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ANTI-NUTRITIONAL COMPOSITION OF (*TACA. LEONTOPETALOIDE*) ROOT TUBER FOR NUTRITIONAL COMPONENT

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ABSTRACT

The freshly harvested wild Polynesian arrowroot, *Tacca leontopetaloides* tubers used for the experiment of proximate, minerals and antinutritional composition were obtained. The proximate composition analysis of *T. leontopetaloides* table 1, revealed the presence of moisture content 7.87%, crude protein 4.50%, crude fiber 1.83%, crude fat 0.40%, ash 1.51%, CHO 83.80 and EV 356.80%. The element analysis of *T. leontopetaloides* table 2, indicate the presence of some trace element include sodium 36.25mg/100g, potassium 1.02mg/100g, calcium 2.04mg/100g, zinc 2.02mg/100g, phosphorus 37.70mg/100g, iron 1.14mg/100g, magnesium 1.86mg/100g. The result of antinutritional composition of *T. leontopetaloides* table 3, also revealed the presence of cyanide 0.11mg/100g, saponin 6.33%, flavonoid 2.15%, tannin 1.41mg/100g, and oxalate 5.8mg/100g. Anti-nutritional factors are present in most foods of plant origin and are responsible for the harmful effects which are related to absorption of nutrients that interfere with the normal functioning of certain organs. *T. leontopetaloides* when eating raw is poisonous and lethal but processing it by soaking in water enhances availability of the micronutrient and aids in the reduction of concentration of the anti-nutritional factors. The anti-nutritional factors and their breakdown products possess beneficial health effects if present in minute amounts. This study has shown that *T. leontopetaloides* when processed properly has the potential of a good food source to man as it contains calcium, iron, potassium and other micronutrients needed for the proper functioning of human body.

Key words: Arrowroot, *Leontopetaloides*, Polynesian, *Tacca*

Introduction

Root and tuber crops provide a substantial part of the world food supply and are also an important source of animal feed and industrial products. On a global basic, approximately 45% of root and tuber crop production is consumed as food, with the remainder used as animal feed or for industrial processing for products such as starch, distilled spirit, alcohol and fermented beverages including beer and a range of minor products FAO, (2004). Millions of people in many developing countries do not have enough food to meet their daily requirements and many more are deficient in one or more micronutrients. In many cases rural communities depend on wild resources including wild edible plants to meet their food needs in periods of food shortage FAO, (2004). The diversity in wild species offers variety in the diet and contributes to household food security. India hold rich genetic diversity in tropical root and tuber crops particularly aroids yams and several minor tuber crops. Wild edible tuber species are an important source of food in India and other parts of the world and have a significant place in the dietary habits of small and marginal farm families and forest dwelling communities during periods of food scarcity Arora *et al* (1996). An edible tuber not only enriches the diet of the people but also possesses medicinal properties. Many tropical tuber species are used in the preparation

of stimulants, toning, carminatives and expectorants. These properties need to be documented to validate, quantify and spread this valuable knowledge Edison *et al* (2006). According to Aberoumand and Deokule (2009), despite the fact that measures have being taken to boost food production by conventional agricultural activities, there is the need to exploit the vast number of unconventional plants resources that exist in the wild. Akubugwo *et al* (2007). Reported that many of such plants have been identified but lack of data on their chemical composition has limited the prospects of their utilization. Proximate analysis of some wild fruits and seeds indicate that they could be good sources of nutrients for man and livestock Aberoumand (2011). The exploration of indigenous wild food plant is one of the measures that could be taken to avoid hunger and malnutrition. Studies have shown that most rural dwellers depend largely on some of these edible wild plants to meet up with shortages in nutrients like minerals, proteins, lipids, and vitamin A Ujowundu *et al* (2008). Apart from the nutritional content of these wild plants, some are known to contained high levels of anti-nutritional components which could be toxic to the body, hence acting as threat to the health and well-being of an individual when consumed. Therefore some knowledge of the nutritional status and the toxic levels of indigenous

edible wild plants are imperative in order to encourage their cultivation and consumption Yisa *et al* (2010).

Tacca leontopetaloides (L.) Kuntze is a species of flowering plant from the family Taccaceae. It is commonly known as Polynesian arrow-root (English) or Amura (Hausa) and is a wild perennial herb. The plant originated from Malaysia and Pacific Islands Kay DE *et al* (1987). This plant is herbaceous plant other than grass or sedges, leaves compound or lobed, stem with longitudinal ridges and hollow Booth *et al.*, (2004). Abdullah *et al.* (2014) stated that Polynesian arrowroot possess the most stunning in orescence with whisker-like liform bracteoles and the colour of the two conspicuous inner involucre bracts range from white, green, purple, brown to near black colour. But is now distributed from western Africa through Southeast Asia to northern Australia. The tubers were known to be a staple foodstuff in Polynesia and also were used as a source of starch. In Nigeria, the plant is more wild spread in the middle belt Manek *et al* (2002) and in the south western states.

The plant still remains in the wild and is under-utilized in Nigeria. It is found in solitary forms on open fields or under the shade of trees or hill tops. In Plateau State, the tubers are found to be a delicacy to the people of Shendam, Langtang and other members of lower Plateau and are eaten especially when other staple foods are scarce. The tubers are believed to be poisonous and contain a bitter principle, Taccalin and toxic saponins Caddick *et al* (2005). Ruminants rapidly die as soon as they consume the peels of these tubers. Aside the nutritional content of this plant, it is believed to contain some levels of anti-nutrients which could be toxic to the human body, thereby acting as threat to the health of an individual if taken. However, Caddick *et al* (2005) reported that the poisonous component of the tubers could be removed by soaking, washing and rinsing repeatedly in clean water before being processed for food. Despite the fact that this tuberous crop is gaining acceptance among people of North Central of Nigeria, little or no information about the anti-nutritional composition of *T. leontopetaloides* plant is known. In addition, consumers may face the risk of toxicity due to improper processing. The present study was then designed to evaluate the nutritional and anti-nutritional composition of *Tacca leontopetaloides* in order to ascertain its suitability for use as food to man.

Materials and methods

The freshly harvested wild Polynesian arrowroot, *Tacca leontopetaloides* tubers used for the experiments were obtained from Benue State Nigeria. These tuberous materials were collected randomly from the field.

Samples preparation

These include manual peeling, washing (in clean water), cutting the tubers into small size and then homogenization using grinding machine, filtering

using muslin cloth, sedimentation, decanting (of watery supernatant), sun drying to brittleness and milling (using mills stone) to flour. About 300 g was the weight of the processed tuber. The flour was stored in air tight containers until required for analysis.

Proximate composition analysis of Polynesian arrow root flour

For the determination of the moisture content, crude protein, crude fibre, crude fat, ash, carbohydrate, standard analytical procedures for food analysis described by AOA, (2006) was adopted.

Determination of moisture content

Weight of 2 g of the sample was put into crucibles, dried in an oven at 105°C to a constant weight. The percentage loss in weight was expressed as percentage moisture content on dry weight basis. This was repeated three times to obtain triplicate values.

Protein determination

Total protein content was determined by the Kjeldahl method. A weight of 500 mg of the sample was weighed in triplicate into a Kjeldahl flask, About 10 cm³ of concentrated H₂SO₄ was added, catalyst mixture (1 g) containing sodium sulphate (Na₂SO₄) copper sulphate (CuSO₄) and selenium oxide (SeO₂) in the ratio of 10:5:1 respectively was added to hasten the digestion. Pieces of granulated Zinc or anti-bump granules were added. The sample was then digested in a fume cupboard until the solution became colourless. Distillation was carried out with about 10 cm³ of 40% NaOH solution. The condenser tip was dipped into a conical flask containing 5 cm³ of 4% boric acid in a mixed indicator (containing 5 drops of bromo cresol green methyl red indicator solution) till the boric acid solution turned green. Titration was done in the receiver flask with 0.01 N HCl until the solution turned red. The percentage (%) protein was then calculated.

Determination of crude fibre

The estimation of the crude fibre was done by acid and alkaline digestion methods. Exactly 2 g of sample was defatted. The defatted sample was boiled in 200 ml of 1.25% Tetra Oxo Sulphate (VI) solution under reflux for 30 minutes. After that, the sample was washed with hot water, using a two-fold muslin cloth to trap the particles. The washed sample was transferred quantitatively back to the flask and boiled again in 200 ml of 1.25% sodium hydroxide solution for 30 minutes, and washed before it was transferred to a weighed porcelain crucible and dried in the oven at 105°C for 3 h. After cooling in a desiccator it was re-weighed. The percentage crude fibre was calculated as follows:

$$CF = \frac{W2 - W1}{W1}$$

Where:

W1=weight of sample

W2=weight of sample crucible

W3=weight of crucible + ash

Determination of crude fat

Crude fat was determined from the powder by solvent extraction method. Two grams (2 g) of the starch sample was placed in Whatman extraction thimble and plugged with nonabsorbent cotton wool. The fat content of the sample was then extracted with 9% petroleum ether at 60-80°C and transferred into Soxhlet extraction apparatus for 6 h at condensation rate of 5-6 drops.

Determination of ash content

About 2 g of the sample was taken in triplicates and placed in pre-weighed crucibles and ashed in a muffle furnace at 600°C for 3 h. The hot crucibles were cooled in a desiccator and weighed. The percentage residual weight was expressed as ash content.

Carbohydrate determination

The carbohydrate content of the sample was determined by estimation using arithmetic difference. Percentage (%) Carbohydrate = $100 - (\% \text{moisture} + \% \text{protein} + \% \text{ash} + \% \text{fat content} + \% \text{Crude fiber})$

Determination of mineral contents

The mineral elements were determined by the modified methods of Mathew *et al* (2014), where sodium and potassium were determined using Jenway Flame Photometer, while calcium, magnesium, iron, zinc, manganese and copper were determined using Buch Model 205 Atomic Absorption Spectrophotometer. Phosphorus level was determined using phosphovanado molybdate colorimetric techniques on JENWAY 6100 Spectrophotometer, blank (control) was also determined in the same manner.

Determination of tannins

Modified method of Pearson (1976) was adopted for the determination of tannins. A weight of 1000 mg of sample was placed into a centrifuge tube containing 2 ml of sterile distilled water. The tube was centrifuged at 2000 rpm for 10 mins. The content was filtered through Whatman filter paper. A volume of 0.5 ml of the supernatant was made up to 1 ml with distilled water. A volume of 0.5 ml Folin Dennis reagent was added and mixed with 2.5 ml of 20% sodium carbonate solution. The mixture was allowed to stand for 40 mins at room temperature. The absorbance was measured using spectrophotometer.

Determination of saponin

Modified spectrophotometric method of Brunner, (1984) was adopted for the determination of saponin in the sample. A weight of 1 g of the sample was added to 20 cm³ of 1 M HCl in a beaker and was boiled for 3 h. After cooling it was filtered and a volume of 50 cm³ of petroleum ether was added to the filtrate and the ether layer evaporated to dryness. A volume of 5 cm³ of acetone/ethanol mixture was added to the residue. 0.4 cm³ of each was taken into 3 different test tubes. 6 cm³ of ferrous sulphate reagent was added into each of them followed by 2 cm³ of concentrated H₂SO₄. It was thoroughly mixed and after 10 min the

absorbance was taken at 490 nm. Standard saponin was used to establish the calibration curve.

Determination of flavonoids

The method of Krishnaiah *et al* (2009) was used for flavonoid determination. A weight of 5 g of the sample was weighed and repeatedly extracted with 100 cm³ of 80% methanol at room temperature. The mixture was then filtered through filter paper into a 250cm³ beaker and the filtrate was transferred into a water bath and allowed to evaporate to dryness and weighed. The % flavonoid was calculated using the formula:

$$X = \frac{W2 - W1}{W3} \times 100$$

Where,

x=percentage flavonoids,

w1=weight of empty beaker,

w2=weight of empty beaker + flavonoid

w3=weight of sample.

Determination of hydrogen cyanide

The cyanogenic glycoside component was determined by alkaline picrate method of Onwuka (2005) with slight modifications. A weight of 5 g of the sample was weighed and dissolved in 50ml of distilled water in corked conical flasks. The mixtures were allowed to stand throughout the whole night and the filtered. A volume of 1ml of the sample was taken in a test tube and then 4mls of alkaline picrate was added and then heated in a water bath for 15 minutes. After colour development, the absorbance of colour intensity was measured in a spectrophotometer at 490 nm and was compared with standard cyanide solution.

Determination of oxalate

The titrimetric method of Krishnaiah *et al* (2009) was used in the determination of oxalate in the samples but with modifications. A weight of 1 g of the sample was weighed into 100 ml conical flask. About 75cm³ of 1.5 M H₂SO₄ was added and the solution was carefully stirred with a magnetic stirrer for about 1 h then filtered using Whatman No1 filter paper. A volume of 25 cm³ of the sample filtrate (extract) was then collected and titrated hot (80°C-90°C) against 0.1 M KMnO₄ solution to the point when a faint pink color appeared which persisted for at least 30 seconds. This was repeated twice more and the concentration of oxalate in each sample was obtained.

Statistical analysis

One way analysis of variance (ANOVA) was used to compare means of variables and results were expressed as means of variables.

Results

The proximate composition analysis of T. leontopetaloides table 1, revealed the presence of moisture content 7.87%, crude protein 4.50%, crude fiber 1.83%, crude fat 0.40%, ash 1.51%, CHO 83.80 and EV 356.80%.

The element analysis of T. leontopetaloides table 2, indicate the presence of some trace element include sodium 36.25mg/100g, potassium 1.02mg/100g, calcium 2.04mg/100g, zinc

2.02mg/100g, phosphorus 37.70mg/100g, iron 1.14mg/100g, magnesium 1.86mg/100g. cyanide 0.11mg/100g, saponin 6.33%, flavonoid 2.15%, tannin 1.41mg/100g, and oxalate 5.8mg/100g. The result of antinutritional composition of *T. leontopetaloides* table 3, also revealed the presence of

Table 1. Proximate composition of Polynesian arrow root flour

Parameter	concentration	
MC (%)	7.96	7.87
CP (%)	4.50	4.54
EE (%)	0.40	0.36
Ash (%)	1.51	1.49
CF (%)	1.83	1.80
CHO (%)	83.80	83.94
EV (Kcal)	356.80	357.16

Means with the same letters in a column are not significantly ($p \geq 0.05$) different.

Table 2. Mineral content of Polynesian arrow root flour

Parameter	Concentration (mg/100g)	
Na	36.22	36.25
P	1.04	1.02
Zn	2.00	2.02
K	37.72	37.70
Fe	1.11	1.14
Ca	2.06	2.04
Mg	1.82	1.86

Means with the same letters in a column are not significantly ($p \geq 0.05$) different.

Table 3. Antinutritional composition of Polynesian arrow root flour

Parameter	Concentration	
Cyanide (mg/100g)	0.12	0.11
Saponin (%)	6.36	6.33
Flavonoid (%)	2.17	2.15
Tannins (mg/100g)	1.45	1.41
Oxalate (mg/100g)	5.89	5.8

Means with the same letters in a column are not significantly ($p \geq 0.05$) different.

Discussion

The results of the analyses of starch of *T. leontopetaloides* showed that it contains important nutrients including minerals and proteins as well as other anti-nutritionals that make the plant a good source of food for man and animals. The proximate composition analysis of *T. leontopetaloides* revealed the presence of moisture, 7.87%, crude protein, 4.54%, crude fibre, 1.80%, crude fat, 0.36%, ash, 1.49%, CHO, 83.94% and EV, 357.16% showed in Table 1. The results of these findings are in agreement with the findings of Boshu *et al* (2013) who reported moisture, ash, fats, fibre, crude protein and carbohydrate in the range of 10.83%, 1.93%, 1.06%,

4.42%, 6.12% and 86.07%, respectively in the marc of wild *Tacca involucrata*. The protein contents of the samples varied from 6.82-9.62% and are comparably higher than reported values of 5.15% for white yam, 4.88% for water yam and 3.64% for sweet potato Alaise and Linden (1999). Substantial fibre content, 5.44% was recorded for the *Polynesian arrow root*. Fiber is very important in food as it helps in alleviating problems associated with constipation by expanding the walls of the colon, absorbs water and provides roughage for the bowels for softer and bulkier stool. It helps reduce the risk of cancers and other bowel diseases as well as reducing the cholesterol levels of the blood Ubwa *et al* (2011) and Princewill *et al*

(2015). The carbohydrate content, 83.94% (Table 1) obtained from the arrow tuber flour analysis is comparable to the figures recorded by other workers including Bosha *et al* (2013) who recorded 76% carbohydrate component for *T. involucrata* and Bosha *et al* (2013) who recorded 71% carbohydrate for *T. leontopetaloides* peels. The high carbohydrate observed in the sample shows that it will be a good source of energy required for the daily activities of man.

The mineral composition of *T. leontopetaloides* as shown in Table 2 revealed that it contained some minerals that are of beneficial effect to human and animal bodies. Calcium helps in calcification of bones and its deficiency results to syndromes like rickets [24]. Magnesium helps in phosphate transfer in most reactions, its deficiency results to severe migraine, hypertension, stroke and other disease conditions Appel and Nonpharmacologic (1999) and Bello *et al* (2008). Zinc is very important for protein and nucleic acid synthesis. Iron is very important in production and building of blood cells and is also needed for transporting haemoglobin and for immune responses Trease and Evans (2009). Phosphorus is essential for bone and teeth structures Mason *et al* (2011).

The present study has confirmed the presence of, cyanides, saponins, flavonoids, tannins and oxalate though in small quantities of 0.11, 6.33, 2.15, 1.41, and 5.8 mg/100 g respectively (Table 3). These phytochemicals have been known for their various nutritional, pharmacological and physiological uses to man and animals Ubwa and Anhwange (2011). Tannins as reported by Nwogu *et al* (2008) are complex phenolic polymers which can bind to proteins and carbohydrates and results to reduction in digestibility and availability of the macromolecules thereby inhibiting microbial growth. Cyanide is poisonous because it binds with cytochrome oxidase and stops its action in respiration in the body Aro *et al* (2005) and Proc (2008). The concentration of hydrogen cyanide obtained from this research work, 0.11mg/100g is slightly close to that, 0.16 mg/100 g obtained by Ndouyang *et al* (2009). However, Ubwa *et al* (2011) reported hydrogen cyanide concentration of 43-45mg/kg in the peels of *T. leontopetaloides*. The reduction in the concentration of hydrogen cyanide could be as a result of thestepping in water during processing. Previous works including that of Chikwendu *et al* (2015) and Ndouyang *et al* (2009). Reported that processing especially soaking reduces hydrogen cyanide content in food substances such as African Yam bean. Saponins are structurally diverse molecules that are chemically referred to as triterpene and steroid glycosides. The bitter taste of saponin is the major factor that limits its use. In the past,saponins were recognized as anti-nutrient constituents, due to their adverse effects such as throat-irritating activity. Golden (2009) who reported saponin content of 67.9

mg/100 g in *T. leontopetaloides* that underwent two steps soaking.

A high saponin diet is known to possess hypocholesterolemic and anti-carcinogenic properties as well as reducing the risk of heart diseases. Liener (1974). Flavonoids content of the *T. leontopetaloides* used in this study was found to be 2.15 mg/100 g (Table 3) and was a little higher than that reported by Golden (2009) which was 2.17 mg/100 g for *T.leontopetaloides* after two steps soaking. Flavonoids have been reported to be strong antioxidants. They help in preventing the damage caused by free radicals to human cells. Ubwa *et al* (2011). Reported that they slow the proliferation of cancer cells, thereby mediating in most chronic cancer and diabetes cases. The oxalates contents of *T. leontopetaloides* used in this study were recorded as 5.8mg/100. In general, the anti-nutritional components of *T.leontopetaloides* was considered low with an indication that the tubers can to a great extent be used as food, believing that there would be no interference of the anti-nutrients with the nutrients such as proteins and other minerals in the body.

Conclusion

Anti-nutritional factors are present in most foods of plant origin and are responsible for the harmful effects which are related to absorption of nutrients that interfere with the normal functioning of certain organs. *T. leontopetaloides* when eating raw is poisonous and lethal but processing it by soaking in water enhances availability of the micronutrient and aids in the reduction of concentration of the anti-nutritional factors. The anti-nutritional factors and their breakdown products possess beneficial health effects if present in minute amounts. This study has shown that *T. leontopetaloides* when processed properly has the potential of a good food source to man as it contains calcium, iron, potassium and other micronutrients needed for the proper functioning of human body.

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