

# EVALUATION OF NUTRITIONAL, NON-NUTRITIONAL, ELEMENTAL CONTENT AND AMINO ACID PROFILE OF *Azanza garckeana* (GORON TULA)

## ABSTRACT

*Azanza garckeana* fruits, leaves, stem-bark and roots were both quantitatively and qualitatively analyzed to determine the nutritional, non-nutritional, elemental and amino acid content. The nutritional (proximate) analysis reveals the highest and lowest moisture content in the fruits (6.50%) and stem-bark (0.50%), crude protein in the fruits (12.00%) and stem-bark (4.91%), crude fibre in the stem-bark (45.30%) and fruits (20.75%), lipid content in the leaves (2.56%) and roots (0.68%), and total ash content in roots (8.70%) and fruits (6.7%), respectively, while vitamin A, B<sub>1</sub>, B<sub>2</sub>, C and E were all found (in the fruits and leaves), and quantitatively more in the fruits. *A. garckeana* contains alkaloids, tannins, flavonoids, steroids, cardiac glycosides, terpenes, phenols, volatile oils, resins and saponins. However, there is a significant variation in the presence of these compounds in the different parts of this plant. The amount of these compounds were also found to be safe (i.e. below established toxic levels), and of medicinal value. The mineral elements present are also below toxic levels, and may contribute to the dietary requirements of these elements. The amino acid profile reveals 17 types; 7 essential, 2 semi-essential and 8 non-essential in the fruits and leaves in varying amounts.

**Key words:** *Azanza garckeana*, nutrition, non-nutrition, mineral elements, amino acids.

## INTRODUCTION

In many tropical countries, rural dwellers traditionally harvest wide range of leafy vegetables, roots, tubers, and fruits from the wild as food supplements, spices, and sometimes for cultural uses. Labeled as famine or hunger food, some wild plants have been recognized to have the potentials to meet household food and income security [1, 2]. The indigenous fruits collected from the wild plays a significant role in food and nutrient security of the poor and rural dwellers. Some wild fruits have been identified to have better nutritional value than cultivated fruits [3, 4]. As a result, in recent years, a growing interest has emerged to evaluate various wild edible plants for their nutritional features [5, 6, 7, 8]. Like in many African counties, Nigeria's indigenous fruit trees, although undomesticated, play many important roles especially to the people living in rural areas. They are important traditional source of nuts, fruits, spices, leafy vegetables, edible oil and beverages [9]. Like the cultivated vegetables, wild indigenous fruit trees provide vitamins and minerals essential for the proper maintenance of human health [10]. According to FAO [11] and Maghembe, *et al.*, [12] the nutritional value of indigenous fruit bearing tree species indicates that many are rich in sugars, essential vitamins and minerals, while others are high in vegetable oil and protein contents. In addition to fruit production and cash, the extensive list of benefits includes firewood, fodder, building material, shade and medicine especially to rural communities. Edible wild leaves and fruits are consumed frequently in Northern Nigeria especially in rural communities where a variety of edible leaves and fruits abound. Some of these are cultivated while others grow in the wild. Several of these wild species bear fruits/leaves during the dry season when cultivated fruits/leaves are scarce [13]. Wild fruits offer a cheap means of providing adequate supplies of mineral, fat, protein and carbohydrate to people living within the tropics [3]. In North eastern part of Nigeria (Gombe State) where common fruits and leaves like bananas and bitter leaves are in short supply, it is possible for wild fruits and leaves of *A. garckeana* (Goron Tula) to provide the vitamin and mineral requirement of the local populace (Tula people). Affordability as a factor is responsible for the high incidence of malnutrition in low income families that traditionally have a large family size in the study area [13]. Most affected are children of preschool age group with most cases of morbidity related to inadequate intake of food containing essential nutrients [6, 13]. Though *A. garckeana* may provide the necessary nutrients needed for body, the availability of these nutrients after ingestion depends on the non-nutritional factors present in the fruits and leaves of the plant. The non-nutrients tend to bind to mineral elements there by forming indigestible complex. Oxalate for instance binds to calcium to form complexes (calcium oxalate crystal). These crystals formed

59 prevent the absorption and utilization of calcium. The calcium crystals may also precipitate around  
60 the renal tubules thereby causing renal stones [6, 13].

61 *Azanza garckeana* is a semi-deciduous tree/shrub with a round medium crooked stem [14,  
62 15]. The tree can grow to a height of 3-15 meters depending on the environment in which it is  
63 grows [15, 16, 17, 18, 19]. The twigs are hairy when young but become smooth with age and  
64 branches have wooly hairs [20]. The leaves are distinctively round with 8 to 12 cm long stalks. The  
65 leaves have 3 to 5 lobes, which are covered in brown star-shaped hairs, and have longitudinal  
66 fissures in the midrib [15, 18, 20]. The flowers have many stamens and 5 petals, which are yellow  
67 or purplish in colour with dark purple or dark red centre [15]. The flowers are bisexual with all floral  
68 parts in fives [18]. It flowers in wet season and fruits in dry season (April-August) [18]. The fruits are  
69 hairy, spherical, hard and about 2.5 - 4 cm long in diameter, internally divided into 4 to 5  
70 longitudinal sections. They are yellowish to brownish green when mature [15, 20]. *A. garckeana* is  
71 widely distributed in East and Southern Africa countries like Botswana, Kenya, Malawi,  
72 Mozambique, Namibia, South Africa, Tanzania, Zambia and Zimbabwe [15]. ICRAF [20], Mbuya, *et*  
73 *al.*, [21] and Mulofwa, *et al.*, [19], reported the species growing from Sudan to South Africa. In  
74 addition, it is also found in Gombe state, Nigeria, West Africa. The species grow naturally in all  
75 types of woodlands from sea level to about 1700 m above sea level [15, 17, 19, 21]. It grows in  
76 semi-arid areas receiving lowest annual rainfall of 250 mm and highest rainfall of 1270 mm [18].  
77 Over the range in its entirety, the species grows in a variety of soils and its found on or near termite  
78 mounds and deserted village fields [17, 18, 19, 21]. In Botswana *Azanza garckeana* grows in open  
79 woodland in north-eastern part of the country. In Nigeria it grows in savanna areas in Tula District,  
80 Kaltungo Local Government Area, Gombe state. The fruits of *A. garckeana* when slightly green or  
81 when ripe, are eaten by the people of Tula community in Gombe State, Nigeria. Some people dry it  
82 and further process it for consumption. The fruits can also be soaked in small amount of water to  
83 make jelly [22]. They can also be boiled and used as relish or made into porridge [14]. Leaves are  
84 used for making relish and also cooked as vegetables. The leaves can also be used as green  
85 manure to improve land productivity [23]. Traditionally, the roots and steam/bark are used to treat  
86 gonorrhea.



Figure 1: Typical *A. garckeana* plant

103 Due to the importance of these nutrients as a basic condition for good human health, we  
104 therefore found it necessary to evaluate the nutrient contents of *A. garckeana* fruits and other plant  
105 parts. This work would provide necessary information on the fruits, plant parts and also provide the  
106 basis for their wider utilization.

## 107 MATERIALS AND METHODS

### 108 Materials

109  $H_2SO_4$ , NaOH, HCl,  $HNO_3$ , diethyl ether,  $K_2SO_4$ ,  $CuSO_4$ ,  $Na_2CO_3$ , Fehling's solutions A and B,  
110 methyl red indicator, Methylene blue indicator, standard glucose, ferric chloride, Whatman filter  
111 paper, Mayer's reagent, and ethanol used in this research work are analytical grade and products  
112 from the British Drug House, (BDH). All materials were used without further purification.

### 113 Collection and treatment of samples

114 *A. garckeana* (Goron Tula) fruits, leaves, roots and stem-bark (each about 3 kg) were  
115 randomly collected from different stands of the plant growing wild in Tula Town in Kaltungo Local  
116 Government Area Gombe State in August, 2014. The plant parts (i.e. fruits for 4 weeks, leaves for  
117 2 weeks, stem-bark for 4 weeks, and roots for 4 weeks) were air dried in the laboratory at room  
118 temperature. They were then grounded into fine powder using pestle and motor (Stainless steel)  
119 and stored in screw capped containers.

## Proximate analysis

These were carried out by adopting the methods as described in Nkafamiya et al., [24] as follows:

### Determination of Moisture

Five grams (5.0 g) of each powdered sample (fruits, leaves, stem/bark and roots) were weighed into previously weighed crucibles and dried at 95-100°C for two hours. The samples were removed, cooled in desiccators, weighed and returned into the oven again for an hour. The samples were then brought out and cooled in desiccators before weighing. This was done until a constant weight was obtained with three consecutive weighing. The percentage moisture was calculated thus:

$$\% \text{ moisture} = \frac{W_2 - W_1}{W_2 - W_1} \times 100$$

Where  $W_1$  = weight of empty crucible

$W_2$  = weight of crucible + sample before drying

$W_3$  = weight of crucible and sample after drying

### Determination of Ash

Two grams (2.0 g) of finely ground dry samples obtained after moisture determination was weighed into porcelain crucibles. The samples were charred on a heating mantle inside a fume cupboard to get rid of the smokes. The samples were then being transferred into a muffle furnace and gradually heated to a temperature of 450°C for 3 hours (which was the time a clear grey ash was obtained). The samples were then cooled in the desiccators and weighed. The percentage ash was calculated thus:

$$\% \text{ ash} = \frac{\text{weight of ash}}{\text{weight of sample}} \times 100$$

### Determination of Crude Fiber

Two grams (2.0 g) of dried sample powder was boiled in 30 ml of 0.15M  $\text{H}_2\text{SO}_4$  for 15 minutes, 40 ml of 1.5 M NaOH was added and the boiling continued for 15 minutes. The mixture was filtered after cooling and washed several times with distilled water. The washed residue was placed in a beaker and shaken with 30 ml of a 0.3 M HCl, then filtered. The residue was washed with distilled water and dried in an oven at 105°C for 30 minutes, then weighed and transferred into a muffle furnace for ashing at 100°C for 2 hours. The ash were removed, cooled in desiccators and weighed. The percentage crude fiber was calculated thus:

$$\% \text{ crude fibre} = \frac{\text{weight of residue before ashing} - \text{weight after ashing}}{\text{weight of sample}} \times 100$$

### Determination of Lipids

Two grams (2.0 g) of the sample were weighed into 250 ml conical flask, 50 ml of diethyl ether were added, shaken and allowed to stand overnight. The mixture was then filtered over a gravity filtration set and washed down with the same solvent. The filtrate was placed in a water bath to evaporate the ether then dried in an oven at 105°C for 1 hour. The conical flasks with extracts were then weight. The percentage lipid was calculated thus:

$$\% \text{ lipid} = \frac{\text{weight of oil}}{\text{weight of sample}} \times 100$$

### Determination of Crude Protein

Five grams (5.0g) of the powdered sample were weighed into 500 ml Kjeldahl flask, 10.0 g of  $\text{K}_2\text{SO}_4$  and 0.5 g  $\text{CuSO}_4$  (as catalyst) was added, then 40 ml of 98%  $\text{H}_2\text{SO}_4$  were also added and the mixture gently heated until fuming ceased. The mixture was further boiled for 2 hours and then cooled to room temperature. Distilled water (250 ml) was added to the digest. The distillation apparatus was set, 50 ml of 0.1M HCl were pipette into the receiving flask and the tip of the delivery tube extended just below the surface of the acid, 60cm<sup>3</sup> of 50% (w/v) NaOH solution was added to the Kjeldahl flask and the flask was immediately connected to the condenser to complete the set up. The digest solution was heated till it starts boiling. Boiling continued until about 150 – 200 ml of the digest solution has been collected. The set up was disconnected, distilled, and titrated against 0.1M NaOH using methyl red indicator. The titre value was recorded, and this was used in the calculations from which the percentage nitrogen was obtained thus:

$$\text{Nitro\%gen} = \left( \frac{N_a - N_b \times 0.1 \times 14}{\text{weight of sample}} \times 100 \right)$$

%Crude protein= % N × 6.25

Where  $N_a$ = moles of acid (Molarity × Volume)

$N_b$ = moles of base

## **Determination of Carbohydrate**

The available carbohydrate content in the samples was determined by difference thus:  
% carbohydrate = 100 – (% moisture + % ash + % crude protein + % lipid extract + % crude fibre).

## **Determination of vitamin (A, B<sub>1</sub>, B<sub>2</sub>, C, and E) content (leaves and fruits)**

Vitamin content was determined according to the method adopted by Nkafamiya *et al.*, [6] as follows:  $\beta$ -carotene in the samples was chromatographically determined, and the formula;  $0.6 \mu\text{g}$  of  $\beta$ -carotene =  $0.3 \mu\text{g}$  of pure vitamin A. other vitamins were spectrophotometrically determined, and the mean values from triple determinations were recorded.

## **Analysis of minerals and amino acids (leaves and fruits)**

Two gram (2 g) of each sample was weighed into separate beakers and treated with 20 ml of  $\text{HNO}_3$ . It was then digested on an electric hot plate at  $70^\circ\text{C}$  to  $90^\circ\text{C}$  for 60 minutes. Blank were then prepared similarly by digesting 20 ml of  $\text{HNO}_3$  acid in an empty beaker. It was then cooled and the content was filtered through Whatman No. 42 filter paper into a volumetric flask and made up to 100 ml with deionized water. The digests was then analyzed for the elemental contents using an atomic absorption spectrophotometer (AAS), Buck 210 VGP. Amino acid profile analysis was carried out according to standard methods as adopted in Nkafamiya *et al.*, [24].

## **Determination of non-nutrients**

These were carried out by adopting the methods described in Idris *et al.* [25] and Barminas *et al* [26]. As follows:

### **Test for Alkaloids**

To 3 ml of the extract in a test tube, 1 ml of 1% HCl was added. The mixture was heated for 20 minutes cooled and filtered. About 2 drops of Mayer's reagent was added to 1 ml of the filtrate. A creamy precipitate indicates the presence of alkaloids.

### **Test for Saponins**

Frothing test: 2 ml of the extract was vigorously shaken in a test tube for 2 minutes and observe for frothing. Emulsion test: 5 drops of olive oil was added to 3 ml of the extract in the test tube and vigorously shaken, the absence of frothing and stable emulsion indicates the absence of saponins.

### **Test for Tannins**

About 0.5 g of the dried powder sample was boiled in 20 ml of water in a test tube and then filter. A few drops of 0.1% ferric chloride was added and observe for brownish green or a blue-black coloration.

### **Test for Flavonoids**

To 3 ml of the extract, 1 ml of 10% NaOH was added. The absence of flavonoids shows yellow coloration.

### **Test for Steroids**

To 0.5 g extract of the sample, 2 ml of acetic anhydride and 2 ml  $\text{H}_2\text{SO}_4$  was added. The color change from violet to blue or green indicates the presence of steroids.

### **Test for Terpenoids**

To 5 ml of the extract, 2 ml of chloroform was added and mixed, 3 ml of concentrated  $\text{H}_2\text{SO}_4$  was carefully added to form layers and a reddish brown coloration of the interface was formed, indicating the presence of terpenoids.

### **Test for Cardiac Glycosides (CGs)**

To 0.5 g of the extract dissolved in 2 ml of chloroform. Sulphuric acid was carefully added to form layers. A reddish-brown colour at the interface indicates the presence of a steroidal ring.

### **Test for Volatile oils**

To 10 ml of extract was added 50 ml of 90% ethanol and few drops of ferric chloride solution. A blue coloration was recorded as the presence of volatile oils.

### **Test for Resins**

About 2 ml aliquot of extract and equal volume of acetic anhydride solution were added followed by drops of conc.  $\text{H}_2\text{SO}_4$ . A violet coloration was recorded as the presence of resins.

### **Test for Phenols**

To 10 ml of extract was added 10 ml of ferric chloride solution. A deep blue coloration was recorded as the presence of Phenols.

## **Quantitative Analysis of Phytochemicals**

The quantitative analyses of the phytochemicals were carried out using standard methods described by Monika *et al.*, [11] and AOAC, [27]. In all the analysis, reagents were of analytical grades and were not subjected to further purification.

## **RESULTS AND DISCUSSION**

The results of the proximate analysis of *A. garckeana* fruits, leaves, roots and stem-bark are presented in Table 1. The fruit is the most proteinous part (12.0 %) and also with the highest moisture content (6.50 %), while the stem-bark is the least (4.91%, protein and 0.5 % moisture content). The stem-bark contains the highest carbohydrate content (72.16 %), closely followed by roots (70.81 %), while the least carbohydrate content is obtained from the fruits (28.40 %). Crude fiber content was found to be highest in fruits (45.00 %) followed by leaves (25.00 %), stem-bark (13.75 %) and roots (11.89 %). This considerable amount of crude fiber implies that *A. garckeana* (especially the fruits and leaves) will perform the role of stool softening, with optimum frequency and regularity of elimination, which is characteristic of fibre-rich diet (Nkafamiya *et al.*, 2010). The highest total ash content was found in the leaves (11.00%), and the least in the fruits (6.70%) (w/w). Comparing this result with the one reported by Nkafamiya *et al.*, [24] for *F. asperifolia* and *F. sycomorus*, the ash contents are comparable, while the other results obtained for *A. garckeana* parts are correspondingly lower. However, values obtained are within the range expected for dry leaf vegetables [24].

**Table 1: Proximate Composition of *A. garckeana* (%)**

| Part of plant | Moisture content (w/w) | Crude protein (w/w) | Crude fibre (w/w) | Lipid content (w/w) | Total ash (w/w) | Total carbohydrate (w/w) |
|---------------|------------------------|---------------------|-------------------|---------------------|-----------------|--------------------------|
| Fruits        | 6.50                   | 12.00               | 45.30             | 1.10                | 6.70            | 28.40                    |
| Leaves        | 5.50                   | 5.60                | 25.00             | 0.96                | 11.00           | 49.94                    |
| Roots         | 2.70                   | 7.42                | 11.89             | 0.68                | 8.70            | 70.81                    |
| Stem/bark     | 0.50                   | 4.91                | 13.75             | 1.12                | 7.56            | 72.16                    |

The non-nutritional component of the fruits, leaves, stem-bark and roots are presented in Table 2 (qualitative) and Table 3 (quantitative). These are compounds that limit the wide use of many tropical plants due to their ubiquitous occurrence as natural compounds capable of eliciting deleterious effect on man and animals [24, 28]. Alkaloids, steroids, cardiac glycosides, terpenes, resins and saponins are present in the plant parts (fruits, leaves, roots and stem-bark). Volatile oils are present in the fruits, leaves and the roots. Flavonoids are present in the fruits and leaves. Phenols and tannins are present only in leaves and fruits respectively. This result (especially the fruits and leaves) is comparable with those reported for some medicinal plants by Kubmarawa *et al.*, [29] and Idris *et al.*, [25].

**Table 2: Qualitative Screening of Non-nutritional Constituents of *A. garckeana***

| Part of plant used | Alkaloids | Tannins | Flavonoids | Steroids | Cardiac glycosides | Terpenes | Phenols | Volatile oils | Resins | Saponins |
|--------------------|-----------|---------|------------|----------|--------------------|----------|---------|---------------|--------|----------|
| Fruits             | +         | +       | +          | +        | +                  | +        | -       | +             | +      | +        |
| Leaves             | +         | -       | +          | +        | +                  | +        | +       | +             | +      | +        |
| Roots              | +         | -       | -          | +        | +                  | +        | -       | +             | +      | +        |
| Stem-bark          | +         | -       | -          | +        | +                  | +        | -       | -             | +      | +        |

Key: + present; - Not detected

The quantitative estimation of the non-nutritional factors (Table 3) indicated that alkaloid has the highest value in fruits (18.40 %) and lowest in roots (6.80 %). Leaves has the highest value of flavonoids (26.50 %) followed by the fruits (24.40 %). Flavonoids were not detected in the root and stem-bark. Saponins are not also detected in the fruits (concentration is below the detection limit of the procedure used), but has the highest value in leaves (30.00 %) followed by the stem-bark (34.50 %). Tannins were not detected in the leaves (concentration is below the detection limit of the procedure used), roots and stem-bark, but amount to 15.05% in the fruits. Phenols quantitatively amount to 29.00% of the plant leaves where it was only found. Although very medicinal [25], non-nutritional compounds above some threshold intake can bind to mineral elements there by forming indigestible complex. Oxalate tends to render calcium unavailable by binding to the calcium ion to form complexes (calcium oxalate crystals). These oxalate crystals formed prevents the absorption and utilization of the calcium. The calcium crystals

may also precipitate around the renal tubules thereby causing renal stones [24]. The non-nutritional compounds present in the plant parts are generally below the established toxic level [13, 24]. This thereby potentially recommends the plant parts (especially the fruits and leaves) for medicinal uses.

**Table 3: Quantitative Screening of Non-nutritional Constituents**

| Part of plant used | Alkaloids % (w/w) | Flavonoids % (w/w) | Saponins % (w/w) | Tannins % (w/w) | Phenols % (w/w) |
|--------------------|-------------------|--------------------|------------------|-----------------|-----------------|
| Fruits             | 18.40             | 24.40              | ND               | 15.05           | ND              |
| Leaves             | 13.60             | 26.50              | 30.00            | ND              | 29.00           |
| Roots              | 6.80              | ND                 | 24.50            | ND              | ND              |
| Steam bark         | 12.80             | ND                 | 34.50            | ND              | ND              |

Key: ND not detected

Table 4 presents some mineral composition of the fruits and other plant parts. The levels of mineral elements in fruits are higher than those found in the fruits of *C. congoensis*, *N. latifolia* and *C. panados* [13, 30]. Iron and zinc are among the essential elements for humans, and their amount (especially in the fruits and leaves) of *A. garckeana* are promising since the adult daily requirements are 15 and 18 mg, respectively. The iron level is also higher than some of the cultivated fruits like orange (0.2 mg/100 g) and mango (0.4 mg/100 g) [13]. Compared to the other parts, the fruits and leaves of *A. Garckeana* generally have appreciable levels of mineral elements. Therefore, consumption of *A. Garckeana* parts, specifically the fruits and leaves, could contribute immensely to the overall daily intake of these elements in amounts that will alleviate symptoms associated with their deficiency such as; hypercholesterolemia, demineralization of bones, microcytic anemia and immunocompetence (in pregnant and menstruating females) resulting from copper and iron deficiency, weakness, cardiac arrhythmia, poor growth, impairment of sexual development and poor wound healing as a result of magnesium and zinc deficiency [13].

**Table 4: Concentration of mineral elements in plant parts (mg/100 g)**

| Element | Fruits       | Leaves        | Roots        | Stem/bark    |
|---------|--------------|---------------|--------------|--------------|
| Ca      | 127 ± 0.04   | 129 ± 0.45    | 100 ± 0.04   | 28.02 ± 0.89 |
| Cd      | ND           | ND            | ND           | ND           |
| Co      | 0.02 ± 0.01  | 0.04 ± 0.02   | 0.01 ± 0.25  | 0.01 ± 0.91  |
| Cr      | ND           | ND            | ND           | ND           |
| Cu      | 0.45 ± 0.33  | 2.01 ± 0.25   | 0.01 ± 0.35  | 0.12 ± 0.97  |
| Fe      | 12.00 ± 0.43 | 15.00 ± 0.73  | 5.05 ± 0.23  | 6.00 ± 0.36  |
| Mg      | 96.25 ± 0.67 | 100.00 ± 0.12 | 45.05 ± 0.24 | 40.09 ± 0.45 |
| Mn      | 0.02 ± 0.23  | 0.01 ± 0.24   | 0.01 ± 0.98  | 0.01 ± 0.24  |
| Ni      | ND           | ND            | ND           | ND           |
| P       | 30 ± 0.87    | 29.07 ± 0.07  | 10.09 ± 0.90 | 9.09 ± 0.67  |
| Pb      | ND           | ND            | ND           | ND           |
| Zn      | 12.02 ± 09   | 11.06 ± 21    | 6.09 ± 07    | 5.06 ± 23    |

The vitamin content of the fruits and leaves of *A. Garckeana* is presented in Table 5. The vitamin content with the exception of vitamin C is higher compared to those found in the fruits of *C. congoensis* and *N. latifolia* [13]. Consumption of the fruits and leaves of *A. garckaena* can serve as vitamin supplements. Presence and amount of vitamin A and E in the fruits and leaves presents them as a potential remedy for symptoms associable with the deficiency of the vitamins e.g. night blindness and peroxidation. The value of vitamin C in both fruits and leaves of *A. Garckeana* is low compared to the fruits of *C. congoensis* (410.50 ± 0.32 mg/100 g ripe) and *N. latifolia* (309.00 mg/100 g ripe). Though the value of vitamin C of *A. Garckeana* is low compared to those of the fruits of *Congoensis* and *N.latifolia*, the fruits and leaves may prove important in the prevention of scurvy and alleviate symptoms of common cold [13].

**Table 5 Vitamin content (mg/100 g) of *A. Garckeana* fruits and leaves**

| Fruits/leaves | A            | B <sub>1</sub> | B <sub>2</sub> | C             | E           |
|---------------|--------------|----------------|----------------|---------------|-------------|
| Fruits        | 75.00 ± 0.23 | 1.28 ± 0.97    | 1.18 ± 0.45    | 319.09 ± 0.45 | 3.08 ± 0.55 |
| Leaves        | 28.75 ± 0.66 | 1.00 ± 0.67    | 0.95 ± 0.78    | 98.02 ± 0.65  | 2.09 ± 0.77 |

• Value in µg/100 g.

Values are means ± SD of 3 determinations.

Table 6 present the amino acid composition of *A. garckeana*. Essential amino acids were present in both the fruits and leaves and are higher than that of *F. asperifolia* and *F. Sycomorus* [24]. Leucine had the highest value for both the fruits and the leaves, while glycine had the lowest. Result is comparable with the result presented by Nkafamiya and his coworkers [24].

Table 6. Amino Acid Composition of the Fruits and Leaves of *A. garckeana* (g/100 g)

| Amino acid    | Fruits | Leaves |
|---------------|--------|--------|
| Alanine       | 3.30   | 4.00   |
| Arginine      | 7.01   | 7.69   |
| Aspartic acid | 9.67   | 10.97  |
| Cysteine      | 3.00   | 3.66   |
| Glycine       | 1.00   | 1.23   |
| Glutamic acid | 10.79  | 11.09  |
| Histidine     | 3.67   | 4.00   |
| Isoleucine    | 4.98   | 5.00   |
| Leucine       | 12.01  | 12.97  |
| Lysine        | 11.78  | 12.85  |
| Methionine    | 2.00   | 2.78   |
| Phenylalanine | 8.00   | 9.00   |
| Proline       | 4.00   | 4.78   |
| Serine        | 3.97   | 4.00   |
| Threonine     | 4.78   | 4.97   |
| Tyrosine      | 4.89   | 4.99   |
| Valine        | 6.00   | 6.76   |

## CONCLUSION

This study presents the nutritional evaluation of *A. garckeana* which is a wild plant. *A. garckeana* contains appreciable levels of nutrients in its various parts (especially the fruits and leaves). The presence and amount of some phytochemicals and mineral elements analyzed has also indicated that the consumption of the plant (especially the fruits and leaves) can be of medicinal and dietary values respectively. The 2 semi-essential (Arginine and Histidine), and 7 out of the 8 essential amino acids were found in appreciable amounts in the fruits and leaves. This consistently indicates the high proteinous content of the plant parts. The study therefore further recommends the consumption of *A. garckeana* (especially the fruits and leaves), while other parts may serve as raw materials for nutrients and medicinal substance extraction.

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