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Proximate and Antinutritional analysis of some under-utilized leafy vegetables consumed in Ebonyi State Nigeria

Abstract

Colocasia esculenta, *Ipomoea aquatica* and *Pennisetum purpurem* collected from Afikpo, Abakaliki and Ohaozara areas of Ebonyi State, Nigeria, were analysed for proximate and antinutritional composition using standard procedures. Carbohydrate content of *Colocasia esculenta* ranged from 41.71±2.43 % to 55.28±1.03 % while that of *Ipomoea aquatica* ranged from 42.88±2.71 % to 59.60±2.51 %. For *Pennisetum purpureum*, the carbohydrate content ranged from 38.74±3.61 % to 51.13±2.04 %. Protein content of *Colocasia esculenta* ranged from 9.20±2.71 % to 20.11±3.00 %, while that of *Ipomoea aquatica* ranged from 17.40±0.46 % to 23 26±0.01 %, and that of *Pennisetum purpureum* ranged from 13.40±2.24 % to 22.08±1.75%. Crude fiber content of *Colocasia esculenta* ranged from 11.99±2.69 % to 18.75±4.24 % while that of *Ipomoea aquatica* ranged from 7.865±2.50 % to 16.18±2.39 %, and that of *Pennisetum purpureum* ranged fom 12.62±3.09 % to 22.67±2.52 %. Oxalate content (mg/100g) of *Colocasia esculenta* ranged from 14.44±6.34 to 16.67±2.22 while that of *Ipomoea aquatica* ranged from 16.58±0.47 to 20.78±0.29, and that of *Pennisetum purpureum* ranged from 16.94±1.29 to 23.92±3.00. The tannin content (mg/100g) of *Colocasia esculenta* ranged from 19.05±3.40 to 20.90±0.76 while that of *Ipomoea aquatica* ranged from 16.50±0.25 to 22.30±2.05 and that of *Pennisetum purpureum* ranged from 20.41±1.72 to 24.77±4.96. For Cyanide content (mg/100mg), that of *Colocasia esculenta* ranged from 2.44±0.01 to 4.23±2.93 while that of *Ipomoea aquatica* ranged from 2.03±0.10 to 3.43±0.52 and that of *Pennisetum purpureum* cyanide content ranged from 3.99±1.39 to 5.24±3.50. Phytate content (mg/100g) for *Colocasia esculenta* ranged from 19.21±6.65 to 22.88±2.26 while that of *Ipomoea aquatica* ranged from 19.26±0.41 to 21.68±1.26 and that of *Pennisetum purpureum* ranged from 22.01±0.73 to 30.31±9.40. In general, the vegetables were exceptionally rich in carbohydrate, protein and fiber. This shows that these vegetables could contribute greatly towards meeting human nutritional requirement for normal body growth and adequate protection against diseases which could result from nutrient deficiency.

Keywords: proximate, anti-nutritional, vegetables, afikpo, abakaliki and ohaozara

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Abbreviations: FAO, Food and Agricultural Organisation; WHO, World Health Organisation; ANOVA, Analysis of Variance; GLV, Green Leafy Vegetable

Introduction

Generally, the earth is blessed with a lot of leafy vegatables which are of immense economic importance. Among alternatives available to meet the food demands cultivable and wild vegetables are regarded as cheep source of food for the marginal communities.[1] According to the Food and Agricultural Organization (FAO), there are about 840 million undernourished people in 1998–2000, of whom 799 million are in developing countries like Nigeria, 30 million in the countries in transition and 11 million in the industrialized countries.[2,3] To apprehend the situation, interests have been centralized on the exploitation, quantification and utilization of food plants, especially the vegetables.[4]

Vegetables being the rich source of vitamins, carbohydrates, fats and proteins, which form the major portion of the human diet, are the cheaper source of nutrients. The importance of these bio-chemicals has been recorded by various scientists.[1]

Some diseases such as diabetes, obesity, cancer, and cardiovascular diseases are manifesting in developing countries than ever before and could be traced to inadequate consumption of fruits and vegetables. It has been projected by world Health organization (WHO) that, if this trend continues the percentage of people living with diabetes alone in developing countries will rise by 170%, from 84 million in 1995 to 228 million by the year 2025.[5]

Besides, moisture, fiber, and ash contents and the energy values of individual vegetable and plant species have also been regarded important to the human health and the soil quality.[6-8] Vegetables can be regarded as those substances which contain chemical compounds that can provide nourishment to the body. These nutrients include water, proteins, lipids, carbohydrates, minerals and vitamins. Additionally, most plant foods also consist of natural compounds or anti-nutrients that appear to function generally in defense against herbivores and pathogens. Anti-nutrients are potentially harmful and give rise to a genuine concern for human health, in that they prevent digestion and absorption of vitamins, minerals and other nutrients. These anti-nutrients may not be toxic as per say, but has the capacity of reducing the nutritional value of a plant there by leading to a deficiency in an essential nutrient or preventing thorough digestion and absorption when consumed by humans or animals.[9] Several anti-nutritional factors are present in plants and are partially neutralized during ordinary cooking. The remaining anti-nutrients can however, be responsIble for the development of serious gastric distress and

may interfere with digestion of nutrients, which inevitably results in chronic deficits in absorption of nutrients. Anti-nutritional factors include cyanogens, glycosides, saponins, phytate, enzyme inhibitors (trypsin and amylase inhibitors), lectins (haemagglutinins), oxalate and total polyphenols.

Amongst the vegetables of interest, Ipomoeae aquatica Forsk is a semi aquatic, tropical plant grown as a leafy vegetable. It is found throughout the tropical and subtropical regions of the world. It belongs to the family of Convolvulaceae and can also be called water spinach or water morning glory.[10] Ipomoea aquatica grows in water or on moist soil. The stems are 2-3 meters (7-10 cm) or more long, rooting at the nodes and they are hollow and can float. In several parts of the East, this vegetable is used to make soup, pottage yam. It popularly referred to as otele-piriri in Afikpo in Ebonyi State. Pennisetum purpureum (Schumach), commonly known as elephant grass or Napier grass belongs to the Poaceae (alt. Gramineae) family. It is called achara by the Ibo speaking people of South Eastern Nigeria. It is generally used as animal feed, an ornamental and for erosion control.[11] The dried matured shoots are used for making fences in Northern Nigeria. The people of Ebonyi State, Abia State, in South Eastern Nigeria use the matrixes of the matured shoots are used for preparing the special soup called 'ofe achara". As noted by Mala et al.[12] that although measures are being taken to boost food production by conventional agriculture, a lot of interest is currently being focused on the possibilities of exploiting the vast number of less familiar food plant resources. Recently, however, it has been incorporated into a pest management strategy. This technique involves the desired crop being planted alongside a 'push' plant, which repels pests, in combination with a 'pull' crop around the perimeter of the plot, which draw insects out of the plot.[13]

Colocasia esculenta is widely cultivated across the world especially in the tropics. It is commonly known as Cocoyam, Elephant ear or Taro, belonging to the Araceae family.[14] In Ebonyi state, Nigeria, both the corm and the leaf of cocoyam are consumable. The corm can be prepared in various ways and the leave as vegetable for soup majorly in the rural areas. Although a few works have been done on the corm, there is still a very scanty work that has been done on the leave of cocoyam probably because of the prevalent believe that the vegetable is exclusively for the marginal communities. And so, no detailed research work done on the phytochemical composition activity of these three (3) vegetables consumed in Ebonyi state, Nigeria.

From Figure 1 to Figure 4

Figure 1 Colocasia esculenta.

Figure 2 Pennisetum Purpureum.

Figure 3 Ipomoeae aquatic.

Figure 4 Map of Ebonyi State.

Materials and Method

Afikpo, Abakaliki and Ohaozara areas of Ebonyi State were each sub-divided into three zones (A, B and C) and composite samples of the young leaves of Ipomoeae aquatic, Pennisetum purpureum and Colocasia esculenta were collected from each of the zones. The samples were prepared by washing thoroughly to remove dust, soil and other contaminants. Furthermore, the outer covering of Pennisetum purpureum and Colocasia esculenta was removed to obtain the innermost tender part of the vegetables. They were cut into small pieces and air-dried for 7 days in the laboratory. After which, all the samples were ground into powder and sieved through 2mm mesh to ensure uniform particle size. The proximate analysis was carried out to obtain values for moisture, crude protein, carbohydrate, crude fibre, crude ash, and crude fat content following the procedure described by Salgado et al.[15]

Anti-nutritional factor determination

Oxalate

The total oxalate was determined according to the procedure of Wilhelmy et al.[16] The extraction was done by weighing 1 g of each of the pulverized vegetable samples and soaked in 100 cm^3 of distilled water. These were allowed to stand for 3 hours and then filtered through a double layer of filter paper. 10, 20, 30, 40 and 50 ppm standard solution with oxalic acid was also prepared and read on the spectrophotometer at 420 nm for the absorbance.

Phytate

The vegetable samples were analyzed for the presence of phytates using the method of,[16] 2g of each sample was weighed. 100 cm^3 of 2% concentrated hydrochloric acid was used to soak each sample into conical flask for 3 hours and filtered through a double layer filter paper. 50 cm^3 of filtrate was measured into a 250 cm^3 beaker and 10 cm^3 of distilled water added in each case to give proper acidity. 10 cm^3 of 0.3% ammonium thiocyanate solution was also added into each solution as indicator. The resultant solution was then titrated with standard iron (III) chloride solution which contains 0.00495 g iron per cm^3. The titration was stopped as the colour changed to brownish-yellow which persisted after 5 mins.

Tannin

5g of the ground sample was shaken constantly for 1 min in 3 cm^3 of methanol in a test tube and then poured into a Buchner funnel with the suction already turned on. The tube was rinsed with an additional 3 cm^3 of methanol and the content poured at once into the funnel. The filtrate was mixed with 50 cm^3 of water and analyzed within an hour. For aqueous extractions, 5 cm^3 of water was used for the extraction and for the rinse and the filtrate added to 50 cm^3 water. 3 cm^3 of 0.1 cm^3 $FeCl_3$ in 0.1 NH_4Cl was also added to 5 cm^3 of the extract and followed immediately by timed addition of 3 cm^3 of Potassium hexaferrate ($K_2Fe(CN)_6$). The absorbance was taken at 720 nm spectrophotometrically.[17]

Saponin

Saponin was determined by weighing 0.5 g of the sample into 20 cm^3 of 1 M HCl and boiled for 4 hours then Cooled and filtered. 50 cm^3 of petroleum ether then added to the filtrate for ether layer and evaporated to dryness. 5 cm^3 of acetone ethanol was added to the residue. 0.4 cm^3 of each then taken into 3 different test tubes. 6 cm^3 of Ferrous sulphate reagent then added into them followed by 2 cm^3 of conc. H_2SO_4 and then thoroughly mixed after 10 min and the absorbance was taken at 490 nm.[15]

Alkaloids

Alkaloids were determined using the procedure of Prajapati et al.[18] 2 g of sample was weighed and 20 cm^3 of 80% alcohol was added to give a smooth paste. The mixture was digested in a boiling water bath for 1.5 h under a reflux air condenser with occasional shaking. The mixture was filtered white hot through a small Buchner funnel. The residue was returned to the flask and redigested for 30 min with 50 cm^3 alcohol after which the alcohol will be evaporated, adding hot water to replace the alcohol lost. When all the alcohol has been removed, 2 to 3 drops of 10% HCl was added and the whole solution was later transferred into a 150 cm^3 volumetric flask. 5 cm^3 of zinc acetate solution and 5 cm^3 of potassium ferrocyanide solution was added, thoroughly mixed to give a homogenous solution.

The flask was allowed to stand for a few minutes, filtered through a dry filter paper and 10 cm^3 of the filtrate was transferred into a separating funnel and the alkaloids present were extracted vigorously by shaking with five successive 30 cm^3 portions of chloroform. The residue obtained was dissolved in hot water and transferred into a Kjeldahl flask with the addition of 0.2 g sucrose and 10 cm^3 conc. H_2SO_4 and 0.02 g selenium for digestion to a colourless solution. To determine the percentage of NH_3 by Kjeldahl distillation method percentage nitrogen gotten is converted to a percentage total alkaloid by multiplying by a factor of 3.26.

The results were expressed as mean ± standard error of mean of different replicates. Significance differences between values are determined using student's T-test and compared among the groups using the Statistical Package for the Social Sciences (SPSS) for mean standard deviation and analysis of variance (ANOVA). Differences existed at $P < 0.05$.[19]

Results and discussion

The results are arranged in Tables 1 and 2 to show results for mean values of proximate analysis, and Antinutritional analysis of the vegetables respectively. The results obtained for each of the vegetables from the three different locations were compared, viz-a-viz those obtained from literature.

Results

Table 1a to Table 2c

Table 1a Mean of Proximate analysis of *Colocasia esculenta*

Location	Moisture(%)	Ash (%)	CrudeProtein(%)	CrudeFiber(%)	Lipid (%)	Carbohydrate(%)	Energy(kcal)
Afikpo	0.34 ± 0.04^a	10.36 ± 1.67^b	9.20 ± 2.71^a	18.75 ± 4.24^a	5.93 ± 1.64^a	55.28 ± 2.76^b	311.30 ± 25.47^a
Abakaliki	0.61 ± 0.02^b	18.95 ± 1.12^c	20.11 ± 3.00^c	11.99 ± 2.69^a	6.86 ± 0.29^a	41.71 ± 2.43^a	308.90 ± 16.54^a
Ohaozara	0.40 ± 0.04^a	3.03 ± 0.96^a	14.47 ± 1.47^b	15.54 ± 3.40^a	11.29 ± 3.65^b	55.28 ± 1.03^b	380.38 ± 35.27^b

Table 1b Mean of Proximate analysis of *Ipomoea aquatic*

Location	Moisture (%)	Ash (%)	CrudeProtein(%)	CrudeFiber(%)	Lipid (%)	Carbohydrate(%)	Energy(kcal)
Afikpo	0.46 ± 0.08^b	2.41 ± 0.47^a	17.40 ± 0.46^a	11.38 ± 3.68^{ab}	8.75 ± 3.43^b	59.60 ± 2.51^c	386.71 ± 30.49^b
Abakaliki	0.76 ± 0.01^c	16.09 ± 1.95^c	20.55 ± 0.38^b	7.85 ± 2.50^a	2.73 ± 0.32^a	52.01 ± 4.27^b	314.85 ± 15.76^a
Ohaozara	0.19 ± 0.03^a	10.44 ± 0.09^b	23.36 ± 0.01^c	16.18 ± 2.39^b	6.53 ±0.51^{ab}	42.88 ± 2.71^a	325.57 ± 8.84^a

Values expressed as mean ± standard deviation

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Table 1c Mean of Proximate analysis of *Pennisetum pupereum*

Location	Moisture(%)	Ash (%)	CrudeProtein(%)	CrudeFiber(%)	Lipid (%)	Carbohydrate(%)	Energy (kcal)
Afikpo	0.52 ± 0.02[a]	4.98 ± 0.53[a]	14.85 ± 0.16[a]	22.67 ± 2.52[b]	5.85 ± 1.89[a]	51.13 ± 2.04[b]	285.42 ± 56.09[a]
Abakaliki	0.64 ± 0.12[b]	19.98 ± 2.69[c]	22.08 ± 1.75[b]	12.62 ± 3.09[a]	5.89 ± 0.93[a]	38.74 ± 3.61[a]	296.19 ± 26.37[a]
Ohaozara	0.42 ± 0.00[a]	10.92 ± 1.41[b]	13.40 ± 2.24[a]	22.36 ± 3.52[b]	10.07 ± 2.00[b]	42.84 ± 2.84[a]	319.04 ± 21.89[a]

Values expressed as mean ± standard deviation

Table 2a Mean of Anti-nutrient analysis of *Colocasia esculenta*

Location	Oxalate (mg/100g)	Tannins (mg/100g)	Cyanide (mg/100g)	Phytate (mg/100g)	Saponin (mg/100g)	Alkaloid (mg/100g)
Afikpo	16.67±2.22[a]	19.05±3.40[a]	4.23±2.93[a]	22.88±2.26[a]	6.31±3.36[a]	9.94±4.49[a]
Abakaliki	15.27±0.06[a]	20.90±0.76[a]	3.22±1.34[a]	20.05±1.46[a]	3.61±0.77[a]	12.64±1.70[ab]
Ohaozara	14.44±6.34[a]	20.83±3.75[a]	2.44±0.01[a]	19.21±6.65[a]	3.72±0.02[a]	18.59±4.52[b]

Values expressed as mean ± standard deviation

Table 2b Mean of Anti-nutrient analysis of *Ipomoea aquatic*

Location	Oxalate (mg/100g)	Tannins (mg/100g)	Cyanide (mg/100g)	Phytate (mg/100g)	Saponin (mg/100g)	Alkaloid (mg/100g)
Afikpo	16.84±1.40[a]	22.30±2.05[b]	2.03±0.10[a]	19.26±0.41[a]	5.65±0.32[a]	10.42±0.00[a]
Abakaliki	16.58±0.47[a]	17.50±2.51[a]	2.93±1.05[a]	20.15±1.84[a]	5.26±1.66[a]	15.47±0.51[c]
Ohaozara	20.78±0.29[b]	16.50±0.25[a]	3.43±0.52[a]	21.68±1.26[a]	3.63±0.08[a]	13.24±0.37[b]

Table 2c Mean of Anti-nutrient analysis of *Pennisetum purpureum*

Location	Oxalate (mg/100g)	Tannins (mg/100g)	Cyanide (mg/100g)	Phytate (mg/100g)	Saponin (mg/100g)	Alkaloid (mg/100g)
Afikpo	23.92±3.00[a]	20.41±1.72[a]	4.60±2.88[a]	22.01±0.73[a]	3.70±0.63[a]	9.04±1.26[a]
Abakaliki	16.94±1.29[a]	24.77±4.96[a]	3.99±1.39[a]	30.31±9.40[a]	4.34±0.25[a]	17.49±7.86[a]
Ohaozara	23.40±8.15[a]	22.43±7.00[a]	5.24±3.50[a]	22.58±3.69[a]	2.98±1.38[a]	16.50±0.55[a]

Moisture content

The results revealed that for Ipomoea aquatica, the moisture of the vegetables collected from Abakaliki location appeared to have the highest value (0.76 % DW). Also in Afikpo sampling location, pennisetum purpureum had the highest value (0.52 % DW) and Ohaozara location shows that out of the three vegetables sampled from there, pennisetum purpurem was the highest (0.42 % DW). It is also important to note that the vegetable that showed the least moisture content was Ipomoea aquatica sampled from Ohaozara location (0.19 % DW). This shows a significant difference when compared with (5.00 – 10.00 % DW) moisture of some selected vegetable species reported by Joshi et al.[20]

Ash content

The mean tables revealed that content of Pennisetum purpuruem sampled from Abakaliki was the highest (19.98 %) and Colocasia esculenta also from this particular location showed 18.95 % ash and that of Ipomoea aquatica showed 16.09 %. The ash content of those vegetables sampled from Afikpo location was consistently lower than other locations apart from that of Colocasia escuenta which was a bit higher than others (10.36 %). It is important to note that the ash content of Ipomoea aquatica sampled from Afikpo showed the least value of 2.41 %. Azeke et al.[21] carried out a research on water spinach in the Northeastern region of Nigeria. They came up with 10.83 % ash content which is closer to the values obtained from Abakaliki and Ohaozara locations except that of Afikpo location which showed a significant difference (2.41 %). Aremu et al.[22] conducted a research only on Pennisetum purpureum around rivers state and reported 18.18 % DW and 2.00 % WW which was quite higher than the value of the Pennisetum purpuruem sampled from Afikpo (4.98 % DW). The importance of ash content in plants can not be over emphasized since it is the index of mineral biota.[20] Also Isirima et al.[23] conducted a study of rural Fulani Northeastern Nigeria and reported a high ash content in some green vegetables used by lactating mothers such as bitter leaves (Veronia colorate) and Moringa oleifera (15.09 % DW). This indicates that those leaves like Pennisetum purpureum, Colocasia esculenta and Ipomoea aquatica with ash content 19.28 % DW, 16.09 % DW and 18.95 % DW respectively collected from Abakaliki location could be good sources of mineral. This difference could be as a result of the composition of the soil.

Crude protein

The three (3) vegetables Pennisetum purpureum, Colocasia esculenta and Ipomoea aquatica collected from Abakaliki showed significantly high crude protein content of 20.11 %, 20.55 % and 22.08 % respectively. Also the mean tables of the result revealed that the Ipomoea aquatica collected from Ohaozara location showed even higher crude protein content of 23.36 %. The least was the Colocasia esculenta sampled from Afikpo location which showed 9.20 %. The values obtained appeared a little less when compared with other plants such as Ipomoea batatas leaves gotten from the South South part of Nigeria with crude protein content of 24.85 %,[24] but were within 11.67 – 18.00 % as reported by Laswai et al,[25] Kumar et al.[26]

reported 24.37 - 29.46 % crude protein for sweet potatoes leaves in Morogoro, Tanzania. Khammarnia et al.[27] reported that the protein level of green leafy vegetable (GLV) consumed Cameroun ranges from 20.48 – 41.66 %. Furthermore, the protein content of the three vegetables analysed could make significant contribution to the dietary intake especially during pre-harvest period when domesticated foods are in short supply. Oyeyemi et al.[28] reported that adults, pregnant and lactating mothers require 34 – 56 g, 13 – 19 g and 71 g of protein daily respectively.

Crude fiber

From the mean table of results, Pennisetum purpureum had the highest percentage fiber content of 22.67 % and 22.36 %. This was followed by Colocasia esculenta (18.75 %) and Ipomoea aquatica (16.18 %). Comparing the sampling locations, Pennisetum purpureum samplied form Afikpo location had the highest fiber content of 22.67 % followed by that from Ohaozara location (22.36 %). Ipomoea aquatica sampled from Abakaliki location had the least percentage fiber (7.85 %) which was very close to that obtained in Ipomoea batatas leaves consumed in South South part of Nigeria as reported by War,[24] but lower than 45.70 – 46.05 % DW reported as dietary fiber in Japanese Ipomoea batatas leaves.[25] One of the disadvantages of the use of vegetables as fiber in human nutrition is their high fiber content which invariably causes intestinal irritation and lower nutrient bioavailability, hence large quantities of plant vegetables have to be consumed to provide adequate levels of nutrients. On the other hand, intake of dietary fiber can lower the serum cholesterol level, risk of coronary heart disease, hypertension, constipation, diabetes, colon and breast cancer.[25] The RDA of fiber for children, Adult, pregnant and lactating mothers are 19 – 25%, 21 – 38 %, 28 % and 29 % respectively.[19] Thus Pennisetum purpureum could be a more valuable source of dietary fiber in human nutrition.

Crude lipid

Among the three vegetables analysed, Colocasia esculenta happened to contain the highest percentage of crude lipid (11.29 %), followed by Pennisetum purpureum (10.07 %) while the least is Ipomoea aquatica (8.75 %). In comparing the sampling locations, samples collected from Ohaozara location appeared to be higher than those from other locations. In this particular location, Pennisetum purpureum, Ipomoea aquatica and Colocasia esculenta showed 10.07 %, 6.53 % and 11.29 % respectively. Samples from Abakaliki location were relatively the lowest with range 2.73 – 6.86 % which falls within the value (4.20%) obtained by War,[24] from Ipomoea batatas leaves consumed in South part of Nigeria and slightly within the range of 2.56 – 6.82 % DW, Laswai et al,[25] reported in Ipomoea batatas leaves. Also, the vegetables collected from Ohaozara location fall within the range 8.5 – 27.8 % reported in some wild green leafy vegetables GLV of Nigeria and republic of Nigera.[29]

Carbohydrate

The mean result presents a significantly high percentage of carbohydrate of 59.60 %, 55.28 % and 51.13 % for Ipomoea aquatica, Colocasia esculenta and Pennisetum purpureum respectively. This shows that Ipomoea aquatica contained the highest percentage of carbohydrate ranging from 42.88 – 59.60 %, Colocasia esculenta 41.71 – 55.28 % and Pennisetum purpureum ranged from 38.74 – 51.13 %. In terms of the sampling locations, Afikpo location showed a consistently high percentage of carbohydrate content while Abakaliki happened to be the least. The values are comparable to 51.80 % in Moringa stenopetala leaves[30] and 54.20 % Ipomoea aquatica leaves[22] conducted in Kebbi State, Nigeria. The estimated available carbohydrate was within that obtained from Trianthema portulacastrum, Spinach oleracea and Praecitrullus fistulosus 40.99 %, 48.82 % and 38.96 % respectively[19]. But lower than Solanium melongena, Abelmoschus esculentus, Luffa acutangula Cucurbita moschata and Cucumis sativus 63.87 %, 60.90 %, 71.54 %, 74.13 % and 64.62 % respectively.[19]

Energy value

Energy value was obtained in Kilocal/100g. The result presents a range of 308.90 – 380.38 Kilocal/100g for Colocasia esculenta, 314.85 – 386.71 Kilocal/100g for Ipomoea aquatica and 285.42 – 319.04 Kilocal/100g for Pennisetum pupureum. Comparing the sample locations, Afikpo location were found to have the energy value range from 285.42 – 386.71 Kilocal/100g (highest) while those samples from Abakaliki and Ohaozara locations were found to be 296.38 – 314.85 Kilocal/100g and 319.04 – 380.38 Kilocal/100g respectively. These values were a little lower compared to 351.30 Kilocal/100g reported in some Nigerian leafy vegetables.[24] The results were also within (276.85 – 359.18 Kilocal/100g) energy values obtained in the various vegetables from Kohat region of Pakistan.[19]

Oxalates

The mean result revealed 14.44 – 16.67 mg/100g, 16.58 – 20.78 mg/100g and 16.94 – 23.92 mg/100g of Oxalates present in Colocasia esculenta, Ipomoea aquatica and Pennisetum purpureum respectively. This means that Ipomoea aquatica showed the highest oxalate. In terms of the sampling location, Afikpo samples were consistently high in oxalate especially Pennisetum purpureum (23.92 mg/100g). Abakaliki samples were thee least in oxalate content (15.27 – 16.94 mg/100g). Ohaozara samples were between 14.44 – 23.40 mg/100g. Joddy & Zilpah,[31] reported a higher oxalate 418 mg/100g in groundnut oil and 495 mg/100g in palm oil. Huang et al.,[32] reported a maximum tolerable limit of 3 to 5g for man.Oxalate is a concern because of its negative effect on mineral availability. Presence of oxalates in foods causes irritation in the mouth.[16] High oxalate in diet can increase the risk of renal calcium absorption and has been implicated as a source of kidney stone.[33] The level of oxalates in these vegetables can be reduced by blanching or cooking.

Tannin

Tannin content for Colocasia esculenta was found to be between 19.05 and 20.83 mg/100g. And that of Ipomoea aquatica and Pennisetum purpureum were found to be 17.50 – 22.30 mg/100g and 20.41 – 22.43 mg/100 g respectively. The vegetables sampled from Abakaliki were significantly higher in tannin (17.50 – 24.77 mg/100g), followed by those from Ohaozara location (17.50 – 22.43 mg/100g) and Afikpo location (19.05 – 22.41 mg/100g). Winiarska-Mieczan et al,[34] reported tannin content of ripe fruits of Spondias mombin (Mombin Plum) from Cote d'Ivoire to range from 69.69 to 142.61 mg/100 g. These results showed high values of Tannin but may be as a result of the fact that raw samples were used for the analysis and can be reduced by cooking or blanching processes. Many studies have shown that tannin is carcinogenic and excessive ingestion of tannin from sources over a prolonged period of time is detrimental to health.[35]

Cyanide

The mean result revealed that cyanide content is highest in Pennisetum purpureum (3.99 – 5.24 mg/100 g) followed by Colocasia esculenta (2.44 – 4.23 mg/100 g) and Ipomoea aquatica showed the least value of cyanide. In terms of the sample location, samples

collected from Afikpo were consistently high in cyanide (2.03 – 4.60 mg/100g), samples from Ohaozara also showed high cyanide content (2.44 – 5.24 mg/100g) and samples from Abakaliki location were the least (2.93 – 3.99 mg/100g). These value are higher than the value reported by Winiarska-Mieczan et al.,[34] of Punica granatum fruits from Nigeria and Saudi Arabia (0.08 mg/100g) and (0.28 mg/100g) respectively. Consumption of high level of cyanide is associated with a serious health problem, a neurological disease known as Tropical Ataxia neurophathy (TAN) was linked to consumption of high level of cyanide in cassava based diet.[36] Similar to others, the effect of this can also be reduced by boiling and even soaking in the water allowed to ferment.

Phytate

The mean result showed high concentration of phytate in the vegetables analysed. Pennisetum purpureum showed the highest concentration of phytate content (22.01 – 30.31 mg/100g), Colocasia esculenta (19.21 – 22.88 mg/100g) while Ipomoea aquatica contain the least amount phytic acid (19.26 – 21.68 mg/100g). Looking at Abakaliki sample location, the samples contain the highest concentration of phytate (20.05 – 30.31 mg/100g) while that of Afikpo Ohaozara samples were almost within the same range (19.21 – 22.88 mg/100g). The values were significantly moderate compared to 418 mg/100g in groundnut oil as reported by Joddy & Zilpah.[31] Also, sweet cassava contains higher phytate (216 mg/100g) and bitter cassava (304.00 mg/100g) as reported by Atli.[37] Phytate is an organically bound form of phosphorus in plant. Phytate in foods are known to bind with essential minerals (such as calcium, Iron, magnesium and zinc) in the digestive tract, resulting in mineral difficiency.[38] They bind minerals to form insoluble salts, thereby dereasing their bioavailability or absorption.[39]

Saponnin

Generally, saponnin values were moderately low. It was least in Pennisetum purpureum and almost the same range for Ipomoea aquatica and Colocasia esculenta, 2.98 – 4.34 mg/100g and 3.61 – 6.31 mg/100g respectively. Unlike the values of phytate content, saponnin concentration was highest in Afikpo location (3.70 – 6.31 mg/100g), Abakaliki samples were between 3.61 – 5.26 mg/100g while Ohaozara location showed the least concentration of saponnin in the vegetables analysed. Saponnin are glucosides, which include steroid saponnins and triterpeniods saponnins.[40] High level of saponnin in feed affects growth rate in poultry. In excess causes hypocholestroleamia because it binds cholesterol thereby making it unavailable for absorption.[41]

Alkaloids

Alkaloids content in Colocasia esculenta was the highest according to the result (9.94 – 18.59 mg/100g). This is followed by Pennisetum purpureum (9.04 – 17.49 mg/100g) and the least was Ipomoea aquatica (10.42 – 15.47 mg/100g). On the area of sampling location, the vegetable sampled from Afikpo location showed the least in alkaloid content (9.04 – 10.42 mg/100g) and those sampled from Ohaozara were a little higher (13.24–18.59 mg/100g) while those vegetables sampled from Abakaliki location were highest (12.64–17.49 mg/100g). The vegetables are moderately rich in Alkaloids. Alkaloids and some other antinutrients are known to have antimicrobial activity as well as other physiological activities.[42]

Conclusion

The results generally have shown that Ipomoea aquatica, Colocasia esculenta and Pennisetum purpureum, like are rich are rich in fibre, carbohydrates, protein, energy, and ash. Looking for vegetable specie with abundant level of protein, Ipomoea aquatica grown in Ohaozara location is a good option. Also Pennisetum purpureum grown in Afikpo location is the richest source of Fiber. For a recommendably rich source of carbohydrate and energy for nutritional improvement, Ipomoea aquatica grown in Afikpo location stands the best option among the three. This means that these vegetables grown in the recommended locations could contribute greatly towards meeting human nutritional requirement for normal body growth and adequate protection against diseases which could result from malnutrition. According to the result, Pennisetum purpureum grown in Afikpo area happens to contain more Oxalates and Tannin than those grown in Abakaliki location. Pennisetum puurpureum grown in Abakaliki location had higher phytic acid. Saponnins were low, but saponnin content of Colocasia esculenta grown Afikpo was higher than that of Abakaliki. Colocasia esculenta, Pennisetum purpureum and Ipomoea aquatica can provide wide range of nutrients which can adequately meet the demands of the body. The vegetables should also be properly processed and cooked before consumption, since cooking and fermentation do indeed reduce the antinutritional factor.[35]

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None

Conflits of interest

The authors declare that they have no conflict of interests.

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