



## Proximate, Phytochemicals and Reducing Power of Leaf Extracts of *Colocasia esculenta* and *Ipomoea batatas*

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### Authors' contributions

This work was carried out in collaboration among all authors. Author AAE designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors UCC and MN managed the analyses of the study. Author UCC managed the literature searches. All authors read and approved the final manuscript.

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### ABSTRACT

**Background:** Reports has shown that edible leaves of vegetable plants serve both nutritional and medicinal purposes, yet are poorly utilized due to inadequate enlightenment of the major populace on their compositions.

**Aims:** The aim of this study was to determine the proximate, phytochemicals and reducing power of leaf extracts of *Colocasia esculenta* and *Ipomoea batatas*.

**Methodology:** Washed and air dried leaf samples were milled and subjected to proximate and phytochemical analysis. Determination of calcium, iron and sodium content was by Atomic absorption spectroscopy. Reducing power was determined by the Potassium ferricyanide reducing power method.

**Results:** *Ipomoea batatas* leaves was found to be higher in moisture (14.05%) and carbohydrate (29.33%) while *Colocasia esculenta* leaves was higher in ash (10.00%), Crude fiber (16.27%), Fat

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(10.17%) and protein (29.41%). A better antioxidant activity and higher levels of all phytochemicals and minerals were observed in leaves of *Colocasia esculenta* compared to leaves of *Ipomoea batatas*.

**Conclusion:** This study suggests that both leaves are of importance to human nutrition considering the observed levels of nutrients, phytochemicals and antioxidant activity. While *C. esculenta* leaves should be preferred for its nutrient and antioxidant advantages, both leaves can contribute immensely to the daily nutrient requirements.

**Keywords:** Proximate; phytochemical; antioxidant; *Colocasia esculenta*; *Ipomoea batatas*.

## 1. INTRODUCTION

Plants are the main sources of Carbohydrate, Protein, Mineral and dietary fiber as well as other non-nutrient bio active compounds. In Nigeria, tuber crops provide the Carbohydrate while leafy vegetables are the major sources of vitamins, dietary fibres, essential amino acids and antioxidants [1]. In spite of the recognized health advantages of leafy vegetables, the availability and consumption in Nigeria is inadequate, partly due to low production, seasonality and susceptibility of these vegetables to various environmental production constraints. It is unfortunate to note that these vegetables though rich in nutritional composition suffer poor utilization due to the inadequate enlightenment of the major populace about the nutritional content of the vegetables.

The complex metabolic events occurring inside the cell of an organism involve a number of oxidative reactions. These reactions produce variety of free radicals which can cause cell damage. A genre of reducing agents exists in the biological world and is known as antioxidants. These antioxidants are well known to quench the free radicals generated due to numerous metabolic reactions in the cell. Hence, the activity possessed by these chemicals is termed as antioxidant activity. However, these antioxidants are a group of plant originated chemicals represented as phytochemicals. It is well known that no single antioxidant is effective in combating the various free radicals and its recovery from various forms of fruits and vegetables is a recent area of research [2].

Leafy vegetables are highly beneficial for maintenance of health and prevention of diseases. They contain valuable source of food ingredients that can be utilized to build up and improve the body [3]. Vegetables are important foods both from economic and nutritional stand points. Their nutritive significance is the richness in minerals which is very essential in the maintenance of human health [4], Minerals such

as iron and calcium are important component of healthy diet, if consumed daily in required amounts, could help prevent major diseases such as cardiovascular disease and certain cancers [5].

Vegetables are at their best when tender or succulent. Many of them can easily be grown in home gardens, thus provides economic, easy access and handy sources of fresh vegetables with active enzymes and nutrients [6]. In Nigeria, vegetables are used for making soups. Most of the leafy vegetables such as *Amaranthus hybridus* L, *Ocimum grattissimum*, *Hibiscus sabdarifa*, *Ocimum bailicum* L. found in Igala land of Kogi state are rich in potent bioactive compounds that can serve therapeutic purposes or as precursors for the synthesis of useful drugs [7]. The feeling of fullness produced by intake of leafy vegetables helps in controlling overweight & obesity since they are low in calories and high in fibres. Leafy vegetables alleviate the problems of malnutrition dominant in tropical Africa [8]. There are over 40 indigenous leafy vegetables eaten in Nigeria. Mensah, et al. [9] identified 29 different green leafy vegetables in Edo state, Nigeria. Indigenous leafy vegetables are valuable sources of food, income and traditional medicine in Nigeria [9,10]. Such Indigenous edible vegetable leaves include white cocoyam leaf (*Colocasia esculenta*) and white sweet potato leaf (*Ipomoea batatas*).

Cocoyam is an herbaceous perennial plant belonging to the family Araceae. It is a root crop cultivated mainly for the edible corms (tuber), although the leaves, petioles and the flowers are used in soup preparation. It constitutes one of the basic food crops of major economic importance in Nigeria. Chukwu, et al. [11] stated that it ranks the third after cassava and yam in terms of total production, land area under crop and consumption. The corms can be boiled or baked and consumed in different forms as soup thickeners, pounded "fufu" and can also be roasted in fire and can also be prepared as a porridge. According to Ajala and Obiechina [12],

the flour of the cocoyam can also be used for the preparation of soups, biscuit, bread and pudding.

Cocoyam corm supplies easily digestible starch and is known to contain substantial amount of protein, vitamin c, thiamine, riboflavin, niacin and significant amount of dietary fiber. Other part of cocoyam plant such as the leaves, flowers and stems are also consumed especially in sauces, purees, stews and soups, depending on the varieties and the local cultural traditions [13].

Sweet potato (*Ipomoea batatas*) is a crop of great nutritional and health significance mainly due to the high concentration of anthocyanin and beta-carotene combined with the high stability of its colour extract makes sweet potato leaves a healthier alternative to synthetic food colouring agents [14]. In some parts of Nigeria, the vines of sweet potato are used as soup ingredients for their flavor, appearance, palatability, and tenderness [15]. The leaves are excellent sources of antioxidative polyphenolics compared to other commercial vegetables [16]. The leaves are consumed as tea in Japan and is believed to serve medicinal purposes for treatment of diabetes and to help reduce the risk of cancer [17]. Sweet potato leaves can be harvested almost on a monthly basis and it is generally tolerant to many diseases, pest, flooding and drought. Its leaves can therefore be served as an important source of vegetables to nutritionally deprived populations in Africa especially during periods of adversity.

Therefore the objective of this study was to compare the proximate, phytochemicals and *in vitro* antioxidant activities of leaf extract of *Colocasia esculenta* and *Ipomoea batatas*.

## 2. MATERIALS AND METHODS

### 2.1 Sample Collection

The leafy vegetables of *Colocasia esculenta* (white cocoyam) and *Ipomoea batatas* (white sweet potato) were purchased after a fresh harvest from a local market in Anyigba, Kogi state. The leaves were authenticated by a taxonomist, Mr. Kingsley Onyia at the Herbarium unit, Department of Bioscience, Kogi State University Anyigba, Kogi State.

### 2.2 Preparation of Leaves for Chemical Analysis

Upon arrival at the laboratory, the fresh vegetables (without insect bite marks) were

immediately washed under tap water and excessive water dripped off, air dried for 72 hours to prevent nutrient loss and to retain the greenish colour. Leaves were cut into small pieces. Kenwood blender (8K 31, 220-240v) was used to mill the samples to fine powder. The powdered leaves was used for analysis immediately, but otherwise were transferred into a clean and air-tight container and kept at -20°C before analysis [18,19]. The powdered leaves were macerated in 80% methanol to obtain the hydro-alcoholic crude extract using Erlenmeyer flask for 3 days at room temperature. After 72 hours, the filtrate was separated from the marc by using filter paper (Whatman No.1). The marc was re-macerated twice. Then the alcohol was allowed to evaporate from the filtrate with mild heating on dry oven to dry at 40°C and then the concentrated extract was stored at 4°C for phytochemical screening and reducing power determination [20].

### 2.3 Determination of Proximate Composition

The macronutrient composition of each treatment was determined using the procedures of Association of Official Analytical Chemists (A.O.A.C) [21]. The macronutrient composition consists of ash content, moisture content, crude protein, crude fat, crude fibre and available carbohydrate.

### 2.4 Determination of Micronutrients (Calcium, Iron, Sodium)

The Atomic Absorption Spectrophotometer (Varian company USA) was used for the analysis of minerals. The ash solutions of the leaves were prepared by weighing 5 g of the powder ignited at 550°C in muffle furnace (Tactical 308) for 5 hours and the residues dissolved in 100 ml of deionized water, suitable salts of the metals were used to prepare their standards, lamps were fixed. The standard minerals solutions were injected to calibrate the AAS using acetylene gas. An aliquot of ash solutions were injected and concentrations obtained from the AAS [21].

### 2.5 Phytochemical Analysis

Phytochemical analysis of extract was carried out according to the general method of Harbourne [22], except otherwise stated.

### 2.5.1 Test for saponins

The extract (1 g) was marcerated with 10 ml of petroleum ether and decanted into a beaker. Another 10 ml of the petroleum ether was added into the beaker and the filtrate evaporated to dryness. The residue was dissolved in 6 ml of ethanol. The solution (2 ml) was put in attest tube and 2 ml of chromagen solution added into it. It was left to stand for 30 minutes and the absorbance was read at 550 nm.

### 2.5.2 Test for tannins

The extract (1 g) was marcerated with 50 ml of methanol and filtered. To the filtrate (5 ml), 0.3 ml of 0.1N ferric chloride in 0.1N HCL and 0.3 ml 0.0008M potassium ferricyanide were added and the absorbance read at 720 nm.

### 2.5.3 Test for phenols

The extract (1 g) was marcerated with 20 ml of 80% ethanol and then filtered. The filtrate (5 ml) was added to 0.5 ml of folinciocalteus reagent and allowed to stand for 30 minutes. Then 2 ml of 205 sodium carbonate was added and absorbance measured at 650 nm.

### 2.5.4 Test for flavonoids

The extract (1 g) was marcerated with 20 ml of ethylacetate for 5 minutes and filtered. To the filtrate (5 ml), 5 ml of dilute ammonia was added and shaken for 5 minutes. The upper layer was collected and the absorbance read at 490 nm.

### 2.5.5 Test for glycosides

The extract (1 g) was marcerated with 50 ml of distilled water and filtered. To the filtrate (1 ml), 4 ml of alkaline pirate solution was added. The mixture was boiled for 5 minutes and allowed to cool. The absorbance was read at 490 nm.

## 2.6 Reducing Power

For the measurement of reductive ability,  $Fe^{3+}$   $Fe^{2+}$  transformations in the presence of *I. batatas* and *C. esculenta* methanolic extracts were investigated following the standard method [23]. According to this method, the aliquots of various concentrations of the standard and test sample extracts (25 to 100  $\mu$ g/ml) in 1 ml of deionised water were mixed with 25 ml of (pH 6.6) phosphate buffer and 2.5 ml of of (1%) potassium ferricyanide. The mixture was incubated at 50°C in water bath for 20 minutes after cooling. Aliquots of 2.5 ml of (10%)

trichloroacetic acid were added to the mixture, which was then centrifuged at 3000 rpm for 10 minutes. The upper layer of solution 2.5 ml w as mixed with 2.5 ml distilled water and a freshly prepared 0.5 ml of (0.1%) ferric chloride solution. The absorbance was measured at 700 nm in UV spectrophotometer (JENWAY 6305). A blank was prepared without adding extract.

### 2.6.1 Preparation of standard solution

3mg of ascorbic acid was dissolved in 3ml of distilled water. Dilutions of this solution with distilled water were prepared to give the concentrations of 25, 50, 75, 100  $\mu$ g/ml.

### 2.6.2 Preparation of test sample

Stock solutions of samples were prepared by dissolving 10 mg of dried hydro alcoholic extract in 10 ml of methanol to give a concentration of 1 mg/ml. Then sample concentrations of 25, 50, 75 and 100  $\mu$ g/ml were prepared.

## 3. RESULTS

### 3.1 Nutritional Composition of *Ipomoea batatas* and *Colocasia esculenta*

The results showed that carbohydrates (29.33%) (22.38%) and crude protein (26.62%) (29.41%) were the most abundant macronutrients in *I. batatas* and *C. esculenta* respectively. Appreciable amounts of crude fibre (14.55%) and (16.27%) were observed in *I. batatas* and *C. esculenta* respectively. It also showed lower levels of crude fat (7.45%) and (10.17%) were observed in *I. batatas* and *C. esculenta* respectively. Appreciable amount of moisture was present at 14.05% and 11.77% in *I. batatas* and *C. esculenta* respectively. Also, low ash content (8.0%) and (10.00%) were observed in *I. batatas* and *C. esculenta* respectively as shown in Table 1.

#### 3.1.1 Mineral composition of dried leaf extracts of *Ipomoea batatas* and *Colocasia esculenta*

The mean values of the minerals showed that calcium (202.13 mg/100 g), (412.07 mg/100 g) were the most abundant mineral element followed by sodium (60.30 mg/100 g), (77.07 mg/100 g) for in *I. batatas* and *C. esculenta* respectively. Appreciable amounts of Iron (30.24 mg/100 g), (43.31 mg/100 g) were recorded in *I. batatas* and *C. esculenta* respectively as shown in Table 2.

**Table 1. Percentage values of the nutritional composition of dried leaves of *Ipomoea batatas* and *Colocasia esculenta***

Samples	Moisture	Ash	Crude fibre	Crude fat	Crude protein	Carbohydrate
<i>I. batatas</i> (%)	14.05±0.15	8.0±0.01	14.55±0.12	7.45±0.01	26.62±0.12	29.33±0.05
<i>C. esculenta</i> (%)	11.77±0.13	10.0±0.01	16.27±0.15	10.17±0.02	29.41±0.16	22.38±0.10

Values are expressed as% dry weight (DW), mean±Standard deviation (SD)  
Conversion factor (crude protein) F= 6.25

**Table 2. Mean values of the mineral elements of dried leaves *Ipomoea batatas* and *Colocasia esculenta***

Sample	Sodium (mg/100 g)	Iron (mg/100 g)	Calcium (mg/100 g)
<i>Ipomoea batatas</i>	60.30 ±0.14	30.24 ±0.14	202.13 ±0.02
<i>Colocasia esculenta</i>	77.07 ±0.04	43.31 ±0.13	412.07 ±0.09

Values are expressed in mg/100 g, mean ± SD

**Table 3. Quantitative phytochemical analysis of *Ipomoea batatas* and *Colocasia esculenta***

Samples	Flavonoids	Phenols	Tannins	Saponins	Glycoside
<i>I. batatas</i> (mg/100 g)	46.11± 0.16	2.97±0.15	8.70±0.04	31.44± 0.57	3.17± 0.01
<i>C. esculenta</i> (mg/100 g)	62.62 ± 0.008	6.28± 0.07	32.15± 0.04	35.14± 0.57	3.53±0.01

Values are expressed in mg/100 g, Mean ± Standard Deviation

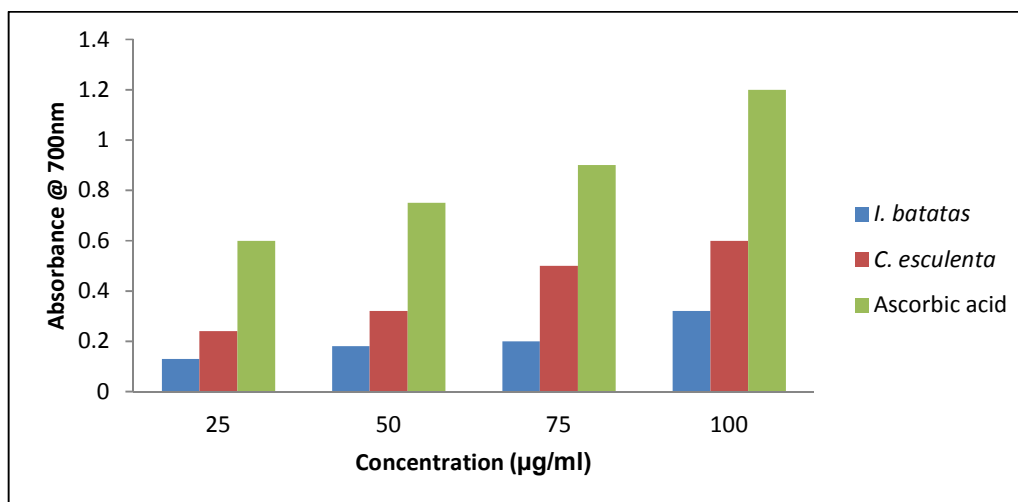


Fig. 1. Antioxidant potentials of leaf extracts of *Ipomoea batatas* and *Colocasia esculenta*

### 3.2 Quantitative Phytochemical Analysis of *Ipomoea batatas* and *Colocasia esculenta*

Result of the quantitative phytochemical screening showed that *I. batatas* and *C. esculenta* had more flavonoids (46.11, 62.62), followed by saponins (31.44, 35.14). Phenols were least (2.97, 6.28) respectively as shown in Table 3.

### 3.3 Reducing Power of Leaf Extracts of *Ipomoea batatas* and *Colocasia esculenta*

The absorbance readings for *C. esculenta* was recorded as (0.24, 0.32, 0.5 and 0.6) nm at different concentrations (25, 50, 70 and 100) µg/ml respectively. While *I. batatas* values were recorded as (0.13, 0.18, 0.2 and 0.32) nm at different concentrations (25, 50, 70 and 100) µg/ml respectively. The reducing power assay method is based on the principle that substances which have reduction potential react with potassium ferricyanide ( $Fe^{3+}$ ) to form potassium ferrocyanide ( $Fe^{2+}$ ) which then reacts with ferric chloride to form ferric-ferrous complex that has an absorption maximum at 700 nm. The reducing power of the methanolic extracts and standard increases with the increase in amount of sample and standard concentrations as shown in Fig. 1.

## 4. DISCUSSION

Global scientific research is focused on improving the nutritional qualities of food crops. This has become an increasingly critical issue in

developing countries, particularly in Nigeria, where plants are the major primary nutritional support in the human diet and animal feed. The nutrient, phytochemical and antioxidant analysis imparted a better understanding on the compositions of *I. batatas* and *C. esculenta*.

In my findings, leaves of *Colocasia esculenta* and *Ipomoea batatas* contain various chemical components such as flavonoids, phenols, tannin, saponins and glycosides. Similar results was reported by Ehiobu and Ogu [24] for *C. esculenta* and Mbaeyi-Nwaoha and Emejulu [25] for *I. batatas*. Phenolic compound with strong antioxidant activity have been identified in edible members of Araceae and LaFree family and are of interest to food manufacturers as consumers move towards functional foods with specific health effects. Based on this study, *C. esculenta* as compared to *I. batatas* was found to be richer in all analysed phytochemicals such as Phenolic compounds; which are considered to be the most important antioxidants of plant materials. They constitute one of the major groups of compounds acting as primary antioxidants or free radical terminator. The glycoside content of the analysed samples was observed to be higher than values obtained for peptone ( $2.240 \pm 0.004$  mg/100 g), water ( $1.646 \pm 0.002$  mg/100 g) and ethanol ( $1.445 \pm 0.003$  mg/100 g) extracts of *Ipomoea batatas* as reported by Mbaeyi-Nwaoha and Emejulu [25]. Glycosides are naturally cardioactive drugs used in the treatment of congestive heart failure and cardiac arrhythmia [26]. The presence of glycosides indicates that they may be potent in curing cardiac insufficiency, coughs and circulatory problems.

Also, they may act as good sedatives and have antispasmodic properties [27]. Flavonoids; which are group of polyphenolic compounds which influence the radical scavenging, inhibition, of hydrolytic and oxidative enzymes and also act as anti-inflammatory agent [28]. The biological functions of flavonoids apart from its antioxidant properties include protection against aggregation, microbes, ulcers, hepatoxins, viruses and tumors [29]. The analysed samples had flavonoid content which was found to be much higher than the values reported for common leafy vegetables consumed in south-eastern Nigeria (0.003-0.22 mg/100 g) by Onyeka and Nwanbekwe [30] The observed results showed that leaf extracts of *C.esculenta* and *I.batatas* have a much higher value of saponins than the value (1.37 mg/100 g) reported for dry samples of *T. Triangulare* by Aja, et al. [31]. Saponins have been shown to possess a natural tendency to ward off microbes and is been used for treatment of fungal and yeast infections [32].The tannin content of the analysed samples was found to be lower than that reported for *Telferia occidentalis* (40.6 mg/100 g) by Aregheore [33] and higher than that reported for *Vernonia amygdalina* (0.6%) by Oboh [34].

The proximate composition of the leaves revealed that *C.esculenta* contains higher levels of protein, crude fibre, fat and ash, while *I. batatas* is richer in Carbohydrate and moisture. This is in agreement with the works of Ezeabara, et al. [32] and Awol [35]. The moisture content from this study was lower than those reported for *I. batatas* by Antia, et al. [36], Woolfe [37] and *C.esculenta* (75%) by Fuglies [38]. The result also showed that the moisture content of the vegetables from the study were lower than the values reported for some leafy vegetables such as *V.amygdalina* (21.60%) *C.olitorious* (27%) and *O.gratissimum* (31.50%) by Mensah, et al. [9] The result was also found to be lower than that reported for *Amaranthus cruentus* (tete) 23.6% *Celusia argenta* (soko) 15.60% and *Corchorus olitoris* (ewedu) leaves 30.90% [39]. The moisture content varies between studies, probably due to different varieties, genetics, environmental, ecology and harvest conditions of the plant [40,41].

The ash content ranged from (8.00%-10.00%) for the two leafy vegetables investigated. The values obtained in this study were higher than the values reported for some leafy vegetables such as *C.olitoris* (0.04%). *O.gratissimum* (0.83%)

[40]. The observed values were also found to be lower than the values of *Talinum triangulare* (water leaf) 19.4%, *Amaranthus cruentus* 19.3%, and *Telfaria occidentalis* (fluted pumpkin) 10.9% as reported by Fasuyi [1]. It was also found to be lower than the values reported for *Celusia argenta* (soko) 32.40% and *Corchorus olitoris* (ewedu) 21.20% [39]. The least obtained value (8.0%) for *I. batat* as although higher, could be compared to that of early stage of *Moringa olifeira* (5.75%) leaves as reported by Bamishaiye, et al. [42].

The crude fat content was moderate ranging from 7.45% to 10.17%. The lower value for crude fat of the vegetables studied was almost similar to the value reported for *Talinum fruticosum* (5.90%), but high as compared to *Basella alba* (3.71%) and *Amaranthus hybridus* (4.80%) [43]. The observed value was also found to be higher than values reported for sweet potato leaves 4.90% by Antia, et al. [36]. *Celusia argenta* 0.21%, *Amaranthus cruentus* 0.45% and *Corchorus olitoris* 0.32% [39]. Low fat food was reported to reduce the level of cholesterol and obesity [43]. The crude protein values ranged from 26.62%-29.41%. The result shows that the leaves contain appreciable amount of crude protein. The protein content values agree with what has been reported for some known leafy vegetables such as *M.oleifera* (20.71%) [44] and *Curcubita pepo* leaves [45]. The observed value was also found to be much higher than values obtained for *Celusia argenta*, *Amaranthus cruentus* and *Corchorus olitoris* which were 9.40%, 12.70% and 11.20% respectively [39]. Although *Piper guineeses* and *T. Triangulare* had higher values at 29.78% and 31.0% respectively [46]. The values obtained can be compared with that reported for late stage *Moringa olifeira* leaves 28.08% as reported by Bamishaiye, et al. [42]. Protein is an important component of human diet needed for the growth of children as well as constant replacement of worn out tissues [47]. The carbohydrate content of the vegetables in this study ranged from 22.28%-29.33% and was significantly higher than that of *Ochthochoaris-dicellandroides* (11.73%) reported by Andzouaroa and Mombouli [48] and *Fruticosum triangulare* (3.17%) *O.gratissimum* (4.45%) *T.occidentalis* (5.65%) and *C.olitorius* (6.25%) reported by Adeniyi, et al. [49]. The values observed were also found to be lower than values reported for *Celusia argenta*, *Amaranthus cruentus* and *Corchoris olitoris* which were 32.80%, 29.40% and 31.30% respectively. The value was also higher than

values reported for sweet potato leaves by Antia, et al. [36]. The carbohydrate content of these vegetables establishes that they can be ranked as carbohydrate rich leaves and considered as a potential source of energy. The crude fiber content ranged from 14.55%-16.27% in the leaves investigated and they compared favourably well with *Myriathus arboreus* (11.60%) [50] *C.pentandra* (21.69%) and *A.esculentus* (17.55%) [51]. The values were also found to be higher than the values reported for *Celusia argenta*, *Amaranthus cruentus* and *Corchorus olitoris* at 11.70%, 7.80% and 6.70% respectively [39]. The crude fiber may aid digestion, low serum cholesterol level, thus reducing the risk of cardiovascular diseases [52].

This study also revealed levels of minerals; calcium 202.13 mg/100 g - 412.07 mg/100 g to be higher than that observed for sun dried leaf extract (19.25 mg/kg) of *C. esculenta* as reported by Azubuikwe, et al. [53]. It is well known that calcium is necessary for teeth and bone formation and is very vital for blood clotting. Osteoporosis could result from a low intake of calcium in adults and children which could further lead to rickets. Therefore, calcium intake is essential for human body and requires sufficient intake. The recommended dietary intake (RDI) for calcium is 1000 mg daily value [54]. The observed values for Sodium (60.30 mg/100 g - 77.07 mg/100 g) showed that analysed samples have higher levels than that reported for dry leaf extracts of *C. esculenta* (22.50 mg/kg) as reported by Azubuikwe, et al. [53] Sodium is known to play significant roles in acid-base balance, blood pressure regulation, fluid balance, muscle contraction and nervous system function. The RDI for sodium is 2400 mg daily value [54]. World Health Organization (WHO) recommends a reduction in sodium intake to reduce blood pressure and risk of cardiovascular diseases, stroke and coronary heart disease in adults. WHO further recommends a reduction to <2 g/day sodium (5 g/day salt) in adults [55]. The result showed levels of iron (30.24 mg/100 g - 43.31/100 g) to be higher than that observed for sun dried leaf extract (12.20 mg/kg) of *C. esculenta* [53]. Iron is needed in the body for formation of red blood cells and haemoglobin. Iron deficiency is a common nutritional problem worldwide leading to anaemia [56]. Iron deficiency is associated with blood loss, malabsorption, folic acid deficiency, infections and inadequate amount of iron in diet [57]. It is also known that green leafy vegetables become concentrated sources of nutrients when

dehydrated. Previous reports have shown markedly increased iron content of some green leafy vegetables after dehydration and such have been used for enrichment of traditional recipes [58,59]. Children (7-10 years) and adult males require 10 mg of iron, adult females require 15 mg and pregnant and lactating mothers require 13 mg [60]. The RDI for iron is 18 mg [54]. This finding disagrees with the report of Antia, et al. 2011 [36] which reported levels of minerals as follows: calcium (154.00 mg/100 g-113.00 mg/100 g) followed by sodium (136.00 mg/100 g -89.00 mg/100 g) and iron (6.47 mg/100 g- 5.49 mg/100 g) for *I. batatas* and *C.esculenta* respectively, but partly in agreement with the works of Ezeabara, et al. [32] which reported higher levels of Calcium (419 mg/100 g), sodium (68.61 mg/100 g) for *C.esculenta* compared to Calcium (320 mg/100 g), Sodium (32.08 mg/100 g) for *I. batatas*.

The reducing power of a compound may point to its antioxidative potentials [61]. It could be seen that the reducing power exhibited by both extracts progressively rose proportionate to increasing concentrations of the extract. *Colocasia esculenta* was found to possess higher antioxidant potentials than *Ipomoea batatas*, this could be due to the observed higher levels of flavonoids and phenols.

## 5. CONCLUSION

The result has shown that both leaves of *C. esculenta* and *I. batatas* possess antioxidant activity and this is attributed to the phytochemical constituents of the leaves. The research further justifies the use of these leaves for the treatment of minor ailments in some parts of the world. It also indicates the potential for green leafy vegetables in the production of safe preservatives for food and use in primary health care to the poor. The analysed leafy vegetables can be recommended as a good source of nutrients which could further help to combat malnutrition in developing countries.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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