STUDIES ON NUTRITIONAL QUALITIES OF *Ceiba pentandra* LEAVES AS INFLUENCED BY ACCESSION AND LEAF TYPE: PROXIMATE AND VITAMIN COMPOSITIONS.

Olajide, K[1]and *Baiyeri, K. P[2]
[1]College of Agriculture, Division of Agricultural Colleges, Ahmadu Bello University, Kabba, Kogi State, Nigeria.
[2]Department of Crop Science, University of Nigeria, Nsukka, Enugu State.
*Author for correspondence: paul.baiyeri@unn.edu.ng

ABSTRACT
Freshly harvested leaves of *Ceibapentandra* sourced from Ayede and Unosi in Kogi State, Nigeria were assayed for proximate and vitamin contents of the mature and succulent leaves using standard analytical procedures. The study was a 2x2 factorial in completely randomized design (CRD) replicated thrice. Data were subjected to Analysis of Variance and result of the analysis of variance indicated that Ayede accession significantly ($p < 0.05$) possessed higher protein value of 13.72 %, other proximate traits were statistically similar. Main effect of leaf age on proximate composition showed that mature leaves significantly gave higher ash content (13.76 %), other attributes were not statistically different. Main effect of accession showed that Ayede accession significantly gave higher vitamin B_2 (0.62 mg/100g).Vitamin $B_{12}$and vitamin C were not significantly affected. Main effect of leaf type showed that mature leaves significantly gave higher vitamin C value (1.19 mg/100g) while vitamin B_{12} and vitamin B_2 were non-significant. The combined effect of accessions and leaf type on proximate and vitamin contents determined with genotype x traits biplot analysis revealed that ash content was more in mature leaves from Ayede and Unosi. Vitamin B_2, B_{12}, moisture and protein were more pronounced in succulent leaves from Ayede. Also, Higher concentration of carbohydrate, crude fat, crude fiber and vitamin C were found in succulent leaves from Unosi. With the rapid increase in the demand for vegetables, natural medicine and complimentary diet foods, *Ceiba pentandra* leaves from Ayede could be explored and selected for genetic improvement, consuming both mature and succulent leaves can solve malnutrition problem.
Key words: *Ceiba pentandra*, accession, leaf type, proximate and vitamins

INTRODUCTION

Ceiba pentandra is a tropical tree belonging to the family Malvaceae. It is among the largest trees in the world, it can grow up to 25-70m in height with a diameter of 100-300 cm (Adeniji *et al.,* 2019). Kapok is the most used common name of the tree and may also refer to the fibre obtained from its seed pods. The tree is also known as the Java cotton, Hara kapok, Silk cotton or Ceiba (Enechi s*et al.,* 2013; Raimi *et al.,* 2014). It is known among some Nigerian ethnic groups as Araba or Ogungun (Yoruba), Akpu-Ogwu (Igbo), Rimi (Hausa), and Bamtami (Fulani) (Anigo *et al.,* 2012; Raimi *et al.,* 2014). The young trunks and branches are armed with thick conical spines and are often green due to photosynthetic pigment (Iroka *et al.,* 2014). The leaves are alternate and palmately compound, with 5-8 entire-margined leaflets.

In Nigeria, *Ceibapentandra* is a popular vegetable in local communities and is a multipurpose plant. The succulent leaves are cooked in form of slurry sauce comparable to Okra. A powder prepared from dried leaves is used to prepared sauce during the dry season (Friday *et al.,* 2011). The leaves of *C. pentandra* can also be used as livestock fodder (Iroka *et al.,* 2014). The seeds, leaves, bark and resin are used to treat fever, asthma, dysentery and kidney disease (Olusola*et al.,* 2003). The seed oil which has antimicrobial activity is used for making soap, the residue is used as fertilizer and cattle feed(Ravi *et al.,* 2012). Presently, *Ceibapentandra* has high value in plywood manufacturing but can also be used for making boxes and crates, and for lightweight joinery (Orwa*et al.,* 2009). Formerly, it was best known for the fibre produced by its fruit. The floss derived from the inner fruit wall is used for stuffing cushions, pillows and mattresses, and for insulation, absorbent material and tinder (Bates, 2004; Orwa *et al.,* 2009; Chairrekij *et al.,* 2011; Adeniji *et al.,* 2019). The use of kapok fibre declined in the late 20th century after the introduction of synthetic substitutes.

In the world, food insecurity results in a continuous calorie deficit of approximately 795 million malnourished people (FAO, IFAD, and WFP, 2015; Umakanta *et al.,* 2020). Balanced and healthy diet can be ensured by consuming leafy vegetable as a source of proximate and vitamins accompanied with staple food. Vegetable has the potential of protecting human health and reduce the risk of cancer, cardiovascular, and other chronic diseases. Several studies have shown that *C. pentandra* leaves contained proximate and vitamin contents. Osuntokun *et al.* (2017) reported that it contained ash (8.72 %), moisture (7.32 %), protein (16.25 %), fat (5.34 %), fiber (8.53 %) and carbohydrate (53.72 %). According to Adepoju and Ugochukwu (2019), ceiba leaves contains vitamin B_2 (0.19 mg/100g) and B_{12} (0.24 mg/100g). Friday *et al.* (2011) reported that *C. pentandra* possessed vitamin C (4.91 mg/100g).

Earlier studies as reported by Ndubuaku *et al*. (2015) observed that location did not have any significant effect on the proximate and vitamin contents of the

leaves of moringa except vitamin A. Ojewuyi *et al.* (2014) reported higher crude protein (10.05 %), total ash (5.05 %), crude lipid (0.26 %), moisture content (8.70 %) and carbohydrate (57.44 %) in mature leaves but higher crude fibre (18.50 %) in young leaves of *PolyalthialongifoliaSonn.* Ndubuaku *et al.* (2015) reported higher vitamin B_2 (0.66 ppm) in older leaves than the succulent leaves but higher vitamin C (0.41 ppm) in succulent leaves of moringa.

Considering the numerous nutritional, economic and health benefits of *Ceibapentandra*, the plant is still under-utilized and may go into extinction unnoticed. There is paucity of data on the effect of accession and leaf type on proximate and vitamin compositions of *Ceibapentandra*. The aim of the study was to determine proximate and vitamin composition of *Ceibapentandra* leaves as influenced by accession and leaf type.

MATERIALS AND METHODS

Samples Collection

Samples of fresh (matured and succulent) leaves of *Ceibapentandra* were collected from Ayede (Kabba/Bunu LGA) and Unosi (Ajaokuta LGA) in Kogi State. The study was a 2 x 2 factorial experiment in completely randomized design (CRD) with three replications. The succulent leaves were small and soft while the matured leaves were dark green. Each leave type was named according to maturity stage and location of collection. The leaves were packed in paper envelops accordingly and taken to Simuch Scientific Analytical Laboratory, Nsukka and assayed for proximate and vitamin in June, 2020.

Proximate Analysis

Proximate were analyzed as recommended by AOAC (2005).Ash was determined byweighing 2g of sample into a silica dish and placed in a muffle furnace set at 600 ^{0} C for 3hours till a white greyish matter is obtained. The amount of residual white greyish matter is obtained by difference. The carbohydrate content was estimated by differences, subtracting the sum of moisture, protein, fat, crude fiber and ash percentages from one hundred. The crude fat content was determined by Soxhlet extraction with petroleum ether as solvent and crude fibre content by the acid and alkaline digestive methods. Moisture content was determined; 5 g of the ground sample was dried to a constant weight at 600 ^{0} C in a hot air circulating oven. The moisture was calculated as the difference in weight after drying. Crude protein in the samples was determined by the routine micro Kjeldahl procedure/technique.

Vitamins Determination

Vitamins were determined following the analytical procedure of AOAC (2007). Concentration of vitamin B_{12} was determined by using Spectrophotometer (Labomedspectronic 21D) and the absorbance of samples was read at a wavelength of 510 nm.At a wavelength of 460 nm, absorbance, the standards and samples were read using fluorescent spectrometer to determine vitamin B_2. Spectrophotometer (Spectronic 21D) at a wavelength of 15 seconds and 30 seconds was employed to determine vitamin C.

Data analysis

Data collected were subjected to the analysis of variance (ANOVA) using GENSTAT Discovery edition 3 Release 7.22 DE (GENSTAT, 2008). Significant treatment means were compared using least sigsnificant difference (LSD) at 5% level of probability.

RESULTS

Main effect of accession showed that there was no significant ($p < 0.05$) difference in the proximate composition of the leaves of *Ceibapentandra* collected from the two locations except protein (Table 1). However, Unosi accession had higher ash (11.25 %), carbohydrate (57.20 %), fat (1.59 %) and fiber (17.60 %) relative to 11.09 % of ash, 54.80 % of carbohydrate, 1.17 % of fat and 16.3 % of fiber obtained in leaves of *C. pentandra* sourced from Ayede. Conversely, Ayede accession recorded higher moisture content and crude protein with respective values of 3.09 % and 13.72 % compared with 3.00 % and 9.42 % of protein obtained in Unosi accession.

Table 1: Main effect of accession on proximate analyses ($^0/_0$) of *Ceibapentandra* leaves

Accession	Ash	CHO	Fat	Fibre	Moisture	Protein
Ayede	11.09	54.80	1.17	16.30	3.09	13.72
Unosi	11.25	57.20	1.59	17.60	3.00	9.42
LSD (0.05)	Ns	Ns	Ns	Ns	Ns	1.658

CHO= Carbohydrate. Ns= non-significant

Table 2 showed that leaf type significantly ($p < 0.05$) influenced ash content but carbohydrate, fat, fiber, moisture and protein contents were statistically similar. Mature leaves possessed higher ash (13.76 %) and carbohydrate (56.30 %) compared with succulent leaves that recorded 8.59 % and 55.60 %, respectively. On the other hand, succulent leaves gave higher crude fat, crude fiber, moisture and protein with 1.50 %, 18.80 %, 3.34 % and 12.34 %, respectively relative to matured leaves that had 1.25 %, 15.10 %, 2.75 % and 10.80 %, respectively.

Table 2: Main effect of leaf type on proximate analyses (%) of *Ceibapentandra* leaves

Leaf type	Ash	CHO	Fat	Fibre	Moisture	Protein
Mature	13.76	56.30	1.25	15.10	2.75	10.80
Succulent	8.59	55.60	1.50	18.80	3.34	12.34
LSD (0.05)	1.288	Ns	Ns	Ns	Ns	NS

CHO= Carbohydrate. Ns= non-significant

Accession had no significant ($p < 0.05$) effect on vitamin B_{12} and vitamin C, but vitamin B_2 differed significantly (Table 4). Higher vitamin B_{12} (0.011 mg/100g) and B_2 (0.62 mg/100g) values were obtained in Ayede accession compared with 0.010 and 0.35 mg/100g recorded in Unosi accession, respectively. Vitamin C value (1.23 mg/100g) was found to be higher in Unosi accession relative to 0.93 mg/100g obtained in Ayede accession.

Table 4: Main effect of accession on vitamins (mg/100g) of *Ceibapentandra* leaves

Accession	B_{12}	B_2	C
Ayede	0.011	0.62	0.93
Unosi	0.010	0.35	1.23
LSD (0.05)	Ns	0.23	Ns

Ns= non-significant

Table 5 showed that leaf type did not significantly ($p < 0.05$) influence vitamin B_{12} and B_2 but vitamin C varied significantly. Succulent leaves had higher vitamin B_{12} and B_2 with respective values of 0.012 and 0.59 mg/100g compared with 0.010 and 0.39 mg/100g recorded in mature leaves, respectively. However, higher vitamin C value (1.19 mg/100g) was obtained in mature leaves when compared with the value (0.97 mg/100g) recorded in succulent leaves.

Table 5: Main effect of leaf type on vitamins (mg/100g) of *Ceibapentandra* leaves

Leaf type	B_{12}	B_2	C
Mature	0.010	0.39	1.19
Succulent	0.012	0.59	0.97
LSD (0.05)	Ns	Ns	0.4947

Ns= non-significant

Combined effect of accessions and leaf age on proximate and vitamin constituent of *Ceibapentandra* leaves are shown in Figure 1.
The biplot revealed that ash content was more prominent in mature leaves from Ayede and Unosi. Vitamin B_2, B_{12}, moisture content and protein were generally higher in succulent leaves obtained from Ayede. Also, higher concentration of carbohydrate, crude fat, crude fiber and vitamin C were found in succulent leaves from Unosi.

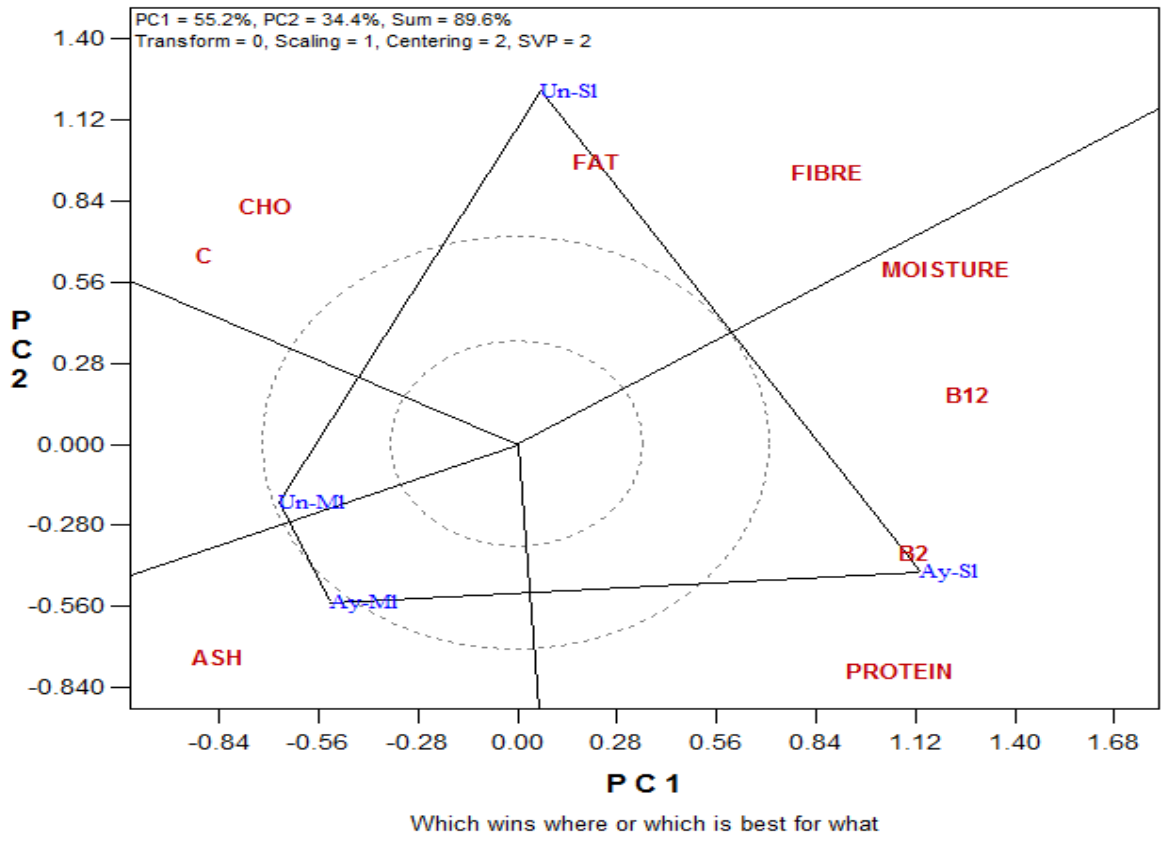

Figure 1: GGE biplot showing combined effects of accessions and leaf age on proximate and vitamin constituent of *Ceibapentandra* leaves.
Ay-Ml= Ayede (Matured leaves), Ay-Sl = Ayede (succulent leaves), Un-Ml= Unosi (Matured leaves) and Un-Sl= Unosi (succulent leaves). B2= vitamin B_2, B12=vitamin B_{12}, C=vitamin C and CHO= carbohydrate.

DISCUSSION

The result of the study indicated the leaves of *Ceibapentandra* contained appreciable quantities of proximate attributes. Ash and carbohydrate values obtained in this study were higher than those reported by Iroka *et al.* (2014) who found 7.26 % of ash and 40.59 % of carbohydrate in Ceiba leaves but fat (2.41 %), crude fiber (18.64 %) and moisture (14.34 %) were higher than the result obtained in this work. However, crude protein (12.32 %) fell within the range of the result recorded in this present study. The fat, crude fiber, moisture, and crude protein contents obtained in this study were lower than those reported in the literature (Raimi *et al.*, 2014) who observed 9.40 % of fat, 21.69 % of fiber, 5.30 % of moisture and 18.80 % of protein in *Ceibapentandra* leaves but ash (10.40 %) and carbohydrate (34.41%) values were lower than the result observed in this study. This *Ceibapentandra* leave a good source of energy. In comparison with the work of Shashin *et al.* (2016) higher concentration of crude fiber (28.44 %) and moisture (11.87 %) contents were obtained in Ceiba leaves thanthe result obtained in this work while ash (8.14 %) and carbohydrate (32.47 %) values were lower when compared with the result recorded in this present study. El Sohaimy *et al.* (2015) reported higher lipid (7.76 %) and moisture (10.74 %) values in moringa contrary to the findings of this study. Although, ash (4.56 %), fiber (11.23 %) and protein (9.38 %) were lower than the values found in this work. However, carbohydrate value (53.72 %) fell within the range of our finding. The ash content gives a measure of total amount of inorganic compounds like minerals present in a sample (Tsado, 2015). Carbohydrates are hydrolyzed in the body to yield glucose, which can be utilized immediately or stored as glycogen in the muscles and liver for future use (Iroka *et al.*,2014). Fats are important in energy production. Also, fats and oils help to regulate blood pressure of vital cell parts (Dutta, 1981; Iroka *et al.*,2014). Fibers reduce the levels of palm cholesterol and prevent colon cancer and cardiovascular disease (Boutwell. 1998). Moisture is a universal solvent that dissolves other substances, carries nutrients and other materials round the body, creating the possibility for organs to perform their function effectively (Iroka *et al.*, 2014). Ceiba leave is a good source of protein. Proteins are body builders, they replace worn out tissues, and proteins are also immune booster and can help in cell

division as well as growth (Okeke and Elekwa, 2006). The differences in proximate attributes noticed in this study could be due to genetic diversity and environmental influence.Olajide *et al*. (2020) reported variability in proximate composition of 10 accessions of African walnut which suggested the probable roles of genetic diversity and variability in soils the accessions grew on.

Ash (6.35 %) and moisture (29.03 %) were found in succulent leaves of moringa as reported by Ndubuaku *et al.* (2015) against the higher ash and moisture contents obtained in mature leaves of *Ceibapentandra* in this study but protein (13.17 %) and fiber (17.94 %) were higher in succulent leaves in agreement with our result. Higher concentration of carbohydrate was obtained in matured leaves which agreed with the result of this work. Total ash (5.05 %) and carbohydrate (57.44 %) were registered to be higher in mature leaves of *Polyalthialongifolia* as earlier reported by Ojewuyi *et al.* (2014) which is in agreement with our finding; fiber (25.15 %) was higher in young leaves in consonance with the result of this study. Higher crude lipid (0.26 %), moisture content (8.70 %) and protein (10.05 %) were obtained in mature leaves as against higher values of these traits recorded in succulent leaves of *Ceibapentandra* in this work. Tambari *et al.* (2015) reported higher ash (12.07 %) in young leaves of *Senna occidentalis* contrary to higher value for ash recorded in mature leaves. Higher nitrogen free extract (74.54 %) was obtained in mature leaves of *Senna obtusifolia* in agreement with the result of this study. However, 4.03 % of crude fibre, 61.43 % moisture and 13.41 % crude protein were highly concentrated in young leaves of *Senna occidentalis* in support of the result of our findings.

The vitamin B_2 found in the leaves of *Ceibapentandra* was higher compared to those obtained by Adepoju and Ugochukwu (2019) who reported vitamin B_2 to be 0.19 mg/100g but Vitamin B_{12} value (0.24 mg/100g) was higher than the values obtained in the present study. Vitamin B_2 value recorded in this study was higher than (0.08 mg/100g) reported by El Sohaimy *et al.* (2015) in moringa. Ndubuaku *et al.* (2015) found lower Vitamin B_2 (0.70 ppm) and Vitamin C (0.38 ppm) in moringa sourced from Jos and Nsukka when compared with the result of this study. Friday *et al.* (2011) reported higher vitamin C (4.91 mg/100g) in Ceiba leaves than the result obtained in the present study. Vitamins are considerednecessary for cellular metabolism. Vitamin C has anti-infective properties, promotes wound-healing, may boost the immune system and help to ward off infections, it has antioxidant properties and may protect against some forms of cancer (Wright, 2002; Tsado, 2015). Genetic and environmental effect might have caused the differences in vitamin composition of *Ceibapentandra* leaves assayed. The variations in the levels of the nutrients obtained by the various researchers could be due to the differences in the study locations and the environmental conditions (Ndubuaku *et al.*, 2015).

Higher Vitamin B_2 (0.66 ppm) was found in older leaves and more concentration of Vitamin C (0.41 ppm) in succulent leaves of moringa as reported by Ndubuaku *et al.* (2015), this report negates the results obtained in this study. Vitamin B_{12} was more pronounced in succulent leaves.

CONCLUSION

The chemical constituent determines the nutritive, economic and medicinal value of any vegetable. The result of the proximate and vitamin constituents revealed that the leaves of *Ceibapentandra* contains ash, carbohydrates, crude fiber and crude protein in high amount but low in fat and moisture. Also, vitamin B_{12}, B_6 and C were present. Mature leaves possessed the highest ash, carbohydrate and vitamin C. Succulent leaves gave the highest fat, crude fiber, moisture, crude protein, vitamin B_{12} and B_2**.** Conclusively, with the rapid increase in the demand for vegetables, natural medicine and complimentary diet foods, *Ceibapentandra* leaves from Ayede is a potential source that could be explored and selected for genetic improvement. Consuming both mature and succulent leaves will go a long way in solving malnutrition problem of the rural populations.

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