Qualitative and Quantitative Evaluation of the Phytochemical Contents in Some Selected Green Leafy Vegetables in the Eastern Part of Nigeria

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Abstract

Background: Leafy vegetables are sources of macro and micronutrients that play major role in maintaining healthy living. Phytochemicals are non-nutrient but bioactive compound with health protecting properties which play a variety of roles such as antioxidants, inhibition of tumor growth, antimutagens, enzyme modulators and free radical scavengers. In this study, the qualitative and quantitative evaluation of the phytochemical contents of "Ahihara" (Corchorus, olitorius), "eriamionu" (Celosia argentea), Tree spinach (Cnidoscolusa conitifolius) and "ugu"(Telfairia occidentalis) consumed in the eastern part of Nigeria was carried out.

Methods: Qualitative and quantitative screenings were carried out on the raw, cooked and shade dried leaves to determine the presence of alkaloids, anthocyanin, carotenoid, flavonoid, glycoside, saponin, oxalate and tannins using standard methods. Fisher's Least Significant Difference was used to compare the different means at $p < 0.05$.

Results: The results showed that the plant materials used for this study contain most of the phytochemicals tested for. Alkaloid was found to be present in high amounts in the shade dried vegetable except "ugu" (1.91, 1.32, 1.25 and 0.95g/100g for "Ahihara", tree spinach, "eriamionu" and "ugu" respectively) while glycoside was absent in "ugu" and tree spinach but present in "Ahihara" and "eriamionu". "Ahihara" was found to also contain the highest amount of anthocyanin (0.11g/100g). Processing affected the availability of the phytochemicals differently. Shade drying significantly ($p<0.05$) increased the concentration of all the phytochemicals. Cooking decreased the content of the alkanoid, anthocyanins, flavonoid, glycoside, oxalate and saponin but did not affect the level of carotenoid and tannin.

Conclusion: The phytochemicals were present in all the vegetables studied. Of all the treatments, shade drying was observed to be a good processing method as it increased the phytochemical contents of the vegetables

Keywords: Phytochemicals, Corchorus, olitorius, Celosia argentea, Shade-drying.

Introduction

Nigeria has rich resources of cultivated, semi-wild and wild species of plants being used as traditional vegetables and different types are consumed by the various ethnic groups for different reasons (1). Edible leaves from vegetable plants are consumed as supporting food or as main dishes. They may be aromatic, bitter or tasteless but are the cheapest and most accessible sources of plant nutrients (2). Leafy vegetables however, are source of macro and micronutrients that play major role in maintaining healthy living. They are regular ingredients in the diet of the average Nigerian and provide appreciable amounts of nutritive minerals. Even though the bulk of their weight is water, leafy vegetables represent a veritable natural component of minerals, vitamins and phytochemicals (3). Phytochemicals are bioactive chemicals of plant origin. They are regarded as secondary metabolites and have been linked with reducing the risk of major degenerative diseases (4). Consumption of green leafy vegetables is good for human health as it improves nutritional status and reduces the risk of specific diseases like diabetes, cancer, cardiovascular diseases, hepatoxicity(5).

The phytonutrients present in green leafy vegetable gives many common health benefits such as protection from eye disorders, oxidative stress, iron deficiency. The emphasis on herbal medicine has increased researchers interest on green leafy vegetables (5). The medicinal values of vegetables and fruits are believed to be dictated by their phytochemical and other chemical constituents (6). As prevention is a more effective strategy than treatment for chronic diseases, a constant supply of phytochemical containing plants with desirable health benefits beyond basic nutrition is essential in reducing the risk of diseases in humans. The importance of these phytochemicals is their presumed ability to inhibit carcinogenesis. They play a variety of role such as antioxidants, inhibitors of tumor growth, antimutagens, enzyme modulators, chemical inactivators, and free radical scavengers (7).This therefore calls for discovering the potentials of our lesser known green leafy vegetables containing these phytochemicals and to what extent they are contained.

Findings from this study will shed some light on the scientific basis of using these vegetable for medicinal purposes and may encourage the consumption of the green leafy vegetables. Leafy vegetables investigated in this experiment were "Ahihara" (Corchorus, olitorius), "eriamionu" (Celosia argentea), Tree spinach (Cnidoscolusaconitifolius), "ugu" (Telfairia occidentalis).

Materials and Methods

Materials and Sample Collection

"Ahihara" (Corchorus, olitorius), "eriamionu" (Celosia argentea), Tree spinach (Cnidoscolusaconitifolius), "ugu" (Telfairia occidentalis) were used for this study. Tree spinach was harvested at Nsukka within the University of Nigeria, while "eriamionu", ahiharia and "ugu" were purchased from a local market at Onitsha Anambra state.

Preparation of samples

"Ahiharia" (Corchorousolitorius)

The leaves were de stemmed and inspected. Three kilograms of the leaf sample were weighed out and divided into 3 equal parts of 1kg each. The first part was washed, drained, and shade-dried on the laboratory bench for 10days, ground into fine powder using hammer mill and labelled as (ALD). The second part was washed, drained, cut, and blended to a uniform pulp using a laboratory mortar and labeled as (ALR). The third portion was washed, drained, cut and cooked for 5minutes and labeled as (ALC).The same measurement and treatment was used for"eriamionu" (Celosia argentea), Tree spinach (Cnidoscolusaconitfolius), "ugu" (Telfairiaocidentalias)

Laboratory Analysis

Phytochemical Analysis

Qualitative and quantitative screenings were both carried out on the raw, cooked and shade dried leaves. Qualitative screening was carried out to determine the presence of alkaloids, anthocyanin, carotenoid, flavonoid, glycoside, saponin, oxalate and tannin phytochemicals in the leaves using the methods described by Trease and Evans (8).

Quantitative analysis: The raw, cooked and shade dried leaves were subjected to quantitative phytochemical analysis using the methods of Harborne (9) for alkaloid and anthocyanin, Dolunay et al., (10) for carotenoid, Boham and Kocipai-Abyazan (11) for Flavonoid, Onwuka (12) for glycoside, Obadori and Ochuko (13) for Saponin, Pearson (14) for Oxalate and Kirk and Sawyer (15) method for Tannin using the Fohn Denis calorimeter.

Statistical Analysis

The design of this work was completely randomized design (CRD). Fisher's Least Significant Difference was used to compare the different means at $p < 0.05$. The mean effect of the green leafy vegetables on their phytochemical contents was compared. The interaction of the different plants and their treatments on the phytochemicals was compared. GenstatReelease (2007) statistical package was used.

Results

Table 1 shows the quantitative composition of phytochemical contents of the green leafy vegetables.The phytochemical screening showed that the plant materials used for this study contain most of the phytochemicals tested for. Alkaloid was found to be present in high amounts in the shade dried vegetable except "ugu". However, glycoside was absent in "ugu" and tree spinach but present in "Ahihara" and "eriamionu".

Table 1: Qualitative phytochemical content of the green leafy vegetables.

Phytochemicals in g/100g of plant samples								
Plant Materials	Alkaliod	Anthocyanin	Carotenoid	Flavonoid	Glycoside	Oxalate	Saponin	Tannin
"Ahihara" raw	++	+	+	+	+	+	+	+
"Ahihara" cooked	++	+	+	+	+	+	+	+
"Ahihara" dried	++	++	+	+	+	+	++	+
"eriamion u" raw	+	+	+	+	+	+	+	+
"eriamion u" cooked	+	+	+	+	+	+	+	+
"eriamion u" dried	++	+	+	+	+	+	++	+
Tree Spinach raw	+	+	+	+	-	+	+	+
Tree Spinach cooked	+	+	+	+	-	+	+	+
Tree Spinach	++	+	+	+	-	+	+	+

+ indicates the presence of constituents.

++ indicates that the constituents are highly present.

- indicates the absence of constituents.

Table 2 shows the mean effects of plant materials on their phytochemical contents. The result revealed that the leafy vegetables are rich sources of most of the phytochemicals tested in this work. "Ahihara" had the highest anthocyanin content (0.11g/100g) while the values for Alkaloids were the highest (1.60, 1.03 and 0.95g/100g for "Ahiara", tree spinach and "Eriamionu" respectively) when compared to other phytoconstituents in the plant materials.

Low amount of carotenoids (0.09, 0.07 and 0.02g/100g for tree spinach, "Ahihara" and "eriamionu" respectively) was detected in the leaves. Comparing the other plants to "ugu", "ugu" is comparable to "eriamionu" but lower than "Ahihara" and tree spinach in their phytocontituents.

Table 2: Quantitative composition of the phytochemical contents of the green leafy vegetables (Mean effects of plant materials on their phytochemical contents)

	Phytochemicals in g/100g of plant samples							
Plant Materials	Alkaliod	Anthocyanin	Carotenoid	Flavonoid	Glycoside	Oxalate	Saponin	Tannin
"Ahihara"	1.60^{b}	0.11^{b}	0.07^{b}	0.17^{b}	0.006^{b}	0.31^{b}	0.75^{a}	0.15^{b}
"Eriamionu"	0.95^{b}	0.04^{a}	0.02^{a}	0.07^{a}	0.003^{b}	0.07^{a}	0.82^{b}	0.14^{b}
Spinach	1.03^{b}	0.08^{b}	0.09^{b}	0.19^{b}	0.00^{a}	0.47^{b}	0.42^{a}	0.21^{b}
Control	0.04^{a}	0.06^{a}	0.04^{a}	0.07^{a}	0.00^{a}	0.09^{a}	0.72^{a}	0.01^{a}
p=0.05	0.043	0.006	0.006	0.006	0.001	0.023	0.007	0.013

Decision rule: If the difference between the two means is greater or equal to the LSD value then the means are significantly different

Table 3 shows the mean effect of processing on the phytochemical contents of the vegetables. Shade drying significantly ($p<0.05$) increased the availability of all the phytochemicals except for tannin. Compared to the raw form, cooking had no significant effect on the phytochemical content of the vegetables.

Table 3: Mean effects of Processing on their Phytochemical contents

	Phytochemicals in g/100g of plant samples							
Processing methods	Alkaliod	Anthocyanin	Carotenoid	Flavonoid	Glycoside	Oxalate	Saponin	Tannin
Cooked	0.71[a]	0.02[a]	0.04[a]	0.06[a]	0.001[a]	0.07[a]	0.33[a]	0.14[a]
Raw	1.17[a]	0.04[a]	0.04[a]	0.11[a]	0.002[a]	0.18[a]	0.64[a]	0.14[a]
Shade dried	1.36[b]	0.15[b]	0.09[b]	0.21[b]	0.003[b]	0.46[b]	1.07[b]	0.22[a]
LSD (p=0.037)	0.037	0.005	0.005	0.005	0.0005	0.020	0.003	0.11

Decision rule: If the difference between the two means is greater or equal to the LSD value then the plants means are significantly different.

Table 4 shows the interaction between plant materials and processing on the availability of phytochemicals. The availability of each phytochemical relative to processing on the individual plant materials is considered here. In all the plants, shade-drying increased the concentration of all the phytoconstituents tested for. Cooking decreased some of the phytochemicals in the plants. Alkaloids decreased significantly ($p<0.05$) in all the leaves on cooking. "Ahihara", "eriamionu" and tree spinach all had higher values of alkaloid than "ugu" in all the treatments. Cooking reduced the anthocyanin content of "Ahihara" (raw-0.09g/100g, cooked-0.05g/100g) and tree spinach significantly ($p<0.05$). But the cooked form of "ugu" and "eriamionu" were statistically the same ($p>0.05$) as the raw form. "Ugu" was comparable with "eriamionu" (0.05) in their anthocyanin contents but not with "Ahihara" and tree spinach. "Ugu" was comparable ($p>0.05$) with eriamonuin in carotenoid content but not with "Ahihara" and tree spinach. Cooking reduced the flavonoid content of all the leaves. "ugu" compared with "eriamionu" in all the treatment in their flavonoid content, while "Ahihara" and tree spinach were not comparable with "ugu". Oxalates are mostly calcium salts. Rich sources of oxalate are green leafy vegetables and some legumes(26).. The raw forms of "ugu" and "eriamionu" were comparable to their cooked forms. Tree spinach and "Ahihara" had higher oxalate value than "ugu" in all the treatments, while "eriamionu" has lesser values than "ugu". There was a significant decrease ($p<0.05$) in the saponin contents of of all the leaves when cooked. Cooking had no effect in the tannin and carotenoid content of all the green leafy vegetables.

Table 4: Interaction of plant materials and their processing on the phytochemical contents

Phytochemicals in g/100g of plant samples								
Plant Materials	Alkaliod	Anthocyanin	Carotenoid	Flavonoid	Glycoside	Oxalate	Saponin	Tannin
"Ahihara" raw	1.69	0.09	0.05	0.16	0.005	0.25	0.72	0.13
"Ahihara" cooked	1.20	0.05	0.05	0.10	0.003	0.11	0.51	0.13
"Ahihara" dried	1.91	1.19	0.10	0.26	0.008	0.58	1.04	0.20
"eriamion u" raw	0.99	0.01	0.02	0.05	0.003	0.06	0.73	0.12
"eriamion u" cooked	0.60	0.004	0.02	0.03	0.001	0.03	0.69	0.11
"eriamion u" dried	1.25	0.12	0.04	0.15	0.005	0.13	1.06	0.19
Tree Spinach raw	1.14	0.05	0.06	0.19	0.000	0.35	0.24	0.18
Tree Spinach cooked	0.63	0.02	0.06	0.09	0.000	0.11	0.04	0.18
Tree Spinach dried	1.32	0.17	0.15	0.30	0.000	0.96	0.99	0.26
"ugu" raw	0.85	0.02	0.03	0.04	0.000	0.06	0.89	0.14
"ugu" cooked	0.41	0.01	0.02	0.02	0.000	0.04	0.07	0.12
"ugu" dried	0.95	0.13	0.07	0.15	0.000	0.17	1.21	0.23
LSD p<0.05	0.074	0.0109	0.0103	0.0106	0.0011	0.0406	0.0406	0.0226

Decision rule: If the difference between the two means is greater or equal to the LSD value then the plants means are significantly different.

Discussion

Several works reported that glycosides play an important role in lowering the blood pressure. They are also used in treatment of congestive heart failure and cardiac arrhythmia (16). The absence of glycoside in tree spinach in this study does not agree with the findings of Awoyinka, Balogun and Ogunnowo (17) who reported high content of glycoside in tree spinach. The absence of glycoside in tree spinach might be as a result of soil difference or specie difference. The presence of saponin in "eriamionu" also disagrees with the result of Mensah, Okoli and Obaju- Obodo (1); who reported the presence of saponin in "eriamionu". The phytochemicals present in these vegetables explains their various uses for medicinal purposes. Flavonoids have anti-inflammatory, anti-carcinogenic, pain relieving effects (18). Saponins affect the immune system in ways that help to protect the human body against savangeing properties (19). Carotenoid is a well known antioxidant that helps reduce the risk of cancer.

The low anthocyanin content in the vegetables is expected since anthocyanins are found more in brightly coloured parts of plant tissues (20). The trace values of anthocyanin in "ugu", tree spinach and "eriamionu" compared to "Ahihara" might be responsible for the duller shade of the leaves while "Ahihara" has a shade of green colour that is brighter than others. Alkaloid, which was found in high contents in the leaves studied, is one of the most important of all phytochemicals which is said to be pharmacologically active, their action are felt in the automatic nervous system, blood vessels, respiratory system and gastrointestinal tract (21). Carotenoid is present in small amount which is comparable with the results of Lakshmi, Maunath ad Prakash (22), who reported 4.42mg of carotene in "eriamionu" and Onyeka and Nwambekwe[23] who reported 0.02g/100g carotene.

Processing affected the availability of the phytochemicals differently. Shade drying led to reduction in moisture content of the vegetables which explained the increased concentration of the phytoconstituents in the shade dried vegetables. Cooking decreased some of the phytochemicals in the plants. The reduction in concentration of alkaloids in all the leaves on cooking is similar to the report of Onyeka and Nwambekwe (23). According to the authors (23), boiling reduced the anthocyanin content of most of the green vegetables studied ("ugu", okazi, nchanwu, utazi, oha, olugbo). However, the reduction of the phytochemicals due to cooking is not in line with the report of Anderson (24) that says phytochemicals are not affected by processing including cooking. But the resistance of carotenoid and tannins to cooking proved the point. This also agrees with the work of Onyeka and Nwambekwe (23). Tannins which have been reported to have antimicrobial, anti-diarrheal, anti-parasitic and anti-irritant property (1), was stable to heat in the leafy vegetables in this study, this contradicts the cooking of food as a means of reducing their antinutritional components (25). Cooking reduced the oxalate content in all the leafy vegetables which is in line with the study of (27). The levels of oxalate in the plant materials were within the safe level; this is an indication that the levels might not be toxic. According to Soetan and Oyewole (28), oxalic acid when consumed in large quantities can prevent the absorption and utilization of calcium and can cause diseases such as rickets and osteomalacia.

Conclusion and Recommendation

Green leafy vegetables ("Ahihara", "eriamionu", tree spinach and "ugu") had satisfactory amounts of most of the phytochemicals tested for. "Ugu" (control) had lesser phytochemicals than "Ahihara" and tree spinach, but it was comparable to "eriamionu" in most of the phytochemical contents. Shade drying was observed to be a good processing method as it affected the phytochemicals positively. The phytochemical contents of the leafy vegetables served as supplements for food and also have the potential to improve the health status of its users as a result of the presence of various compounds vital for good health. The moderate presence of phytochemicals show that the leaves could be used in pharmacological industries and that the ethnomedical use of these vegetables might not be toxic to health. The use of these green leafy vegetables should be encouraged because of their health benefits. Their cultivation should be encouraged to prevent extinction of these green leafy vegetables.

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