

Full Length Research Paper

Effect of concentration of debittering agent on the mineral, vitamin and phytochemical contents of *Lasianthera africana* leafy vegetable

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White variety of *Lasianthera africana* leaves were blanched in hot water (control) and in different concentrations (0.25, 0.50, 0.75, 1.00 and 1.25%) of unripe plantain peel ash solution for 3 min at 100°C, cooled, drained, oven dried (50°C) for 36 h. Then, raw leaf and all oven dried samples were analyzed for minerals, vitamins and phytochemicals. The raw leaf contained potassium (78.98±0.78 mg/100 g), calcium (190.25±0.44 mg/100 g), sodium (75.69±0.95 mg/100 g), magnesium (14.68±0.74 mg/100 g), iron (3.96±0.55 mg/100 g), zinc (5.95±0.52 mg/100 g), phosphorus (17.79±0.81 mg/100 g), ascorbic acid (109.64±0.08 mg/100 g), beta-carotene (2.86±0.04 mg/100 g), riboflavin (0.22±0.03 mg/100 g), thiamine (1.01±0.06 mg/100 g), alkaloids (2.67±0.33 g/100 g), flavonoids (0.32±0.03 g/100 g), saponins (3.09±0.04 g/100 g) and tannins (0.28±0.01 g/100 g). Blanching the leaves either in hot water or in different concentrations of unripe plantain peel ash solution led to varying losses of the minerals, vitamins and phytochemicals. Samples blanched in different levels of ash solution retained higher mineral content than hot water blanched samples. Percentage minerals retained increase with increased levels of ash in the blanching solution. Conversely, percentage retention of vitamins and phytochemicals decreased with increase in the levels of ash in the blanching solution. Ash concentration had no significant ($p>0.05$) effect on the levels of magnesium, zinc, beta-carotene and tannins retained in the blanched samples. For higher retention of vitamins and health benefiting phytochemicals, lower concentration of unripe plantain peel ash solution (0.50% to 0.75%) should be used to debitter *L. africana* leaf.

Keywords: *Lasianthera africana* leaf, debittering agent, minerals, vitamins, phytochemicals.

INTRODUCTION

Green leafy vegetables (wild or cultivated) are important items of diets in many Nigerian home as valuable sources of nutrients especially in rural areas where they contribute substantially to micronutrients which are

usually in short supply in most diets. Leaves in general are important sources of iron, potassium, calcium, magnesium, zinc, provitamin A, thiamine, riboflavin, ascorbic acid and folic acid (Uwaegbute, 1989; Fasuyi,

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2006). The dietary fibre in vegetables increases bulk and reduces the incidence of constipation and other related diseases (Jalili et al., 2000). Green leafy vegetables also contain bioactive compounds (phytochemicals) that have potentials in helping to reduce the risk of several deadly diseases in man (Sofowora, 1989; Williamson et al., 1997; Chung et al., 1998; Agte et al., 2000). Epidemiological studies have shown that consumption of vegetables can protect humans against oxidative damage by inhibiting or quenching free radicals and reactive oxygen species (Ames et al., 1981). High consumption of green leafy vegetables therefore plays vital role in human nutrition and health (Odukoya et al., 2007). Various traditional post harvest processing treatments such as soaking in hot water, boiling, squeeze washing with water, and hot water blanching may however lead to losses of some of the characteristics which initially made green leafy vegetables consumers delight (Adeboye and Babajide, 2007).

Lasianthera africana is one of the top six commonly consumed green leafy vegetables by Efik and Ibibio ethnic groups of Nigeria (Williams et al., 2009). It belongs to the family *Icacinaeae*. It is called "editan" in Efik and Ibibio local dialects of Nigeria. It is a perennial, glabrous, shrub that reaches a height of 61-136 cm (Hutchinson and Dalziel, 1973). Among the Ibibios, four local varieties distinguished by their taste, leaf colour and ecological distribution are known (Basse et al., 2006). The varieties are "afia" (white variety), "obubit" (black variety), "idim" (riverine variety) and "akai" (forest variety). The leaf has been used since pre-historic time for preparing soup and in many traditional concoctions for the treatment of various ailments (Sofowora, 1989). Ebana et al. (1996) reported that the leaves of *L. africana* are rich in chemical compounds of nutritional and medicinal importance. Preliminary screening of the leaves for phytochemicals indicated the presence of alkaloids, flavonoids, saponins, anthraquinones, glycosides and tannins in all the four ethnovarieties (Basse et al., 2006).

One unique characteristic of *L. africana* leaf is that it has bitter taste that requires debittering prior to culinary use. Debittering helps to enhance palatability and acceptability of the soup prepared with the leaf. Traditionally, the leaf is usually debittered by squeeze washing with water or treatment with aqueous extract from unripe plantain peel ash. The use of higher concentration of unripe plantain peel ash usually gives objectionable flavour to the soup prepared with the debittered leaf and may have negative effect on other beneficial constituents in the leaf. Presently, nothing is known about the effect of debittering treatments on the nutrients, especially the water soluble and heat sensitive nutrients as well as constituents of medicinal value. This study was therefore conducted to assess the effects of debittering *L. africana* leaves in different concentrations of unripe plantain peel ash solution on the nutrients and phytochemical content in the leaves.

MATERIALS AND METHODS

Sample collection and preparation

Twigs of *L. africana* (white variety) were harvested from a garden at Aka Offot in Uyo Local Government Area of Akwa Ibom State and authenticated at the taxonomy unit of the Department of Botany and Ecological Sciences, University of Uyo. The harvested twigs were destalked, washed in potable water, spread out under a shade to air dry. The leaves were cut (2 mm width), shared into six portions (1 kg each) and blanched in 0.00, 0.25, 0.50, 0.75, 1.00 and 1.25% solution of unripe plantain peel ash (1:3 w/v) at 100°C for 3 min. The blanched samples were drained immediately, cooled, dried (50°C) for 36 h in a conventional air oven (Model P.P. 22 US, Genlab, England), milled, packaged in plastic containers, labeled and stored in a refrigerator (4°C) for analyses. The contents of minerals, vitamins and phytochemicals in the cut raw leaf were also determined.

Mineral analysis

The mineral elements (K, Na, Ca, Mg, Zn, Fe and P) were determined using atomic absorption spectrophotometer (UNICAM, Model, 939, UK) as described by AOAC (2000).

Vitamin analysis

Ascorbic acid, beta-carotene, thiamine and riboflavin were determined using the method described by AOAC (2000).

Phytochemical analysis

Alkaloid and flavonoid were determined using the method of Harborne (1973). Saponin and tannin were determined by AOAC (2000) 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 mean \pm SD (standard deviation) of triplicate determinations. Significant variation was accepted at $p < 0.05$.

RESULTS AND DISCUSSION

Table 1 shows the mineral content of *L. africana* leaves blanched in hot water (control) and in different concentrations of unripe plantain peel ash solution. The raw leaves had higher mineral content than the blanched and dried samples. Hot water blanched and dried samples exhibited higher losses of minerals than ash solution blanched and dried samples.

The potassium content in the raw (unblanched) leaf was 78.98 ± 0.78 mg/100 g. The level of potassium in the hot water blanched and dried samples was 70.43 ± 0.10 mg/100 g, whereas the values for samples blanched in different concentrations of unripe plantain peel ash

Table 1. Effect of concentration (%) of unripe plantain peel ash blanching solution on the mineral content of *L. africana* leaf (mg/100 g).

Mineral	Ash concentration (%)					
	0.00	0.25	0.50	0.75	1.00	1.25
K	70.43 ^d ±0.14	72.20 ^c ±0.33	72.95 ^c ±0.31	73.92 ^b ±0.09	74.31 ^a ±0.14	74.88 ^a ±0.27
Na	61.09 ^c ±0.13	61.47 ^c ±0.21	62.35 ^b ±0.28	62.79 ^{ab} ±0.29	63.04 ^{ab} ±0.04	63.57 ^a ±0.06
Ca	177.91 ^d ±0.16	178.62 ^c ±0.16	179.00 ^c ±0.04	179.53 ^b ±0.16	179.82 ^{ab} ±0.08	180.06 ^a ±0.08
Mg	12.23 ^a ±0.17	12.24 ^a ±0.19	12.30 ^a ±0.14	12.35 ^a ±0.14	12.38 ^a ±0.07	12.42 ^a ±0.16
Zn	5.010 ^a ±0.13	5.14 ^a ±0.04	5.17 ^a ±0.03	5.18 ^a ±0.06	5.20 ^a ±0.03	5.21 ^a ±0.01
Fe	3.45 ^a ±0.44	3.49 ^a ±0.21	3.53 ^a ±0.08	3.56 ^a ±0.00	3.57 ^a ±0.13	3.61 ^a ±0.29
P	15.34 ^b ±0.19	15.93 ^b ±0.41	16.22 ^b ±0.39	16.79 ^a ±0.45	16.86 ^a ±0.23	17.01 ^a ±0.41

Values are means ± SD of triplicate determinations. Means on the same row with different superscripts are significantly different at $p < 0.05$.

solution ranged from 72.20±0.33 mg/100 g in 0.25% ash solution blanched and dried samples to 74.88±0.27 mg/100 g in 1.25% ash solution blanched and dried samples (Table 1). Significantly, $p < 0.05$ higher retention of potassium in ash solution blanched and dried samples relative to hot water blanched and dried samples could be due to differences in the soluble solute concentration of the blanching medium.

Ejoh et al. (2007) similarly reported that leafy vegetables blanched in 2.5 and 5.0% “kanwa” solution exhibited lower mineral losses than hot water blanched samples.

The sodium content in the raw leaf was 75.69±0.95 mg/100 g. The hot water blanched and dried samples had lower sodium content (61.09±0.14 mg/100 g). The ash solution blanched and dried samples had higher sodium content than hot water blanched and dried samples. The values for ash solutions blanched and dried samples ranged from 61.47±0.21 mg/100 g for sample blanched in 0.25% ash solution to 63.57±0.66 mg/100 g for samples blanched in 1.25% ash solution. This shows that sodium retention (%) increased with increase in ash concentration (Table 1).

The result suggests that the use of high concentration of unripe plantain peel ash to debitter *L. africana* leaves should not be encouraged as high sodium intake is an identified risk factor for the development of hypertension in susceptible individuals (Tobian, 1997; Campbell-Platt, 2009). Salt restriction and low salt diets have been shown to lower blood pressure in both normotensive and hypertensive subjects (Ebuehi et al., 2003).

Calcium was the most predominant mineral element in raw *L. africana* leaf (190.25±0.44 mg/100 g). The high calcium content in the leaf is significant because the cells need calcium and more than 99% of calcium in the body is used as a structural component of bones and teeth. This represents about 40% of all minerals present in the body (Grosvenor and Smolin, 2002). The blanched and dried samples had lower calcium content than the raw leaf. This could be due to leaching into the blanching medium. Samples blanched in ash solutions had signifi-

cantly ($p < 0.05$) higher calcium content than hot water blanched samples (Table 1). This could be due to differences in soluble solute concentration of the blanching medium. Percentage calcium retention increased with increase in the ash concentration (%) in the blanching medium ranging from 93.89% for samples blanched in 0.25% ash solution to 94.64% for samples blanched in 1.25% ash solution. Similar observation was made by Ejoh et al. (2007) who reported calcium content of 0.83±0.02 g/100 g, 1.04±0.11 g/100 g and 1.28±0.01 g/100 g for *Vernonia calvoana* blanched in hot water, 2.5% “kanwa” and 5.0% “kanwa” solutions, respectively.

The contents of magnesium, zinc, iron and phosphorus in the raw leaf were 14.68±0.74 mg/100 g, 5.95±0.52 mg/100 g, 3.96±0.55 mg/100 g and 17.79±0.81 mg/100 g, respectively. Their values in the blanched and dried samples were lower. This could be due to leaching of these minerals into the blanching medium. The hot water blanched and dried samples had lower content of these minerals than ash solutions blanched and dried samples. There were systematic increases in these minerals with increases in the concentration of ash in the blanching solutions. This could be due to possible contributions from the unripe plantain peel ash in the solutions used for blanching the leaves. Similar observation was reported by Ejoh et al. (2007) for *Vernonia calvoana* leaf blanched in hot water and in “kanwa” solutions.

Data on vitamin analysis (Table 2) indicate that there was inverse relationship between the increase in the concentrations of unripe plantain peel ash in the blanching solution and the level of vitamins retained in the blanched and dried samples. There were consistent reductions in the vitamins analyzed with increase in the concentration of ash in the solutions used for blanching the leaves.

The ascorbic acid content in the raw leaf was 109.64±0.08 mg/100 g. The human body cannot produce ascorbic acid, so it must be obtained entirely through one's diet. Hot water blanched and dried samples had the ascorbic acid content reduced to 65.12±0.14 mg/100 g.

Table 2. Effect of concentration (%) of blanching ash solutions on some vitamins in *L. africana* leaf (mg/100 g).

Ash concentration (%)	Ascorbic acid	Beta-carotene	Riboflavin	Thiamine
0.00	65.12 ^a ±0.14 (59.39)	1.89 ^a ±0.04 (66.08)	0.19 ^a ±0.03 (86.36)	0.61 ^a ±0.01 (60.40)
0.25	61.43 ^b ±0.04 (56.03)	1.87 ^a ±0.06 (65.39)	0.17 ^{ab} ±0.01 (77.27)	0.57 ^{ab} ±0.03 (56.44)
0.50	59.72 ^c ±0.17 (54.45)	1.86 ^a ±0.04 (65.04)	0.16 ^{ab} ±0.00 (72.73)	0.54 ^{ab} ±0.03 (53.47)
0.75	55.90 ^d ±0.09 (51.90)	1.86±0.02 (65.04)	0.14 ^{ab} ±0.03 (63.64)	0.52 ^{ab} ±0.05 (51.49)
1.00	55.03 ^e ±0.04 (50.19)	1.85±0.07 (64.69)	0.13 ^{ab} ±0.01 (59.09)	0.51 ^{ab} ±0.01 (50.50)
1.25	53.79 ^f ±0.04 (49.06)	1.85±0.00 (64.69)	0.11 ^b ±0.01 (50.50)	0.49 ^b ±0.04 (48.51)

Values are means ± SD of triplicate determinations. Mean on the same column with different superscripts are significantly different at $p < 0.05$. Values in parenthesis indicate percentage retention of vitamins.

This could be attributed to leaching, thermal decomposition and to a lesser extent, oxidation (Fellows, 2000).

Ascorbic acid contents of unripe plantain peel ash solution blanched and dried samples were significantly ($p < 0.05$) lower than the content in hot water blanched and dried samples (Table 2). The values for samples blanched in different concentrations of ash solution ranged from 53.79±0.04 mg/100 g for samples blanched in 1.25% ash solution to 61.43±0.94 mg/100 g for samples blanched in 0.25% ash solution. Ascorbic acid is not only soluble in water but is also the most heat labile of the vitamins (Grosvenor and Smolin, 2002; Bolari, 2006).

The lower levels of ascorbic acid in samples blanched in solutions of unripe plantain peel ash relative to hot water blanched samples could be due to the fact that the alkaline media predisposed the vitamin to decomposition which enhanced the level of losses. Ihekoronye and Ngoddy (1985) noted that when leafy vegetables are cooked with baking soda to retain the greenness, they lose much of their ascorbic acid. Grosvenor and Smolin (2002) also stated that the loss of ascorbic acid is accelerated by low acid conditions.

The beta-carotene content in the raw leaf was 2.86±0.04 mg/100 g. Hot water blanched and dried samples had lower content of beta-carotene (1.89±0.06 mg/100 g) than the value in the raw leaf. This reduction in beta-carotene could be attributed to possible destruction by heat and oxidation reaction. According to Meyer (1978), McDowell (1989) and Roche (1990), beta-carotene is especially prone to oxidative destruction in the presence of heat, light, oxygen and metal ions. Blanching the leaves in various concentrations of ash solution did not have any significant ($p > 0.05$) effect on the beta-carotene content of the blanched samples

(Table 2). There were however, slight reductions in beta-carotene of the blanched leaves with increase in the concentration of ash in the solution ranging from 1.87±0.06 mg/100 g for samples blanched in 0.25% ash solution to 1.85±0.00 mg/100 g for samples blanched in 1.25% ash solution.

The non-significant difference ($p > 0.05$) in the beta-carotene content of samples blanched in different concentrations of ash solution and hot water confirms the fact that beta-carotene is not affected by changes in pH (Meyer, 1978). Ihekoronye and Ngoddy (1985) also stated that dilute acid, bases and water have little effect on carotenoids.

The riboflavin content in the raw leaf was 0.22±0.03 mg/100 g. Samples blanched in either hot water or various concentrations of unripe plantain peel ash solution and dried had lower riboflavin contents than the value in raw leaf. Sample blanched in hot water had higher riboflavin content (0.19±0.03 mg/100 g) than samples that were blanched in different concentrations of ash solution whose values ranged from 0.17±0.01 mg/100 g for samples blanched in 0.25% ash solution to 0.11±0.01 mg/100 g for samples blanched in 1.25% ash solution.

The observed higher retention of riboflavin in hot water blanched and dried samples (86.36%) when compared with ash solutions blanched and dried samples (77.22 – 59.00%) could be due to the fact that riboflavin is more soluble in alkaline solution than in water (Jacob, 1999), and is destroyed under alkaline condition, light and excessive heat (Fellows, 2000).

The thiamine content in the raw leaf was 1.01±0.06 mg/100 g. Hot water blanched and dried samples and ash solutions blanched and dried samples had lower thiamine content than the raw leaf. Thiamine is known to

Table 3. Effect of concentration (%) of blanching ash solutions on the phytochemical content in *L. africana* leaf (g/100 g).

Ash concentration (%)	Alkaloid	Flavonoid	Saponins	Tannins
0.00	2.14 ^a ±0.06 (19.85)	0.21 ^a ±0.01 (34.37)	2.98 ^a ±0.06 (3.56)	0.24 ^a ±0.04 (14.29)
0.25	1.96 ^{ab} ±0.04 (26.59)	0.16 ^{ab} ±0.03 (50.00)	2.33 ^b ±0.04 (24.60)	0.19 ^a ±0.00 (32.14)
0.50	1.84 ^{bc} ±0.06 (31.08)	0.15 ^{bc} ±0.00 (53.12)	2.31 ^b ±0.03 (25.24)	0.19 ^a ±0.01 (32.14)
0.75	1.76 ^{bc} ±0.07 (34.09)	0.13 ^{bc} ±0.01 (59.37)	2.27 ^b ±0.04 (26.54)	0.16 ^a ±0.04 (42.86)
1.00	1.69 ^{cd} ±0.56 (36.70)	0.10 ^{cd} ±0.00 (68.75)	2.25 ^b ±0.07 (27.18)	0.15 ^a ±0.01 (46.43)
1.25	1.60 ^{cd} ±0.00 (40.07)	0.09 ^{cd} ±0.01 (71.87)	2.20 ^b ±0.00 (28.80)	0.14 ^a ±0.03 (50.00)

Values are means ± SD of triplicate determinations. Mean on the same column with different superscripts are significantly different at $p < 0.05$ values in parenthesis indicate percentage reduction of phytochemicals.

decompose readily in alkaline and neutral solutions if heated (Jacob, 1999; Fellows, 2000; Grosvenor and Smolin, 2002). Hot water blanched and dried samples had higher thiamine content (0.61 ± 0.03 mg/100 g) than ash solutions blanched and dried samples whose values ranged from 0.57 ± 0.03 mg/100 g for samples blanched in 0.25% ash solution to 0.49 ± 0.04 mg/100 g for samples blanched in 1.25% ash solution (Table 2). The value for hot water blanched sample was only significantly ($p < 0.05$) higher than that of 1.25% ash solution blanched sample, whereas the rest of the values were not significantly ($p > 0.05$) different from each other.

The contents of alkaloid, flavonoid, saponin and tannins in the raw *L. africana* leaf were 2.67 ± 0.33 g/100 g, 0.32 ± 0.03 g/100 g, 3.09 ± 0.04 g/100 g and 0.28 ± 0.01 g/100 g, respectively. The presence of these phytochemicals in the leaf is significant because of their health protecting and promotion potentials. Blanching the leaves in either hot water or different concentrations of unripe plantain peel ash solution had negative effect on these phytochemicals as their values in the blanched and dried samples were lower than those in the raw leaf (Table 3). This could be due to leaching of these phytochemicals into the blanching media. Similar reduction of phytochemical constituents in vegetables as a result of blanching had been reported by Adeboye and Babajide (2007), Onyeka et al. (2010) and Nkafamiya et al. (2010).

The unripe plantain peel ash solutions blanched and dried samples had lower alkaloids, flavonoids, saponins and tannins than hot water blanched and dried samples. This result corresponded with the report of Adeboye and Babajide (2007) who reported that leafy vegetables blanched in hot water contained higher phytochemicals than those blanched in 1% potash solution for five minutes. The reduction of alkaloids, flavonoids, saponins

and tannins consistently increased with increase in the level of unripe plantain peel ash in the blanching solution. Percentage reduction of alkaloids, flavonoids, saponins and tannins ranged from 40.07, 71.87, 28.80 and 50.00% for 1.25% ash solution blanched and dried samples to 26.59, 50.00, 24.60 and 32.14% for 0.25% ash solution blanched and dried samples.

It is important to minimize losses of these phytochemicals as they are implicated with various health benefits. Alkaloids and flavonoids for instance are listed among the plant chemical constituents responsible for hypoglycemic effect in humans (Akah et al., 2002, Li et al., 2004). Flavonoids have strong anti-cancer properties and protection against cardiovascular disease by inhibiting the oxidation of low density lipoprotein (Grosvenor and Smolin, 2002, Okwu, 2004).

Saponin in food decreases the cholesterol absorption from the gastrointestinal tract and therefore lower blood cholesterol, a major risk factor for cardiovascular disease (Topping et al., 1980; Grosvenor and Smolin, 2002). Tannins on the other hand can form complexes with protein and iron thereby inhibiting their bioavailability (Grosvenor and Smolin, 2002). Besides this deleterious effect of tannins, they exhibit antioxidant properties and may inhibit activation of carcinogens and cancer promotion (Grosvenor and Smolin, 2002). This implies that tannin can serve dual purpose of reducing some essential nutrients and protecting the body against cancer.

Conclusion

In conclusion, debittering *L. africana* leaf in hot water and different concentrations of unripe plantain peel ash solution led to varying losses of minerals, vitamins and phytoche-

micals in the leaf. Mineral losses decreased with increase in the levels of ash concentration in the blanching solution. Conversely, losses of vitamins and phytochemicals increased with increase in the level of ash in the blanching solution. For higher retention of vitamins and health benefiting phytochemicals, lower ash concentration (0.50% to 0.75%) should be used for debittering the leaf.

Conflict of interests

The authors did not declare any conflict of interest.

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