolin, 2002; Akindahunsi and Salawu, 2005).

Green leafy vegetables also contain health promoting phytochemicals such as alkaloid, flavonoids, saponin and tannins and are associated with the reduction in the risk of cancer and other degenerative diseases (Levander, 1990; Okwu, 2005). According to Aletor and Adeogun (1995), some anti-nutritional phytochemicals such as tannin and phytate exhibit protective effect, thus making them to serve a dual purpose of reducing some essential nutrients and protecting the body against a number of biochemical, physiological and metabolic disorders.

Lasianthera africana is one of the commonly consumed green leafy vegetables by the Efik and Ibibio ethnic groups of Nigeria (Williams et al., 2009). The plant is called "editan" in Efik and Ibibio local dialects of Nigeria. It is a perennial glabrous shrub that reaches a height of 61 – 136cm (Hutchison and Dalziel, 1973). It belongs to the family lcacinaceae. Available four varieties distinguished by their taste, leaf colour and ecological distribution are "afia", "obubit", "idim" and "akai". The leaves of all ethno-varieties have been used since pre-historic time for preparing soup and in many traditional concoctions for the treatment of various ailments like constipation and general stomach ach (Sofowora, 1989). Ebana et al. (1996) reported that the leaves of *Lasianthera africana* are rich in chemical compounds of nutritional and medicinal importance.

One unique characteristic of *Lasianthera africana* leaf is that it has bitter taste that requires debittering prior to culinary use. Traditionally, the leaf is usually debittered by squeeze washing with water or treatment with aqueous extract from unripe plantain peel ash. Debittering helps to enhance palatability and acceptability of the soup prepared with the leaf. Following debittering, the extract obtained is usually discarded while the leaf residue is used for soup preparation. It is anticipated that valuable constituents of nutritional and therapeutic importance are lost during the debittering process. This study was therefore designed to assess the level of nutrients and phytochemicals retained in the leaf residue following some debittering treatments.

Materials and methods

Twigs of *Lasianthera africana* (white variety) were harvested from a garden at Aka Offot in Uyo Local Government Area of Akwa Ibom State, Nigeria and authenticated at the Taxonomy Unit of the Department of Botany and Ecological Science, University of Uyo, Nigeria. The leaves were destalked, washed in potable water, spread under shade to air dry and cut (2mm width). The cut leaf was shared into four equal portions of 1kg each and subjected to different processing treatments. The first portion was blended with water (1:3w/v) using Kenwood bender (Kenwood Ltd, Havant, UK) and filtered through 425 micrometer pore size sieve to obtain extract and residue (R_1). The secondary portion was blanched in water (1:3 w/v) at 100^{o}C for 3 minutes, cooled, blended and filtered through 425 micrometer pore size sieve to obtain extract and residue (R_2). The third portion was blended with 0.50% solution of unripe plantain peel ash (1:3 w/v) and filtered through 425 micrometer pore size sieve to obtain extract and residue (R_3). The fourth portion was blanched in 0.50% solution of unripe plantain peel ash (1:3 w/v) at 100^{o}C for 3 minutes, cooled, blended and filtered through 425 micrometer pore size sieve to obtain extract and residue (R_4). The residues (R_1, R_2, R_3, and R_4) were oven dried at 50^{o}C for 36 hours in a conventional air oven (Model P.P.22US, Genlab, England), milled, packaged in plastic containers, labeled and stored at 4^{o}C for analysis.

Methods of analysis

Moisture, crude protein, fat, ash and crude fibre were determined by AOAC (2000) methods. Carbohydrate was calculated by difference (Ihekoronye and Ngoddy, 1985). Minerals (K, Na, Ca, Mg, Zn, Fe and P) were determined using atomic absorption spectrophotometer (UNICAM, Model 939, UK) as described in AOAC (2000). Ascorbic acid, beta-carotene, thiamine and riboflavin were determined by AOAC (2000) methods. Alkaloid and flavonoid were determined using the methods of Harborne (1973). Saponin, tannin, hydrogen cyanide (HCN) and oxalic acid were determined by the methods described in AOAC (2000). Phytate determination was by Oberleas (1973) method and trypsin inhibitor by Arnfield et al. (1985) method.

Statistical analysis

Data obtained were subjected to one way Analysis of Variance (ANOVA) using SPSS version 18 statistical package (SPSS, Inc, USA) to determine variation between treatments. Means of data generated were separated using Duncan Multiple Range Test (DMRT). Results were expressed as means ± SD (standard deviation) of triplicate determinations. Significant variation was accepted at $p<0.05$.

Results

Effect of treatments on proximate composition

Data in Table 1 shows the effect of processing treatments on the proximate composition of dried *Lasianthera africana* leaf residues. Residues from unblanched leaves blended with water (R_1) and with 0.50% solution of unripe plantain peel ash (R_3) had significantly ($p<0.05$) higher protein and ash contents and non-significantly ($p>0.05$) higher fat content than residues from the blanched and blended samples (R_2 and R_4). Residue from the sample that was blanched and blended in 0.50% ash solution (R_4) had significantly ($p<0.05$) higher protein and ash contents than residue from hot water blanched and blended sample (R_2). Residue from ash solution blanched and blended sample (R_4) had the highest fibre content (19.86±0.45%) while residue from unblanched leaf blended in water (R_1) had the least value (17.02±0.09%).

Table 1. Effect of processing treatments on the proximate composition of dried *Lasianthera africana* leaf residue (% dry matter).

Parameters	Samples			
	R_1	R_2	R_3	R_4
Crude protein	19.00^{a} ±0.04	17.81^{c}±0.01	19.20^{a}±0.06	18.55^{b}0.07
Fat	4.58^{a}±0.02	4.47^{a}±0.06	4.55^{a}±0.00	4.45^{a}±0.03
Ash	13.76^{b}±0.03	11.14^{d}±0.01	13.97^{a}±0.03	12.94^{c}±0.04
Crude fibre	17.02^{b}±0.09	19.34^{a}±0.28	17.21^{b}±0.06	19.86^{a}±0.45
Carbohydrate	45.65^{b}±0.16	47.24^{a}±0.06	45.07^{c}±0.09	44.20^{d}±0.12

Values are means ± SD of triplicate determinations. Means on the same row with different superscripts are significantly different at p<0.05.
R_1 = Residue from unblanched leaf blended with water
R_2 = Residue from hot water blanched and blended leaf
R_3 = Residue from unblanched leaf blended with 0.50% ash solution
R_4 = Residue from 0.50% ash solution blanched and blended leaf

Table 2. Effect of processing treatments on the mineral content of dried *Lasianthera africana* leaf residue (mg/100g).

Minerals	Samples			
	R_1	R_2	R_3	R_4
K	70.35^{a}±0.52 (89.07)	61.28^{c}±0.51 (77.59)	71.81^{a}±0.65 (90.92)	64.73^{b}±0.45 (81.96)
Na	66.01^{b}±0.41 (87.21)	54.34^{d}±0.66 (69.15)	68.11^{a}±0.45 (89.99)	55.91^{c}±0.42 (73.87)
Ca	173.75^{b}±0.83 (91.33)	154.51^{d}±0.58 (81.21)	178.02^{a}±0.72 (93.57)	161.65^{c}±0.58 (84.96)
Mg	12.94^{a}±0.48 (88.15)	10.78^{b}±0.41 (73.43)	13.01^{a}±0.01 (88.62)	11.85^{a}±0.38 (80.72)
Zn	5.03^{a}±0.07 (84.54)	4.82^{a}±0.35 (81.01)	5.11^{a}±0.15 (85.88)	5.01^{a}±0.09 (84.20)
Fe	3.90^{a}±0.69 (98.49)	3.14^{a}±0.17 (79.29)	3.93^{a}±0.47 (99.24)	3.37^{a}±0.39 (85.10)
P	15.62^{b}±0.19 (87.80)	13.40^{c}±0.17 (75.32)	16.95^{a}±0.31 (95.28)	14.83^{b}±0.17 (83.36

Values are means ± SD of triplicate determinations. Means on the same row with different superscripts are significantly different at $p<0.05$. Values in parenthesis indicate percentage mineral retention.
R_1 = Residue from unblanched leaf blended with water
R_2 = Residue from hot water blanched and blended leaf
R_3 = Residue from unblanched leaf blended with 0.50% ash solution
R_4 = Residue from 0.50% ash solution blanched and blended leaf

Effect of treatments on minerals

The effect of the processing treatments on the mineral content in *Lasianthera africana* leaf residues is presented in Table 2. Residues obtained from unblanched leaves that were blended in water (R_1) and in 0.50% solution of unripe plantain peel ash (R_3) had higher mineral contents than residues from the blanched and blended leaves (R_2 and R_4). Residue from sample that was blanched and blended in 0.50% ash solution (R_4) had higher mineral elements than residue from hot water blanched and blended sample (R_3).

Effect of treatments on vitamins

Table 3 presents the effect of processing treatments on the vitamin contents in the leaf residues. Residue obtained from unblanched blended leaves (R_1 and R_3) had higher ascorbic acid, beta-carotene, riboflavin and thiamine contents than residues from the blanched and blended leaves (R_2 and R_4). Residues from unblanched leaves blended in water (R_1) had the highest vitamin content while residue from 0.50% ash solution blanched and blended leaves (R_4) had the least values for all the vitamins.

Table 3. Effect of processing treatments on the vitamin content of dried *Lasianthera africana* leaf residue (mg/100g).

Parameters	Samples			
	R_1	R_2	R_3	R_4
Ascorbic acid	$70.60^a \pm 0.42$ (64.39)	$47.25^c \pm 0.07$ (43.10)	$67.01^b \pm 0.08$ (61.12)	$40.90^d \pm 0.14$ (37.30)
Beta-carotene	$1.44^a \pm 0.04$ (50.00)	$1.41^a \pm 0.03$ (49.31)	$1.42^a \pm 0.00$ (49.65)	$1.40^a \pm 0.03$ (48.95)
Riboflavin	$0.20^a \pm 0.03$ (90.91)	$0.16^a \pm 0.06$ (72.73)	$0.18^a \pm 0.04$ (81.82)	$0.10^a \pm 0.00$ (45.46)
Thiamine	$0.84^a \pm 0.04$ (83.17)	$0.49^b \pm 0.03$ (48.51)	$0.73^a \pm 0.04$ (72.28)	$0.41^b \pm 0.01$ (40.51)

Values are means ± SD of triplicate determinations. Means on the same row with different superscripts are significantly different at $p<0.05$. Values in parenthesis indicate percentage mineral retention.
R_1 = Residue from unblanched leaf blended with water
R_2 = Residue from hot water blanched and blended leaf
R_3 = Residue from unblanched leaf blended with 0.50% ash solution
R_4 = Residue from 0.50% ash solution blanched and blended leaf

Table 4. Effect of processing treatments on the phytochemical content of dried *Lasianthera africana* leaf residue (mg/100g).

Minerals	Samples			
	R_1	R_2	R_3	R_4
Alkaloid (g/100g)	$2.23^a \pm 0.04$ (83.52)	$1.42^b \pm 0.03$ (53.18)	$2.19^a \pm 0.06$ (82.02)	$1.01^c \pm 0.01$ (37.83)
Flavonoid (g/100g)	$0.25^a \pm 0.03$ (78.13)	$0.18^b \pm 0.01$ (56.25)	$0.24^a \pm 0.08$ (75.00)	$0.13^b \pm 0.03$ (40.63)
Saponin (g/100g)	$2.87^a \pm 0.06$ (92.88)	$2.60^b \pm 0.00$ (84.14)	$2.74^b \pm 0.07$ (88.67)	$2.28^c \pm 0.04$ (73.79)
Tannins (g/100g)	$0.26^a \pm 0.03$ (92.86)	$0.22^a \pm 0.03$ (78.57)	$0.25^a \pm 0.01$ (89.29)	$0.17^a \pm 0.05$ (60.71)
HCN (mg/100g)	$1.01^a \pm 0.04$ (46.76)	$0.69^b \pm 0.01$ (31.94)	$0.91^a \pm 0.06$ (42.13)	$0.34^c \pm 0.03$ (15.74)
Phytate (mg/100g)	$28.07^a \pm 0.05$ (83.89)	$19.52^c \pm 0.03$ (58.34)	$26.30^b \pm 0.00$ (78.60)	$12.41^d \pm 0.04$ (37.09)
Oxalate (mg/100g)	$7.64^a \pm 0.01$ (80.08)	$3.80^c \pm 0.07$ (39.83)	$7.01^b \pm 0.03$ (73.48)	$3.01^d \pm 0.06$ (31.55)
Trypsin inhibitor (TUI/mg)	$1.57^a \pm 0.04$ (90.76)	$0.87^b \pm 0.06$ (50.29)	$1.50^a \pm 0.04$ (86.71)	$0.62^c \pm 0.03$ (35.84)

Values are means ± SD of triplicate determinations. Means on the same row with different superscripts are significantly different at $p<0.05$. Values in parenthesis indicate percentage mineral retention.
R_1 = Residue from unblanched leaf blended with water
R_2 = Residue from hot water blanched and blended leaf
R_3 = Residue from unblanched leaf blended with 0.50% ash solution
R_4 = Residue from 0.50% ash solution blanched and blended leaf

Effect of treatment on phytochemicals

Table 4 shows the effect of processing treatments on the phytochemical content in the leaf residues. Residues prepared from unblanched blended leaves (R_1 and R_3) had significantly (p<0.05) higher contents of alkaloid, flavonoid, saponin, HCN, phytate, oxalate and trypsin inhibitor and non-significantly (p>0.05) higher tannins than their values in the residues from the blanched and blended samples (R_2 and R_4). Residue from 0.50% ash solution (R_4) had significantly (p<0.05) lower alkaloid, saponin, HCN, phytate, oxalate and trypsin inhibitor and non-significantly (p>0.05) lower flavonoid and tannins than the residues from hot water blanched and blended leaves (R_2).

Discussion

On dry matter basis,, the protein, fat, ash, crude fibre and carbohydrate contents of raw *Lasianthera africana* leaf (unprocessed) were 19.60±0.04, 4.70±0.00, 14.16±0.06, 16.82±0.29 and 44.72±0.11%, respectively. Result of proximate composition as presented in Table 1 shows that all the residues had lower contents of protein, fat and ash relative to the values found in the raw leaf. The result indicates losses of these constituents as a result of processing treatments. The higher levels of protein, fat and ash in the residues from the unblanched blended samples (R_1 and R_3) relative to the blanched and blended samples (R_2 and R_4) suggests higher losses of these constituents in the blanched and blended samples than in the unblanched blended samples. Lower levels of protein, fat and ash in vegetables due to blanching had been reported by Mepba et al. (2007), Nkafamiya et al. (2010) and Sobowale et al. (2010). The significantly (p<0.05) higher protein and ash contents in the residue from the ash solution blanched and blended sample (R_4) relative to residue from hot water blanched and blended sample (R_3) suggests that the ash solution caused decreased leaching of protein and minerals into the solution. Some metal ions present in the unripe plantain peel ash used for preparing the solution might have formed complexes with the leaf protein and reduce its solubility. Meyer (1978) listed copper, nickel and iron as examples of metal ions which can form complexes with protein. The minerals in the solution of unripe plantain peel ash might have affected the concentration gradient thereby leading to less leaching of the minerals in the samples that were treated with ash solution relative to samples treated with water. The higher fibre content in the residues than in the raw leaf might be due to concentration effect as soluble constituents were leached out of the leaf. High fibre consumption has been reported to modify glycaemic response (Wildman and Medeiros, 1999), decrease incidence of heart disease, various types of cancer and diverticulosis (Jalili et al., 2000). The high fibre content of *Lasianthera africana* leaf residue suggests that it may be employed in the management of diseases such as obesity, diabetes and gastrointestinal disorders (Saldanha, 1995).

The K, Na, Ca, Mg. Zn, Fe and P of the raw *Lasianthera africana* leaf (unprocessed) were 78.98±0.75, 75.69±0.95, 190.25±0.44, 14.68±0.74, 5.95±0.52, 3.96±0.55 and 17.79±0.81mg/100g, respectively. Application of different processing treatments led to varying reductions of all the mineral elements in the residues as evident in their values on Table 2. This could be due to leaching of part of these elements into the water or ash solution used for processing the leaf. Some authors had earlier reported on lower levels of minerals in vegetables that were blanched (Ejoh et al., 2007; Mepba et al., 2007; Sobowale et al., 2010; Musa and Ogbadoyi, 2012). Higher levels of minerals in the residues from the unblanched blended samples (R_1 and R_3) could be due to less leaching relative to the residues from the blanched and blended samples (R_2 and R_4). The higher levels of minerals in the residue from ash solution blanched and blended sample (R_4) relative to hot water blanched and blended sample (R_2) is in conformity with the report by Ejoh et al. (2007) that leafy vegetables blanched in 2.5% and 5.0% "kanwa" exhibited lower mineral losses than hot water blanched samples. This result shows that solution of unripe plantain peel ash not only debittered the leaf, but also helped in mineral retention in the leaf residue that is usually used for soup preparation while the extract is discarded. The higher retention of minerals in the residues is significant because minerals in the diet are needed for the regulation of body processes, growth and replacement of tissues (Ihekoronye and Ngoddy, 1985).

The ascorbic acid, beta-carotene, riboflavin and thiamine contents of raw *Lasianthera africana* leaf (Unprocessed) were 109.64±0.08, 2.86±0.04, 0.22±0.03 and 1.01±0.06mg/100g dry matter, respectively. The lower values of ascorbic acid, riboflavin and thiamine in the residues prepared from the unblanched and blanched blended samples (Table 3) relative to raw leaf could be attributed to leaching and thermal destruction (Ihekoronye and Ngoddy, 1985; Jacob, 1999; Grosvernor and Smolin, 2002) while lower level of beta-carotene could be attributed to possible destruction by heat and oxidation reaction (Meyer, 1978; McDowell, 1989; Roche, 1990). Higher levels of vitamins in the residues from the unbalanced blended leaves relative to the residues from the blanched blended samples is in conformity with the reports by Mepba et al. (2007), Sobowale et al. (2010), Nkafamiya et al. (2010), Musa and Ogbadoyi (2012) that hot water blanched leafy vegetables had lower vitamins than the unblanched counterparts. The lower levels of ascorbic acid, riboflavin and thiamine in the residue from ash solution blanched and blended sample (R_4) relative to residue from hot water blanched and blended sample (R_2) could be due to the fact that they are sensitive to heat, oxygen and alkaline condition (Ihekoronye and Ngoddy, 1985; Grosvernor and Smolin, 2002).

The alkaloids, flavonoids, saponin, tannins, HCN, phytate, oxalate and trypsin inhibitor content in raw *Lasianthera africana* leaf (unprocessed) were 2.67±0.33g/100g, 0.32±0.03g/100g, 3.09±0.04g/100g, 0.28±0.01g/100g, 2.16±0.08mg/100g, 33.46±0.05 mg/100g, 9.54±0.06mg/100g and 1.73±0.04TUI/mg dry matter basis, respectively. Application of different debittering treatments led to varying reductions in all the phytochemicals as evident by their lower values in the residues prepared from the leaf (Table 4) relative to their values in the raw leaf. This could be attributed to the leaching of these compounds into the treatment solutions.

The higher level of phytochemicals in the residues prepared from the unblanched and blended leaves (R_1 and R_3) relative to the contents in residues from the blanched and blended samples (R_2 and R_4) agrees with the report by Nkafamiya et al. (2010) that non-conventional vegetables blanched in hot water contained lower levels of alkaloid, HCN, tannin, oxalate and phytate than unblanched samples. Other authors had similarly reported on lower phytochemical contents in hot water blanched vegetables than in unblanched samples (Onyeka and Nwambekwe, 2007; Onyeka and Nwanjo, 2010, Musa and Ogbadoyi, 2012). The lower levels of phytochemicals in the residue from ash solution blanched and blended sample relative to residue from hot water blanched and blended sample is in agreement with the report of Adeboye and Babajide (2007) that vegetables blanched in 1% solution of potash showed lower tannin, saponin, oxalate and phytate than hot water blanched vegetables. Reduction in levels of tannin, phytate, oxalate and trypsin inhibitor in this study is significant as this may lead to improvement of bioavailability of some essential nutrients in the residues. However, steps should be taken to curtail losses of alkaloid, flavonoid and saponin during debittering processes because of their health promoting and protecting properties.

Conclusion

The results of the study showed that processing treatments aimed at debittering *Lasianthera africana* leaves led to varying losses of nutrients and non-nutrient phytochemicals as evident in their lower levels in the leaf residues. The losses notwithstanding, the leaf residues still contained appreciable levels of nutrients and beneficial phytochemicals and the levels of anti-nutrients were low and would not pose threat to health. High level of fibre and appreciable levels of nutrients and health protecting phytochemicals in the residues suggests that *Lasianthera africana* leaf residue could be useful in the preparation of functional foods and management of some chronic diseases.

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