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Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

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Effect of Some Post-Harvest Treatments on the Nutritional Properties of *Cnidoscolus acontifolus* Leaf

Ganiyu OBOH
Biochemistry Department, Federal University of Technology, P.M.B. 704, Akure, Nigeria
E-mail: goboh2001@yahoo.com

Abstract: *Cnidoscolus acontifolus* (Americana leaf) leaves are used as soup condiment in Nigeria either in the processed or unprocessed forms. This study aims at assessing the effect of some post-harvest treatment on the nutrient, antinutrient and antioxidant potentials of the leafy vegetable. In this study fresh leaves of *Cnidoscolus acontifolus* were subjected to different food processing method such as soaking, blanching, abrasion with or without salt. The proximate, antinutrient (phytate and cyanide), minerals (Ca, Fe, Mg, Na, K, Zn and Mn), Vitamin C and total phenol content were subsequently determined. The result of the study shows that the unprocessed *Cnidoscolus acontifolus* leaf had 7.8% protein, 1.6% fat, 2.4% crude fibre, 2.3% ash and 83.4% moisture content. The total phenol (0.7%), phytate (479.5 mg/100g), mineral and vitamin C (535.6mg/100g) content were generally high, while the cyanide content was low. However, the various conventional food processing techniques caused a significant decrease ($P<0.05$) in the protein, vitamin C, cyanide and phytate content. While it caused a significant increase ($P<0.05$) in the fat and total phenol content of *Cnidoscolus acontifolus* leaf. In conclusion, the leaf of *Cnidoscolus acontifolus* has a very high nutrient, antinutrient, mineral and antioxidant potential; however the various conventional post-harvest treatments will cause a significant decrease ($P<0.05$) in the nutrient and antinutrient content, and same time caused a significant decrease in the antioxidant potential.

Key words: *Cnidoscolus acontifolus,* processing, nutrient, antinutrient, antioxidant

Introduction

Vegetables play significant role in human nutrition, especially as a source of vitamins (C, A, B, 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, 48% of vitamin A; 27% of Vitamin B; 17% of thiamine and 15% of Niacin in the US diet. Vegetables also supply 16% of Mg, 19% of Fe and 9% of the per capital availability of protein in the US diet and their protein are of high quality as to their content of essential amino acids. Other important nutrients supplied by vegetables include Folic acid, riboflavin, Zn, Ca, K and P (Gockowski *et al.*, 2003; ECHO, 2003).

Vegetables contain compounds that are valuable antioxidant and protectants. The main protective action of vegetables has been attributed to the presence of antioxidants, especially antioxidant vitamins including the ascorbic acid, α-tocopherol and β-carotene. However, numerous studies have conclusively shown that the majority of the antioxidant activity may be from compound such as flavonoids, isoflavone, flavones, anthocyanin, catechin and isocatechin rather than Vitamin C, E and β-carotene (Amic *et al.*, 2003). Although almost all organisms possess antioxidant defense and repair systems that have evolved to protect them against oxidative damage, these systems are insufficient to protect them against oxidative damage entirely.

In Nigeria, unlike the Western Worlds where green leafy vegetables are usually consumed in their unprocessed forms, green leafy vegetables are usually subjected to various Post-harvest treatments such as blanching, soaking, abrasion with or without salt (Oboh *et al.*, 2005), in order to improve their palatability and to remove the bitter taste and some of the acids present in the vegetables. The various processing techniques had been reported to alter both the nutrient, antinutrient and antioxidant property of some commonly consumed plant foods in Nigeria (Oboh and Akindahunsi, 2004; Oboh *et al.*, 2005).

Cnidoscolus acontifolus (Americana) is a green leafy vegetable of dry region of the tropics. It is a plant that was introduced into Cuba and from there into Florida in South Florida. It is often found as rank shrub, but seldom appreciated for it's good value as a vegetable. *Cnidoscolus acontifolus* is a large, leafy shrub reaching a height of about 6.8 feet. It's somewhat resembles a vigorous hibiscus plant or the cassava plant. The dark green leaves are alternate, simple, stick surface. Each leaf is about 6.8 inches across and is borne on a long slender petiole (leaf stem). *Cnidoscolus acontifolus* (Americana) leaf is popularly used in soup preparation in its processed and unprocessed forms, however their is dearth of information with regard to the proximate, mineral, antinutrient and antioxidant potentials as typified with its total phenol and ascorbic acid content. This study therefore sought to determine the proximate,

Table 1: Proximate composition of *Cnidoscolus acontifolus* (Americana) leaves (% wet weight)

Sample	Moisture	Crude fibre	Ash	Protein	Fat
Unprocessed	83.4±0.2^{b}	2.4±0.2^{b}	2.3±0.1^{b}	7.8±0.2^{a}	1.6±0.1^{b}
Processed					
Blanching	86.5±0.4^{a}	2.9±0.4^{a}	1.4±0.2^{c}	6.9±0.3^{b}	1.8±0.3^{b}
Soaked	86.1±0.3^{a}	1.4±0.1^{c}	1.1±0.1^{c}	6.8±0.2^{b}	2.6±0.2^{a}
AWOS	81.1±0.2^{c}	2.9±0.3^{a}	1.0±0.1^{c}	5.2±0.3^{c}	2.7±0.4^{a}
AWS	86.0±0.2^{a}	2.7±0.2^{b}	4.1±0.2^{a}	4.0±0.2^{d}	1.9±0.1^{b}

Values represent means of triplicate. Values with the same alphabet along the same column are not significantly different (P>0.05)

mineral, antinutrient and antioxidant potential of the leaf, and to assess the effect of the commonly practiced food processing techniques namely blanching, soaking, abrasion with salt or without salt on those parameters.

Materials and Methods

Material: *Cnidoscolus acontifilous* leaves were collected from strategic market locations (farm stand) in Nigeria. The silver nitrate, orthophosphoric acid, HCl and Ferric cholride are products of BDH, UK, while the sodium hyrdoxide, sulphuric acid, nitric acid, potassium iodide are the products of Eagle Scientific. The water used in the analysis was glass distilled.

Sample preparation: *Cnidoscolus acontifilous* leaves were subjected to some conventional food processing techniques as reported by Akindahunsi and Oboh (1999). A portion (100g) of each of the sample was soaked in water for 24 hours, while another portion (100g) was blanched in boiling water for 5 minutes. 200g of each of the sample were divided into two portions, each of the sample was mechanically squeezed (Abrasion) with or without NaCl (5.0g) until the foaming of the vegetable stops. The remaining 100g serves as the control (unprocessed). Both the processed and unprocessed were subsequently analyzed.

Sample analysis: The nutrient composition (ash, fat, moisture and crude fibre) of the processed and unprocessed vegetables were determined using the standard AOAC (1990) method and the protein content was determined using the micro-Kjeldhal method (N x 6.25). The phytate content was determined by the method of Wheeler and Ferrel (1971) based on the ability of standard ferric chloride to precipitate phytate in dilute HCl extracts of the vegetables. The cyanide contents of the processed and unprocessed vegetables were determined by silver-nitrate titration procedure as described by De Bruijn (1971), briefly 4.0 g of vegetable samples were soaked for 24 hours in 40ml, 5.0M orthophosphoric acid, the filtrate was then distilled into 40ml of 0.25% NaOH, the distillate was made to 50ml volume with distilled water, and 20ml of the distillate was titrated against 0.01M silver nitrate, using 0.4ml, 5% KI as indicator. The Zn, Na, Mg, Fe, K, Mn and Ca contents were determined on aliquots of the solutions of the ash by established flame atomic absorption spectrophotometry procedures using a Perkin-Elmer atomic absorption spectrophotometer (model 372) (Perkin-Elmer, 1982). The vitamin C content of the vegetables were determined by AOAC (1990) method, briefly 5g of the sample was extracted by 100ml H_2O, and 10ml of the extract was mixed with 25ml of 20% glacial acetic acid and titrated against standardized 2, 6-dichloroindophenol (0.05g/ 100ml) solution. The total phenol content was determined by mixing 0.5ml aliquot (0.2g of the sample extracted by 20ml 70% Acetone) with equal volume of water, 0.5ml Folin-Cioalteu's reagent and 2.5ml of Sodium carbonate were subsequently added, and the absorbance was measured after 40 minutes at 725nm (Singleton *et al.*, 1999).

Analysis of data: The result of the three replicates were pooled and expressed as mean±standard error (S.E.). A one way analysis of variance (ANOVA) and the Least Significance Difference (LSD) were carried out (Zar, 1984). Significance was accepted at $P \leq 0.05$.

Results and Discussion

Vegetables play an important role in human diet they are important source of both digestible and indigestible carbohydrates. They are also important sources of minerals and certain vitamins especially vitamin A and C, they are responsible for more subtle feelings of daily well-being and for protection from long term degenerative diseases (Achinewhu, 1983; Oboh, 2005). The result of the nutrient, antinutrient and antioxidant potentials of *Cnidoscolus acontifolus* (Americana) leaf, commonly used in soup preparation and preparation of folk medicine for the management of anaemia in Nigeria and the effect of the various conventional food processing techniques on the parameters is highlighted as follows:

The result of the proximate analysis of *Cnidoscolus acontifolus* (Americana) leaf as shown in Table 1, revealed that the leaf has 7.8% protein. However the various conventional food processing technique cause a significant decrease (P<0.05) in the protein (4.0- 6.8%) content except in the leaves subjected to blanching (6.9%), where there was no significant decrease (P<0.05). It is worth noting that of all the processing

Table 2: Mineral content of *Cnidoscolus acontifolus* (Americana) leaves (ppm wet weight)

Sample	Mn	Fe	Mg	Na	Ca	K	Zn
Unprocessed	15.5±0.1[a]	72.8±0.3[a]	266.8±0.4[a]	325.5±0.5[b]	533.0±3.1[a]	386.2±3.0[a]	17.0±0.2[a]
Processed							
Blanching	6.4±0.1[d]	33.0±0.6[c]	167.0±0.3[d]	236.3±1.0[d]	178.3±2.0[d]	177.6±0.7[d]	5.4±0.5[b]
Soaked	14.6±0.2[b]	49.0±0.1[b]	236.3±0.2[b]	294.9±0.4[c]	319.5±0.6[b]	327.8±0.8[b]	16.9±0.3[a]
AWOS	10.7±0.1[c]	32.5±0.4[c]	185.0±0.2[c]	217.4±1.1[e]	201.3±0.4[c]	205.5±1.2[c]	7.0±0.4[b]
AWS	5.9±0.4[d]	22.3±0.4[d]	120.7±0.6[e]	340.5±0.6[a]	147.5±0.4[e]	142.8±1.0[e]	6.2±0.5[b]

Values represent means of triplicate. Values with the same alphabet along the same column are not significantly different (P>0.05)

techniques, abrasion with salt brought about the highest decrease in the protein content, the decrease in the nutrient content caused by the various treatment most especially abrasion with salt could be attributed to the fact that some nutrients were leached off by water when they were being mechanically squeezed (Oboh *et al*., 2005). The values for both the processed and unprocessed *Cnidoscolus acontifolus* (Americana) leaf were higher than the reported values for closely related edible leaves of *Solanum meloneana*, *Solanum aethiopicum* (4.8%), *Solanum lycospersicum* (2.8%) and *Solanum nigrum* (3.2%) (Leung *et al*., 1968) and *Solanum macrocarpon* (Oboh *et al*., 2005).

The higher protein content in the *Cnidoscolus acontifolus* (Americana) leaf could be as result of more and active nitrogen fixing bacteria giving rise to high nitrogen content, which could result in high amount of protein. In addition the various conventional food processing techniques brought about a significance increase (P<0.05) in the fat content of the leaf. The unprocessed leaf had a fat content of 1.6%, while the processed leaves had a fat content ranging from 1.8% for those subjected to blanching to 2.6% for soaked leaves.

The fat content of the unprocessed *Cnidoscolus acontifolus* (Americana) leaf is quite high when compared to that of *Solanum macrocarpon* leaf (Oboh *et al*., 2005), *Solanum lycospersicum* leaf (0.6%), *Solanum melanaema* (0.4%) and *S. anthiopum* leaf (0.3%) (Leung, 1968). Blanching of the leaves did not cause any significant change in the fat content of the leaf. The unprocessed leaf had 83.4% moisture content, while the various techniques caused a significant increase (P<0.05) in the moisture content except those subjected to abrasion without salt (81.1%). However, the moisture content of the processed (except abrasion without salt) leaves ranges from 86.0% for abrasion with salt to 86.5% for blanching. The change in crude fibre content were not consistent, however, there was a significant decrease in the ash content of the vegetables except those vegetables subjected to abrasion with salt, the general decrease in the ash content during processing could be as result of the fact that some of the inorganic salt might have leached off during processing (Akindahunsi and Oboh, 1999; Oboh *et al*., 2005), while the increase in the ash content in those *Cnidoscolus acontifolus* (Americana) leaf subjected to abrasion with salt could be as result of the fact that some of the Na ion in the salt could have been trapped in the vegetable during the abrasion (Oboh *et al*., 2005) .

The result of the mineral content is shown in Table 2, the result of the study revealed that Zn (17.0ppm), Mn (15.5ppm) and Fe (72.8ppm) content were low, while the Mg (266.8ppm), Na (325.5ppm), Ca (332.1ppm) and K (386.2ppm) were high. The minerals are within the same range with the values reported by Akindahunsi and Oboh (1999) and Oboh *et al*. (2005) for some commonly consumed green leafy vegetables in Nigeria. However, the various conventional food-processing techniques in Nigeria cause a significant decrease (P<0.05) in all the minerals analyzed except Na where those *Cnidoscolus acontifolus* (Americana) leaves subjected to abrasion with salt (347.5ppm) had higher Na content. This trend is in agreement with the trend in ash content, and this higher value could be as result of the salt used in the treatment that were trapped in the vegetables during processing.

Antinutrient (cyanide and phytate) content of *Cnidoscolus acontifolus* (Americana) leaves are shown in Table 3. Cyanide either in inorganic forms as in KCN or NaCN or organic forms as in cyanogenic glycosides is a potential inhibitor of cytochrome oxidase (terminal oxidase) of the electron transport chain (Aletor, 1993). There was a significant decrease (P<0.05) in the cyanide content of the processed *Cnidoscolus acontifolus* (Americana) leaves (1.1mg/kg) when compared to the unprocessed plant leaves (1.8mg/kg). Abrasion without salt caused the highest decrease in the cyanide content of the leaves (0.4%). This suggests that abrasion without salt is a very effective method of reducing cyanide in *Cnidoscolus acontifolus* (Americana) leaf. The cyanide content of the unprocessed leaf was higher than that of some other commonly consumed greenly vegetables in Nigerian such as *Telfairia occidentalis* (0.86 mg/kg), *Struchium sparganophora* leaf (1.35mg/kg) and *Vernonia amygdalina* leaf (1.1mg/kg) (Oboh unpublished data). However, *Cnidoscolus acontifolus* (Americana) leaves could be considered safe with regard to acute cyanide poisoning due to the fact that the cyanide levels were far below the detrimental levels of 30mg/kg reported by Oboh and Akindahunsi (2003).

Phytic acid though considered, as an antinutritional factor is a common storage form of phosphorus in seeds and in few tubers and fruits. The complexing of phytic acid with nutritionally essentials minerals are

Table 3: Antinutrient content of *Cnidoscolus acontifolus* (Americana) leaves (wet weight)

Sample	Phytate (mg/100g)	Cyanide (mg/kg)
Unprocessed	479.4±0.6[b]	1.8±0.2[a]
Processed		
Blanching	435.9±1.0[c]	0.5±0.1[c]
Soaked	310.3±1.2[d]	1.0±0.1[b]
AWOS	296.1±0.8[e]	0.4±0.1[c]
AWS	492.2±4.2[a]	1.1±0.2[b]

Values represent means of triplicate.
Values with the same alphabet along the same column are not significantly different (P>0.05)

Table 4: Vitamin C and Total Phenol content of *Cnidoscolus acontifolus* (Americana) leaves (wet weight)

Sample	Vitamin C (mg/100g)	Total phenol (%)
Unprocessed	52.6±0.2 [a]	0.7±0.1[a]
Processed		
Blanching	30.2±0.3[c]	0.8±0.2 [a]
Soaked	48.6±0.1[b]	1.1±0.1[a]
AWOS	27.4±0.2[d]	1.2±0.2 [a]
AWS	17.3±0.2[e]	0.8±0.3 [a]

Values represent means of triplicate.
Values with the same alphabet along the same column are not significantly different (P>0.05)

suggested as responsible for the antinutritional activity. The phosphorus in phytic acid is not nutritionally available to monogastric animals. Phytic acid interferes with Ca, Fe, Mg and Zn absorption because of its ability to chelate divalent cationic minerals (Oboh *et al*., 2003). As shown in Table 3 the phytate content of the unprocessed leaf was 479.5 mg/100g, this value compared favourably well with that of *Solanum macrocarpon* leaf (Oboh *et al*., 2005), but lower than that of *Tralinum triangulare* leaf (2341.1 mg/100g) that has exceptionally high phytate content (Akindahunsi and Oboh, 1999). However, the various processing techniques caused a significant decrease in the phytate content (296.2-435.9 mg/100g) except those subjected to abrasion with salt, the basis for this increase could not be categorically stated, however the fact that other processing techniques brought a marked decrease in the phytate content agrees with earlier report that processing will bring about decrease in phytate content of plant foods (Oboh *et al*., 2003). Of all the processing techniques employed in this experiment, soaking cause the highest decrease in the phytate content of Americana leaf.

Ascorbic acid contributes to the antioxidant properties of vegetables by protecting the membrane erythrocyte, maintaining the blood vessel flexibility and improving blood circulation in the arteries of smokers as well as facilitating the absorption of iron in the body. As shown in Table 4, the Vitamin C content of the unprocessed leaf is 52.6mg/100g; this value was below the Vitamin C content of the following leafy vegetables *Telfairia occidentalis* (148.0mg/100g), *Amaranthus cruentus* (70.0 mg/100g) and *Baselia alba* (64.6 mg/100g); however, it was above that of *Corchorus olitorus* (43.5 mg/100g) and *Solanum macrocarpon* (43.5mg/100g) (Oboh, 2005). The various conventional food processing techniques caused a significant decrease (P<0.05) in the Vitamin C content (17.3 (abrasion with salt) - 48.6 (soaked) mg/100g], the loss in Vitamin C during processing agrees with ealier report by Achinewhu (1983), Oboh (2005) and Oboh and Akindahunsi (2004) to the extent that various conventional food processing methods would bring a loss in Vitamin C content, this loss in Vitamin C during processing could be attributed to the fact that Vitamin C is very soluble in water and at same time not stable at high temperature (Nagy and Smooth, 1977). And all the processing techniques employed in this research were carried in water with/ or without high temperature.

Phenols have antioxidant capacities that are much stronger than those of Vitamin C and E. Flavonols and flavonones are flavonoids of particular importance because they have been found to posses' antioxidant and free radical scavenging activity in vegetables (Amic *et al*., 2003). Some evidence as shown that flavonoids could protect membrane lipids from oxidation and a major source of flavonoids is vegetables and fruits (Amic *et al*., 2003). The total phenol content of Cnidoscolus *acontifolus* (Americana) leaf is 0.7%, this value is quite above what Oboh (2005) reported for some commonly consumed green leafy vegetables in Nigeria namely: *Amaranthus cruentus*, *Ocimum gratissimum*, *Telfairia occidentalis, Baselia alba, Solanum macrocarpon, Corchorus olitorus* which is 0.3%, while *Struchium sparganophora* and *Vernonia amygdalina* had 0.1% and 0.2% respectively. Furthermore, this value is also higher than that of some commercial mushroom (0.01 - 0.02%) reported by Yang *et al.* (2002). However, the various food-processing methods unlike Vitamin C caused an increase but not significant increase (P>0.05) in the total phenol content of the *Cnidoscolus acontifolus* (Americana) leaves (0.8 - 1.2%). The basis for this increase could not be categorically ascertained, however, it has been reported that cooking or wet heating could increase phenol content, likewise blanching and Sun-drying (Oboh and Akindahunsi, 2004; Oboh 2005).

Conclusion: In conclusion, the leaf of *Cnidoscolus acontifolus* has a very high nutrient, antinutrient, mineral and antioxidant potential; however the various conventional post-harvest treatments will cause a significant decrease (P<0.05) in the nutrient and antinutrient content, and same time caused a significant decrease in the antioxidant potential.

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