*JHER Vol. 27 No. 1 September 2020, pp. 160 - 171*

# Nutrient and Phytochemical Composition of Selected Fresh and Dried Leafy Vegetables in Nsukka Local Government Area of Enugu State

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**Abstract**

The study investigated the nutrient and phytochemical composition of selected fresh and dried leaves of *Bryophyllum pinnatum* (odaopue), *Corchorus olitorius* (ahihiara) and *Amaranthus hybridus* (eriemionu). Specifically, it determined; proximate (crude protein, fat, ash, fiber, moisture, carbohydrate); vitamins (vitamin C, pro-vitamin A, folate), minerals (calcium, iron, zinc, iodine) and phytochemical (flavonoids, saponins, phytate) compositions of the vegetables as consumed. It was an experimental study. The vegetables were harvested and carefully prepared for chemical analysis. Association of Official Analytical Chemists (2005) and other analytical methods were used to evaluate the chemical profile of the vegetables. Data were analysed using descriptive statistics. Results show that the shade dried samples were nutrient dense compared to the fresh samples except vitamin C. Phytochemicals tested show that flavoniods ranged from (3.19-5.75mg/100g), saponin (632.83-642.93mg/100g) and phytate (0.04-1.26mg/100g). Shade drying was observed to be a good processing method as it increased the nutrient and phytochemical contents of the vegetables. It should be adopted because more nutrients were conserved. It is therefore an effective way to help maintain healthy diet and to combat micronutrient and other dietary deficiencies.

**Keywords**: Nutrient, Phytochemical, Composition, Vegetable, Fresh, Dried

## Introduction

Nutrients are substances found in food which when ingested, digested and absorbed are metabolized to perform various physiological functions in the body. Green leafy vegetables play important roles in human nutrition. They are made up of cellulose, hemi-cellulose and pectin substances that give them their texture and firmness (Mohammed and Sharif, 2011). They contribute substantially to minerals such as phosphorus, magnesium, potassium, zinc, calcium, iron; vitamins, fibers, proteins and other nutrients which are usually in short supply in daily diets (Ene-Obong, 2011). Vitamin K content of dark green leafy vegetables protects bones from osteoporosis and prevents inflammatory diseases

(Edmond, 2008). Leafy vegetables are also important sources of health promoting phytochemicals.

Phytochemicals are plant chemicals that occur naturally in fruits and vegetables including saponin, flavonoids, phytates and carotenoids. They have antioxidant, antibiotic, anticancer and other nutraceutical properties (Yang & Keding 2009) which help in disease prevention and reduction of risk of age related chronic diseases such as coronary heart diseases, diabetes, high blood pressure and certain types of cancer (Mohammed and Sharif, 2011; Jamie & Yacoub, 2014).

In Nigeria there are many lesser known vegetables of promising nutritive values. These vegetables have remained underutilized due to poor awareness and popularization of technologies for utilization. They include but not all, *Amaranthus hybridus*, *Bryophyllum pinnatum and Corchorus olitorius.*

*Amaranthus hybridus* is a herbaceous, erect, annual plant belonging to the family, *Amaranthaceae.* It is a monoecious, multipurpose crop (Grobelnik-Mlakar, 2009). Their nutritious leaves have a mild flavour; the seeds are usually ground into flour and used as porridge and in bread making. The leaves are used in the treatment of intestinal bleeding, diarrhoea and excessive menstruation (Foster and Druke, 2003). It is also a rich source of pro-vitamins A, C, B and folate (Soriano-Garrcia, Arias-Olguin and Montes, 2018); Arasaretnam, Kiruthika, & Mahendran (2018)

Another underutilized locally available leafy vegetable is *Bryophyllum pinnatum* also called Odaopue in Igbo language. It is a medicinal plant used to cure diseases and heal injuries. It belongs to the family Grassulacaceae (Agoha, 1974). It is known as air plant, never die, and miracle leaf. In South Eastern Nigeria, it is used to facilitate the dropping of the placenta of a newly born baby (Dalziel. 1995). It is also considered sedative, wound healing, diuretic, anti-inflammatory and cough suppressant. The leaf juice is also used to treat boils and skin ulcers.

Similarly, *Corchorus olitorius* 'Ahihara' in Igbo, of the family *Tiliaceae,* is another leafy vegetable with a mucilaginous (somewhat "slimy") texture, similar to okra, when cooked. The seeds used as flavoring and herbal tea are made from the dried leaves. Studies have shown that the leaves are rich in iron, calcium and vitamin c (Stewart, 2011). According to Zakaria et al (2006) the leaf is used in folklore medicine for the treatment of gonorrhea, pains, fever, tumor and cystisis. *Corchorus olitorius* is also used for the treatment and prevention of anaemia. The leaves have been reported to be rich in vitamins, minerals, phenolic and antioxidant properties (Choudhary *et al*., 2013).

The vegetables are subjected to certain postharvest treatments such as drying, blanching, or cooking to remove potential toxic components, improve organoleptic properties and for preservation purposes. Some of these processing techniques alter nutrient content of vegetables (Frances, Thomas, & Gabriel 2013), rendering them

consumable or toxic. There is need to explore the numerous locally available vegetables for their beneficial nutrient properties especially the underutilized ones going into extinction.

It has been observed that the diets of many Nigerians in relation to vitamins, minerals, etc are inadequate. Iron deficiency is the most prevalent, and iron deficiency anaemia is estimated to affect more than one billion people worldwide (Trowbridge & Martorell 2002). Anaemia, weak bones, tooth decay and decreased fertility are iron deficiency related diseases (Groff, 1995). Approximately, three million (3,000 000) deaths a year have been attributed to nutrient deficiency disorders and vegetable intake, a risk factor almost as deadly as tobacco (World Health Organization, WHO, 2003). The study on the nutrient and phytochemical compositions of these lesser known and underutilized locally available vegetables is therefore imperative.

**Purpose of the study**

The major purpose of the study was to evaluate the nutrient and phytochemical compositions of selected fresh and dried leafy vegetables in Nsukka Local Government Area of Enugu State.

Specifically, the study determined:

1. proximate composition (crude protein, fat, ash, fiber, moisture and carbohydrate) of fresh and shade-dried leaves of *Amaranthus hybridus* (*eriemionu*), *Bryophyllum pinnatum* (*odaopue*) and *Corchorus olitorius* (*ahihara*).
2. vitamin composition (vitamin C, pro-vitamin A, folate) of the fresh and shade dried leafy vegetable samples.
3. mineral composition (calcium, iron, zinc, iodine) of the fresh and shade dried leafy vegetable samples.
4. phytochemicals (flavonoids, saponins, phytate) present in the fresh and shade dried leafy vegetable samples.

**Materials and Methods**

***Design of the Study*:** It is an experimental study done in three stages. Stage 1: Procurement and processing of the vegetables. Two processing methods, fresh and shade drying were adopted to determine their effects on the nutrient compositions of the vegetables. Stage two: Chemical analysis of the nutrient and phytochemical compositions of the vegetables. Stage III: Statistical analysis and result presentations. The experimental procedures were carried out at the Food and Analytical Laboratory of the Department of Home Science and Management, University of Nigeria, Nsukka.

***Materials*:** Fresh leaves of *Corchorius olitorius* (*Ahihara*), *Amaranthus hybridus* (*Eriamionu*) and *Bryophyllum pinnatum* (*Odaopuo*) were harvested from a garden at Hill Top Plaza, Ugwuechara, in Nsukka Local Government Area, Enugu State and authenticated at the Department of Botany, University of Nigeria, Nsukka.

**Preparation of Samples:** *Corchorus olitorius* (*Ahihara*), leaves were carefully selected and de stemmed. Two kilograms of the leaf sample were weighed out and divided into 2 equal parts of 1kg each. The first part was

washed, drained, and shade-dried on the laboratory bench for 10days until brittle, ground into fine powder using hammer mill and labeled shade dried *Corchorius* (SDC). The second part was washed, drained, cut, and blended to a uniform pulp using a laboratory mortar and labeled fresh *Corchorius* (FC). The same measurement and treatment was used for *Bryophyllum pinnatum* (*Odaopue*) and *Amaranthus hybridus* (*Eriamionu*) to get SDB, FB, SDA, and FA respectively.

***Chemical Analyses***

**Crude Protein:** Total Nitrogen (N) was estimated using the micro Kjeldahl method as described by AOAC (2005). One millilitre of each sample was digested with concentrated sulphuric acid, distilled and titrated. The crude protein was obtained by multiplying N by the conversion factor of 6.25 ($^{c}$P =TN x 6.25).

**Fat:** The AOAC method (2005) was used to determine the fat content of the samples. Two millilitres of each sample was extracted with acetone (BP $40^0$C – $60^0$C) using "Sohxlet extractor" for 1 hour. The solvent free samples were dried in an oven, cooled in a dissector and reweighed prior to calculation of crude fat content.

**Ash:** Ash was determined using AOAC (2005) method. Two millilitres of each sample was weighed into already weighed crucibles, labelled and put into the furnace, heated gradually until the temperature was maintained or 550 - $600^0$C was reached for 6 hours. After ashing, the furnace was switched off; temperature was allowed to drop prior to removing the crucibles. Crucibles was put in desiccators and cooled, samples were reweighed and percentage ash calculated.

**Fiber:** The crude fiber was determined using acid and alkaline 600ml round bottom flask. 100ml of 1.25% sulphuric acid (H2SO4) was added into the flask and made to boil over a heater for about 30minutes, filtered using a Buckner funnel and filter flask. The residue was put back into flask and diluted with 100ml of 1.25% NaOH and heated for another 30minutes and filtered using suction method. The residue was rinsed with 1% Hcl, and added to neutralize the NaOH present, washed with methylated spirit to remove any trace of acid. The residue was put into a weighed crucible, dried in an oven set at 100°C for 30minutes, cooled in a dessicator and reweighed. The residue was put into a muffled furnance set at 550°C for 2hours for complete ashing. The ash was weighed and the percentage fiber in the sample calculated.

**Moisture:** This was determined by hot–air oven method (Pearson, 2005). The Petri dishes were washed, dried in hot air oven at $100^0$C for about 25 minutes, and cooled in desiccators for 10minutes. The dishes were reweighed. Two millilitres of sample was added to each dish in hot air oven, dried for 2 hours, removed, cooled in desiccators, reweighed and dried until a constant weight was obtained. The percentage moisture was calculated.

**Carbohydrate:** This was determined by Difference that is, subtracting the sum of the % of protein, fat, moisture, and ash from 100%. Carbohydrate percentage was calculated.

*Vitamin Analysis*

**Ascorbic Acid:** The AOAC (2005) method was used. Fifty millilitres of each sample was added to different 100ml volumetric flasks containing 25ml of 20% metaphosphoric acid as stabilizing agent. This was made up to mark with diluted water. Ten millilitres of the solution was put into a conical flask, and 2.5ml of acetone was added and titrated with the indophenols solution until a faint pink color persists for 15 seconds. The ascorbic acid content was calculated as mg/100ml sample.

**Beta-Carotene:** This was determined according to Pearson (2005) method. Two millilitres of each sample was put into a film container and 20ml of petroleum ether was added. The solution was filtered through whatman filter paper No 42. The filtrate was evaporated to dryness, later dissolved with 0.2mls of chloroform acetic anhydride, 2mls of TCA chloroform was added and read at 620nm using a spectrophotometer.

**Folic Acid:** The method as described by AOAC (2006 was used). An amount of test protein was measured in flask and added volume H20 equal in ml to ≥10 times dry weight test portion in gram. The resulting solution was ≤ 1.0mg folic acid/ meal, equivalent of 2ml NH4OH (2+3)/100ML liquid was added. When test portion was not readily soluble, it was comminuted to disperse it evenly in liquid, agitated vigorously and washed down sides of flask with 0.1ml NH2OH. Mixture of 5mm at 121-123$^0$C was autoclaved and cooled, diluted to measured volume with water, undissolved particles was left to settle and filtered. Aliquot of clear solution was taken, added water to it, adjusted to PH 6.8 and diluted with additional water to measured volume containing pernil folic acid. It was designated as test solution.

*Mineral Analysis*

**Iron** (Fe): This was determined using the Phenanthroline method as described by AOAC (2005). Five millilitres of Phenanthroline solution and two millilitres of concentrated HCl were added in the test-tube. One millilitre of hydroxylamine solution was added and left to boil for 2mins. Nine millilitres of ammonium acetate buffer solution was added and diluted with 50ml of water. The absorbance was read at 510nm wavelength.

**Calcium** (Ca): This was carried out according to AOAC (2005) method. Previously ashed sample was dissolved in 5ml of 30% HCl and 45ml of distilled water. The diluted samples were filtered and the filtrates were used to analyze for calcium using atomic absorption spectrophotometer.

**Zinc**: Zinc content was determined using the dithizone method described by AOAC (2005). Zinc was separated from other metals by extraction with dithizone and then determined by measuring the colour of the zinc dithizone in carbon tetrachloric. The separation was achieved by extraction at pH of 4.0-5.5 and the addition of sufficient sodium thiosulphate. Zinc also forms a weak thiosulphate complex that tends to retard the slow and incomplete reaction between zinc dithizone. 2g of the digested sample

was pipette into test tube and 5ml of acetic buffer was added. 1ml of sodium thiosulphate solution was added and mixed after which 10ml of dithizone solution was added. The mixture was shaken for 40 minutes, and the reading taken at 535nm, the standard was prepared and zinc concentration of the sample was calculated.

**Flavonoid**: This was done using Bohm and Kocipai – Abyazan (2005) method. Ten grammes of each sample were extracted repeatedly with 100ml of 80% aqueous methanol at room temperature. The whole solution was filtered through Whatman filter paper No 42 (125mm). The filtrate was later transferred to a crucible and evaporated to dryness over a water bath and weighed to a constant weight.

**Saponin:** The Obadori and Ochuka (2007) method was used in determining the saponin content for the sample. Two grams of each sample was weighed into a beaker containing 20ml of 20% ethanol, heated over hot water for four hours with continuous stirring at about $55^0$C. The mixture was filtered, and the residue re-extracted with another 20ml of 20% ethanol. The combined extract of 4ml was reduced over a water bath at $90^0$C. The concentrate was transferred into 250ml separator, filtered and washed with 20ml of diethyl ether. The aqueous layer was removed, ether discarded and purification process repeated. About 6ml of n-butanol was added into the extract and washed twice with 10ml of 5% aqueous sodium chloride. The remaining solution was heated in a water bath. After evaporation, the dry samples in the oven were weighed to obtain a constant weight. The saponin content was then calculated in percentage**.**

**Phytate:** The method used was described by AOAC (2000). About 0.5gram of the sample was weighed into 500ml of 2.4% HCl for 1hour at room temperature, poured out and filtered. From the filtrate, 5millilitre was pipette and diluted to 25ml of water. From the diluted sample, 10ml was pipetted into a test-tube through amber litres in grade 200 – 400 mesh to elude inorganic phosphate and added 15mililiter of 0.7m sodium chloride. The absorbance was taken at 520nm.

***Data Analysis***: Data generated from the study were analysed with descriptive statistics (mean and standard deviation).

**Results of Chemical Analysis of the Study**

**Table 1:** Proximate composition of fresh and shade dried leaves of *Bryophyllum pinnatum* (*odaopue*), *Amaranthus hybridus* (*eriemionu*) and *Corchorus olitorius* (*ahihara*). (mg /100g)

| Proximate (100g/sample) | FB | SDB | FA | SDA | FC | SDC |
|---|---|---|---|---|---|---|
| Moisture% | 90.53±0.31 | 45.67±0.42 | 82.33±0.31 | 28.93±0.95 | 79.46±0.30 | 23.80±0.35 |
| Protein% | 1.09±0.06 | 2.82±0.07 | 2.79±0.04 | 3.04±0.01 | 2.88±0.05 | 2.94±0.62 |
| Carbohydrate% | 4.26±0.93 | 8.02±2.39 | 6.54±0.19 | 45.96±5.68 | 11.33±0.58 | 27.57±0.31 |
| Fat% | 0.87±1.03 | 2.87±1.86 | 1.87±0.31 | 3.00±0.80 | 0.47±0.64 | 1.00±0.00 |
| Fibre% | 1.99±0.34 | 31.37±0.51 | 2.31±0.30 | 13.20±0.85 | 2.94±0.51 | 29.33±0.68 |
| Ash% | 1.27±0.12 | 9.27±0.12 | 4.47±0.50 | 9.67±0.12 | 2.87±0.12 | 15.00±0.20 |

Key: *Mean± standard deviation of 3 determinations FB = Fresh *Bryophyllum pinnatum* SDB = shade dried *Bryophyllum pinnatum* FA = Fresh *Amaranthus hybridus* SDA= shade dried *Amaranthus hybridus* FC = Fresh *Corchorius olitorius* SDC= Shade dried *Corchorius olitorius*

Data in Table 1 indicate that Moisture was highest in fresh *Bryophyllum pinatum* (90.533±0.31) and lowest in shade dried *Corchorius olitorius* (23.80±0.35). Protein was highest in shade dried *Amaranthus hybridis* (3.04±0.01). Carbohydrate was highest in shade dried *Amaranthus hybridid* (45.96±5.68). Fat content was highest in shade dried *Amaranthus hybrid* (3.00±0.80) and lowest in fresh *Corchorius olitorius* (0.47±0.64). Fibre was highest as well as lowest in both shade dried and fresh *Bryophyllum pinatum* (31.37±0.51 and 1.99±0.34 respectively). Ash was highest in shade dried *Corchorus olitorius* (15.00±0.20) and lowest in fresh *Bryophyllum pinnatum* (1.27±0.12)

**Table 2:** Vitamin composition of fresh and shade dried leaves of *Bryophyllum pinnatum* (*odaopue*), *Amaranthus hybridus* (eriemionu) and *Corchorus olitorius* (*ahihara*). (mg/100g)

| Nutrients | FB | SDB | FA | SDA | FC | SDC |
|---|---|---|---|---|---|---|
| Pro vitamin A | 2.83±0.19 | 4.53±0.06 | 0.96 ± 0.02 | 5.04 ± 0.12 | 0.78±0.01 | 3.29±0.10 |
| Vitamin C | 4.24±0.60 | 4.05±1.05 | 8.85±2.45 | 6.47±1.17 | 11.73±1.00 | 5.79±0.58 |
| Folic acid | 1.93±0.12 | 4.33±1.10 | 3.16±0.08 | 0.24±0.11 | 1.22±0.05 | 1.51±0.11 |

**Key**: *Mean± standard deviation of 3 determinations FB = Fresh *Bryophyllum pinnatum* SDB = shade dried *Bryophyllum pinnatum* FA = Fresh *Amaranthus hybridus* SDA= shade dried *Amaranthus hybridus* FC = Fresh *Corchorius olitorius* SDC= Shade dried *Corchorius olitorius*

Table 2 shows the vitamin contents of the studied vegetables. Pro vitamin A was generally higher in all shade dried samples than the fresh ones. Pro vitamin A was highest in shade dried *Amaranthus hybridis* (5.04 ± 0.12). Conversely Vitamin C was higher in all fresh than shade dried samples. It was highest in *Corchorius olitorius* (11.73±1.00). Pholic acid was highest in shade dried *Bryophyllum pinnatum* (4.33±1.10).

**Table 3:** Mineral composition of fresh and shade dried leaves of *Bryophyllum pinnatum* (*odaopue*), *Amaranthus hybridus* (*eriemionu*) and *Corchorus olitorius* (*ahihara*). (mg/100g)

| Nutrients | FB | SDB | FA | SDA | FC | SDC |
|---|---|---|---|---|---|---|
| Calcium | 0.62±0.17 | 2.62±0.13 | 0.64±0.08 | 2.57±0.09 | 0.66±0.03 | 2.72±0.03 |
| Iron | 8.36±0.14 | 18.98±0.23 | 9.95±0.39 | 19.13±0.76 | 8.21±0.44 | 15.87±0.40 |
| Zinc | 16.30±3.25 | 49.87±6.69 | 33.37±1.79 | 50.77±3.23 | 33.33±3.18 | 57.43±6.12 |
| Iodine | 71.67±0.90 | 172.67±9.02 | 71.20±0.69 | 133.67±14.12 | 54.10±5.82 | 59.73±18.53 |

**Key**: *Mean± standard deviation of 3 determinations. FB = Fresh *Bryophyllum pinnatum* SDB = shade dried *Bryophyllum pinnatum* FA = Fresh *Amaranthus hybridus* SDA= shade dried *Amaranthus hybridus* FC = Fresh *Corchorius olitorius* SDC= Shade dried *Corchorius olitorius*

Mineral analyses in Table 3 reveal that calcium was highest in shade dried *Corchorius olitorius* (2.72±0.03). Iron was highest in shade dried *Amaranthus hybridis* (19.13±0.76). Zinc was highest as well as lowest in both shade dried and fresh *Corchorius olitorius* (57.43±6.12 and 33.33±3.18 respectively). Irodine was highest in shade dried *Bryophyllum pinnatum* (172.67±9.02) fresh and lowest in *Corchorius olitorius* (54.10±5.82).

**Table 4:** Phytochemical composition of fresh and shade dried leaves of *Bryophyllum pinnatum* (odaopue), *Amaranthus hybridus* (eriemionu) and *Corchorus olitorius* (ahihara). (mg/100g)

| Nutrients | FB | SDB | FA | SDA | FC | SDC |
|---|---|---|---|---|---|---|
| Flavonoids | 3.19±0.16 | 5.75±0.30 | 3.21±0.15 | 5.35±0.08 | 3.33±0.13 | 5.42±0.03 |
| Saponin | 632.83±1.45 | 636.43±0.64 | 634.96±1.04 | 642.93±1.45 | 634.97±0.64 | 639.83±0.23 |
| Phytate | 1.26±2.01 | 0.47±0.01 | 0.11±0.00 | 0.04±0.01 | 0.83±0.00 | 0.04±0.01 |

**Key**: *Mean± standard deviation of 3 determinations. FB = Fresh *Bryophyllum pinnatum* SDB = shade dried *Bryophyllum pinnatum* FA = Fresh *Amaranthus hybridus* SDA= shade dried *Amaranthus hybridus* FC = Fresh *Corchorius olitorius* SDC= Shade dried *Corchorius olitorius*

The flavonoid content of the fresh and shade dried leaves in Table 4 ranged from 3.19 to 5.75mg/100g. Flavonoid was highest in shade dried *Bryophyllum pinnatum* (5.75±0.30). Saponin showed highest prevalence in shade dried *Amaranthus hybridis* (642.93±1.45). Phytate was highest in fresh *Bryophyllum pinnatum* (1.26±2.01)

**Discussion**

Moisture was relatively high in th fresh vegetables. The high moisture contents ranging from 79.46 to 93.53mg/100g are indicative of their freshness. The leaves available moisture provides for greater activity of water soluble enzymes and co-enzymes needed for metabolic activities of the vegetables and makes them aid digestion of food better (Iheanacho & Ubebani (2009). However, high moisture contents facilitate bacterial action, giving them a very short shelf life and easy perishability (Adepoju & Oyewole, 2008). The result on the protein contents of the leaves revealed that shade dried Amaranthus hybridus had the highest value (3.04±0.01). Protein is nutritionally significant in food as a source of amino acids (Orech, Akenga, Ochora, Friss & Aagaard-Hassen, 2005) and aids in formation of antibodies that enable the body to fight infection. Shade dried *Bryophyllum pinnatum* had the highest fibre content of all the three leafy vegetables studied. Fibre helps in maintaining bulk motility, increasing intestinal peristalsis by surface extension of the food in the intestinal tract for healthy condition, curing of nutritional disorders and food digestion. Dietary fibre is reported to lower the risk of coronary heart

diseases, hypertension, diabetes and colon and breast cancer, piles and appendicitis (Orech, Akenga, Ochora, Friss & Aagaard-Hassen, 2005).

The carbohydrate contents of *Amaranthus hybridus* and *Corchorius olitorius* (shade dried) were 45.96 and 27.57% respectively and higher than the fresh and shade dried *Bryophyllum pinnatum.* Carbohydrates are pivotal nutrients required for a healthy adequate diet (Emebu & Anyika, 2011). The fat content of *Amaranthus hybridus* was higher than *Bryophyllum pinnatum* and *Corchorius olitorius*. This may suggest that this latter vegetable may not be high in fat. It could therefore be used by individuals on weight reduction. However, *Amaranthus hybridus* may not be fattening because of its high level of crude fiber. The ash content of any sample is the measure of the mineral content of the food (Nnamani, Oselebe, & Agbatutu 2009). The ash content was higher in the shade dried samples when compared to the fresh samples. However, the result differs from the findings of Akubugwo, Obasi, Chinyere, and Ugbogu (2007) that recorded 13.8% for *Amaranthus hybridus.* Variation in the compositions of the same food type from different sources may be due to the location, soil variation, maturity and the cultural practices adopted during planting (Adeleke & Abiodun, 2010).

The result of this study showed that the vegetables studied are rich sources of pro-vitamins A, C and folate. This finding is in agreement with the result of Soriano-Garrcia, Arias-Olguin and Montes (2018); Arasaretnam, Kiruthika, & Mahendran (2018) and Akubugwo, Obasi, Chinyere, and Ugbogu (2007). Shade dried *Amaranthus hybridus*, had the highest level of pro-vitamin A, a vitamin that protects the body cells from the damaging effects of free radicals, enhance the functioning of immune system and aids reproductive system to function properly (Young & Lowe 2001). The Vitamin C content was within the range 5.25mg/110g to 416.2 mg/100g on wet weight basis (W/W) of 16 common leafy vegetables by Mathiventhan & Sivakaneshan (2015), and generally higher in fresh than shade dried samples in all vegetables studied. Ascorbic acid (vitamin C) is an antioxidant which helps to protect the body against cancer and other degenerative diseases such as arthritis and type II diabetes mellitus (Adeniran, Olajide, Igwemmar & Orishadipe 2013) and strengthens the immune system.

Calcium content was high in shade dried *Corchorius olitorius* (2.72mg/100g).The relatively high content of calcium in *Corchorius olitorius* suggests that it may be of therapeutic value in hypocalcaemic state like osteoporosis. Iron contents in the vegetable samples are higher than those reported for some vegetables elsewhere in Nigeria (Odangowei, Esie and Dike 2019). Iron is an important element in body immune function, cognitive development, temperature regulation, energy metabolism and work performance. It is essential for haemoglobin formation, normal functioning of the central nervous system and in the oxidation of carbohydrates, protein and fats (Chaturvedi, Shrivastava & Upreti 2004).

The zinc content of the vegetables ranged from 16.30-57.43mg/100g. Zinc is an essential trace element for protein and nucleic acid synthesis and normal body development (Melaku, Clive & Habtamon, 2005), stimulates vitamins activities and formation of red and white blood cells and improves male fertility. The presence of zinc in the leaf samples could mean that the plant can play valuable roles in the management of diabetics which result from insulin malfunction.

The presence of flavonoids in appreciable amount (3.19 - 5.75mg/100g), inferred that the leaf samples have anti-inflammatory, anti-carcinogenic, pain relieving effects (Okunlola, Jimoh, Olatunji & Olowolaju, 2017). Saponins affect the immune system and help to protect the human body against scavenging properties (Marierfield, 2003). Phytate is present in the investigated vegetables at different concentrations. The antinutrient potential of phytate is owing to its strong binding affinity for essential minerals like zinc, iron and calcium. Binding to these minerals leads to the formation of insoluble precipitates that are far less absorbable in the intestines; thereby reducing their bioavailability (Dendougui & Schwedt 2004).

**Conclusion**

The study has provided useful information on nutrient and phytochemical composition of the studied vegetables. It can be concluded that shade drying is a good processing method for the vegetables as it conserved more nutrients than the fresh leafy vegetables. There was better retention of nutrients like protein, carbohydrates, fat, fibre, ash, some vitamins, minerals and some phytochemicals except vitamin C and phytate which had nutrient values reduced in shade dried samples though insignificant.

**Recommendations**

Based on the results of this study, these recommendations were made.

1. The utilization of these vegetables using shade drying methods except vitamin C and increase in family diet should be encouraged by Nutrition educators as they have been found to be high in proximate, micronutrients, and phytochemicals.
2. Nutrition education should be given by Nutritionists to rural women through seminars, women conferences and meetings to sensitize them on the importance of careful shade drying these vegetables and their need to be adopted to conserve nutrient in food preparation for good health
3. Combination with other foodstuffs is recommended to meet nutritional needs of the rural poor and the vulnerable groups.
4. Promotion of the consumption of these vegetables can help reduce food insecurity and improve nutrition.
5. The cultivation of these green leafy vegetables in home gardens by home makers should be encouraged to prevent extinction of these green leafy vegetables and to make them easily available all seasons for family consumption.

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