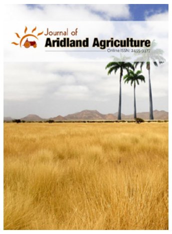
Journal of Aridland Agriculture 2022, 8: 20-26
doi: 10.25081/jaa.2022.v8.7161
https://updatepublishing.com/journal/index.php/jaa

Research Article



ISSN: 2455-9377

Influence of poultry manure rates on proximate, mineral, vitamin and anti-nutrient compositions of Baobab (*Adansonia digitata*) leaves

Kolawole Olajide[1]*, Paul Kayode Baiyeri[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, Nigeria

ABSTRACT

Succulent leaves of two accessions of Baobab (Odo-Ere and Okoloke) grown under three poultry manure rates (PM) (0, 15 and 30 t ha^{-1}) were harvested and assayed for proximate, mineral, vitamin and anti-nutrient compositions using standard analytical procedures in replicated trials. Results of the analysis of variance revealed a significant ($p<0.05$) effect of accession and poultry manure on some proximate, mineral, vitamin and anti-nutrient contents of Baobab leaves. Accession sourced from Okoloke contained higher carbohydrates and protein while Odo-Ere accession had higher moisture content. Application of 15 t ha^{-1} of PM increased moisture content. The effect of accession was non-significant ($p>0.05$) on mineral contents. No application of PM enhanced iron, iodine and zinc concentrations. Vitamins B_6, E and carotenoid contents were higher in Okoloke. Application of 30 t ha^{-1} of PM increased vitamin B_6 and carotenoids. Odo-Ere produced higher flavonoids, oxalate and phytate while Okoloke contained higher phenol. Application of 30 t ha^{-1} of PM increased phenol content. Plants grown without PM and plants treated with 15 t ha^{-1} of PM topped regarding saponin. Biplot analysis revealed wide variability in nutritional qualities of Baobab leaves in response to the combined effects of accession and poultry manure. The results provided further insight into the utilization potential of leaves of Baobab. Furthermore, the results showed that poultry manure application could have a positive impact on the vitamin, proximate and anti-nutrient contents of Baobab leaves.

Received: June 09, 2021
Revised: October 30, 2022
Accepted: November 01, 2022
Published: November 18, 2022

***Corresponding Author:**
Kolawole Olajide
E-mail: okolawole40@yahoo.com

KEYWORDS: Baobab accessions, Mineral, Anti-nutrient, Vitamin, Proximate

INTRODUCTION

The problem of food security remains a major challenge in most developing countries of the world. Nutritional deficiencies are the cause of acute malnutrition affecting most people (Enzonga *et al.*, 2019). According to Stephenson *et al.* (2000), malnutrition is the most important cause of mortality in the global human population. One of the ways out of this impasse is the valuation of edible vegetables including wild ones available but less exploited. Fruits and vegetables are considered as very good sources of minerals, vitamins, protein, carbohydrates, phenolic compounds and antioxidants and can contribute to a qualitative improvement in the health of populations (Ahodegnon *et al.*, 2018). *Adansonia digitata* (L.) (Malvaceae) is a deciduous, massive and majestic tree up to 25 m high which may live for hundreds of years (Gebauer *et al.*, 2002; Angiosperm Phylogeny Group II, 2003). The trunk is up to 10 m in diameter, often buttressed; usually tapering or cylindrical and abruptly bottle-shaped (Arowora *et al.*, 2018). Branches are large and distributed irregularly. The leaves are alternate and foliate. The plant is widespread throughout the hot and drier regions of tropical Africa (FAO, 1988). The tree is grown in courtyards of villages and cities of Northern Nigeria. Baobab seems to be the most protected tree in the arid and semi-arid zones of Nigeria. Baobab tree has multi-purpose uses and every part of the plant is reported to be useful (Ibrahim *et al.*, 2014).

In Nigeria, Baobab leaves have been a major component in the traditional diets of the rural population (Husseini *et al.*, 2016). The young leaves are used for soup in form of slurry sauce comparable to Okra used for eating starchy balls made from cassava, yam and millet. The leaves are also dried and made into a powder which is used to prepare sauce during the dry season. Seeds are used as a thickening agent in soups, but they can be fermented and used as a flavouring agent, or roasted and eaten as snacks (Arowora *et al.*, 2018). The pulp is either sucked or made into a drink while the bark is used in making ropes. The different parts of the plant provide food, shelter, clothing, medicine and material for hunting and fishing and it provides income and employment to rural and urban households (Sibibe & Williams, 2002; Arowora *et al.*, 2018).

Biochemical analyses revealed that the leaves of Baobab are rich in nutrients. Study of Abiona *et al.* (2015) revealed that Baobab leaves contain protein (13.6%), fat (2.71%), sugar (0.01%), ash (4.08%), crude fiber (2.45%), moisture content (78.2%) and vitamin C (14.98mg/100g). Previous work of Arowora *et al.* (2018) reported 31.43 mg/100g of tannins, 9.35 mg/100g of alkaloids, 63.43 mg/100g of flavonoids, 124.36 mg/100g of phenolics and 14.63 mg/100g of Glycosides. In an earlier study (Ndubuaku *et al.*, 2015) showed that location did not have any significant effect on the proximate and vitamin contents of the leaves of *Moringa* except vitamin A. Mahgoub (2014) reported genetic diversity in nutritional traits in Baobab leaves. Also, Ibrahim *et al.* (2014) found genetic variability in nutritional qualities of Baobab leaves. According to Stevens *et al.* (2021) who worked on twenty accessions of *Moringa* reported accessional variation in vitamin contents in the leaves.

Non-significant effect of poultry manure on the proximate, chemical, anti-nutrient and vitamin contents of *Moringa* leaves (Ndubuaku *et al.*, 2015). Earlier study by Singh (2010) reported increase in N, P, K Zn, protein and carbohydrate contents of corn (*Zea mays* L.) with poultry manure application. Poultry manure and other organic fertilizers increase the nutrient status of most soils and boost crop productivity (Annenber, 2010; Singh, 2010). However, there is little information on the influence of accession and poultry manure application rates on proximate, minerals, vitamins and anti-nutrient constituents of leaves of Baobab. This is probably the first study on the influence of accession and poultry manure application rates on proximate, minerals, vitamins and anti-nutrient traits of Baobab leaves in Nigeria. This study evaluates variations in proximate, mineral, vitamin and anti-nutrient compositions of leaves of two accessions of Baobab as influenced by poultry manure rates.

MATERIALS AND METHODS

Sample Collection

Succulent leaves (Figure 1) of two accessions of Baobab sourced from Odo-Ere and Okoloke in Yagba West Local Government Area of Kogi State and grew under three poultry manure rates (0, 15 and 30 t ha^{-1}) in the germplasm garden of the Department of Crop Science, University of Nigeria, Nsukka were harvested and assayed for proximate, minerals, vitamins and anti-nutrient compositions. First to third leaf from the shoot-tip were used for laboratory analyses. The experiment was a 2x3 factorial in a completely randomized design. Triplicate samples of the leaves were taken at 11 months after transplanting to the field. The leaves were packed in paper envelopes and taken to Simuch Scientific Analytical Laboratory, Nsukka.

Figure 1: Succulent leaves of Baobab used for laboratory analysis

Proximate Analysis

Proximate contents were analyzed as recommended by AOAC (2005). Ash was determined by weighing 2g of sample into a silica dish and placed in a muffle furnace set at 600 ^{0}C for 3 hours till a white greyish value was obtained. The amount of residual white greyish matter was 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.

Analysis of Minerals

The official method of AOAC (2007) was adopted for the mineral analysis of the samples. Two grams of each ground sample was weighed into a silica dish, then placed in a muffle furnace and heated at 600 ^{0}C for three hours, allowed to cool in a desiccator and weighed. The samples were dissolved with HCl and prepared for reading using an atomic absorption spectrometry (AAS). Calcium, iron and zinc were determined using atomic absorption spectrometer (AA-7000) and absorbance read at 422.7 kk-nm, 248.3 kk-nm and 213.9 kk-nm wavelengths respectively. Iodine was determined using wijs' method. The extracted oil of 0.5 ml was poured into a beaker and a small rod was added and a little quantity was weighed out of the sample by difference into a dry glass-stoppered bottle of about 250 ml capacity. 0.5 ml of the oil was taken by dividing 20 by the highest iodine value. 10 ml of carbon tetrachloride was added to the oil and dissolved. 20 ml of Wijs' solution was added, the stopper was inserted and was allowed to stand in the dark for 30 min.15 ml of potassium iodide solution (10%) and 100 ml water was mixed and titrated with 0.1 M thiosulphate solution using starch as indicator just before the end-point. Carryout a blank at the same time commencing with 10 m of carbon tetrachloride.

Vitamin Determination

Carotenoid was determined by weighing 2.0 g of sample into a set of conical flasks. The sample was saponified, extracted with 10 ml of xylene-kerosene mixture, shaken for 30 minutes and centrifuged for 25 minutes. The supernatant was run on the spectrometer at 328 nm and 460 nm respectively. Vitamins were determined following the analytical procedure of AOAC (2007). The concentration of vitamin B_{12} was determined using a Spectrophotometer (Labomed Spectronic 21D) and the absorbance of samples was read at a wavelength of 510 nm. Vitamin E was also determined using a Spectrophotometer (752P) and absorbance was taken at a wavelength of 520 nm. At a wavelength of 540 nm, vitamin B_6 was determined using a Spectrophotometer (752P).

Anti-nutrient Analysis

Anti-nutrients were analyzed as recommended by Harborne (1973). Oxalate, phenols, Saponin and phytate were determined using a spectrophotometer (752P) at wavelengths of 490, 425, 720 and 520 nm, respectively. UV-VIS spectrophotometer at a wavelength of 720, 550 and 520 nm was employed to determine the concentration of tannin flavonoids and cyanogenic glycosides in the samples.

Data Analysis

Data were collected across the accessions in triplicates and subjected to the analysis of variance (ANOVA) in completely randomized design (CRD) using GENSTAT statistical software. Significant treatment means were compared using the least significant difference (LSD) at a 5% level of probability. Genotype plus genotype by environment interaction (GGE) biplot was used to illustrate the combined effect of accessions and poultry manure rates on proximate, mineral, vitamin and anti-nutrient compositions of Baobab leaves.

RESULTS

The results of the main effect of accession and poultry manure rates on the proximate composition of Baobab leaves are presented in Table 1. The quantity of ash, fat and fiber was not statistically different with the accessions but carbohydrate, moisture and protein contents differed significantly ($p<0.05$). Leaves collected from the Okoloke accession contained higher carbohydrates and protein of 58.50 and 18%, respectively when compared with the values (51.70% and 14.21%) obtained from the Odo-Ere accession. Higher moisture content (14.10%) in the leaf samples was associated with the accession sourced from the Odo-Ere relative to the moisture content (7.40%) obtained in the Okoloke accession. The different poultry manure application rates had no significant ($p > 0.05$) difference in the proximate compositions of the leaves except in moisture content. The highest value (13.40%) of moisture was obtained at 15 t ha^{-1} followed by 0 t ha^{-1} (12.80%) and 30 t ha^{-1} (6.10%) in that order.

The biplot in Figure 2 showed the combined effects of accessions and poultry manure on proximate traits of Baobab leaves. Odo-Ere accession fertilized with 15 t ha^{-1} of poultry manure (PM) had a higher value for fiber. Moisture content was higher in accession from Odo-Ere that was treated with no poultry manure. Fat content was evidently higher in Odo-Ere accession grown with 30 t ha^{-1}. Okoloke accession that was grown without manure application was outstanding with respect to carbohydrates and protein.

The results of the effect of accession and poultry manure rates the mineral composition of Baobab leaves are shown in Table 2. Accession had no significant ($p > 0.05$) effect on the mineral contents of Baobab leaves. Similarly, there was no significant ($p > 0.05$) effect of poultry manure

Table 1: Main effect of accession and poultry manure rates on proximate composition (%) of Baobab leaves

Accession	Ash	Carbohydrate	Fat	Fiber	Moisture	Protein
Odo-Ere	8.44	51.70	6.10	5.39	14.10	14.25
Okoloke	7.68	58.50	2.90	4.73	7.40	18.29
SEM	0.58	3.16	2.48	1.29	2.16	1.30
Manure rates (t ha^{-1})						
0	8.35	55.40	2.70	4.25	12.80	16.34
15	7.34	54.70	3.40	5.83	13.40	14.74
30	8.48	55.20	7.30	5.09	6.10	17.73
SEM	0.71	3.87	3.04	1.58	2.64	1.60

Ns=non-significant

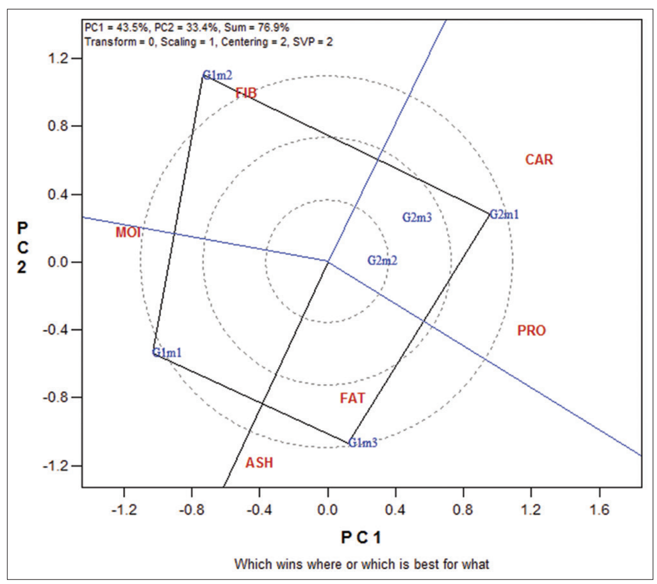


Figure 2: GGE biplot showing combined effects of accessions and poultry manure on proximate traits of Baobab leaves. Proximate code: ASH-ash, CAR-carbohydrate, FAT- fat, FIB-fiber, MOI-moisture and PRO-protein. Accession and manure code: G1M1- accession 1 (Odo-Ere) and manure rate 1 (0 t ha^{-1}), G1M2- accession 1 (Odo-Ere) and manure rate 2 (15 t ha^{-1}), G1M3- accession 1 (Odo-Ere) and manure rate 3 (30 t ha^{-1}); G2M1- accession 2 (Okoloke) and manure rate 1 (0 t ha^{-1}), G2M2- accession 2 (Okoloke) and manure rate 2 (15 t ha^{-1}), G2M3- accession 2 (Okoloke) and manure rate 3 (30 t ha^{-1})

rates on the concentration of calcium but all other mineral constituents were not statistically similar. Concentration of iron (10.00 mg/100g), iodine (9.69 mg/100g) and zinc (0.98 mg/100g) were more pronounced in plants grown without poultry manure application (control). Application of 30 t ha^{-1} of poultry manure (PM) produced the least values (6.00 and 0.88 mg/100g) for iron and zinc, respectively while plants grown under 15 t ha^{-1} of PM had the least iodine. A biplot of the mineral and vitamin contents of the accessions as influenced by poultry manure rates indicated wide variability with accessions and poultry manure occupying different vertexes of the biplot (Figure 3). Odo-Ere accession grown without poultry manure had a higher proportion of calcium and vitamin B_{12}. Higher concentration of zinc, iron and iodine was attributed to Okoloke accession without poultry manure application. Okoloke accession grown with 30 t ha^{-1} and the same accession that received 15 t ha^{-1} had a higher accumulation of vitamin E, carotenoid and vitamin B_6.

Table 2: Main effect of accession and poultry manure rates on mineral composition (mg/100g) of Baobab leaves

Accession	Calcium	Iron	Iodine	Zinc
Odo-Ere	98.10	7.78	8.44	0.90
Okoloke	89.70	8.00	7.83	0.93
SEM	11.84	1.17	0.55	0.03
Manure rates (t ha^{-1})				
0	102.50	10.00	9.67	0.98
15	87.50	7.67	7.00	0.90
30	91.60	6.00	7.75	0.88
SEM	14.51	1.43	0.68	0.04

Ns=non-significant

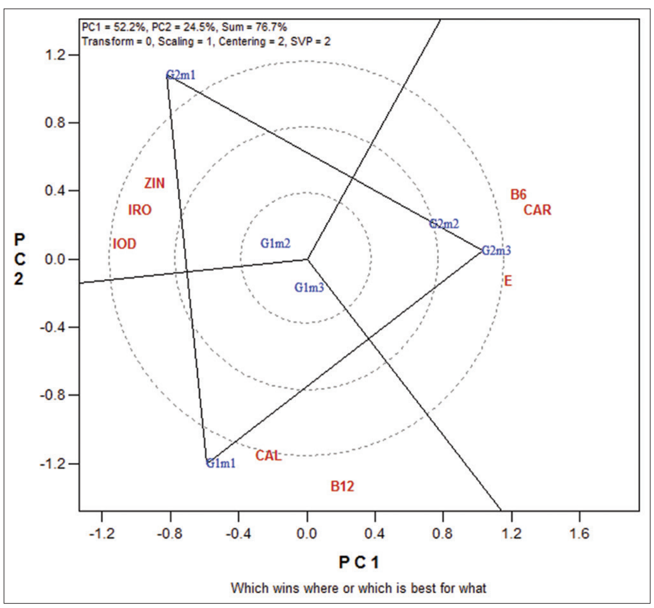


Figure 3: Biplot analysis showing the interaction of accession and poultry manure rates on mineral and vitamin contents of the leaves of Baobab. Mineral elements code: CAL-calcium, IRO- iron, IOD- iodine and ZIN-zinc. Vitamin code: B12- Vitamin B12, B6- Vitamin B6, E – vitamin E and CAR-carotenoids. Accession and manure code: G1M1- accession 1 (Odo-Ere) and manure rate 1 (0 t ha^{-1}), G1M2- accession 1 (Odo-Ere) and manure rate 2 (15 t ha^{-1}), G1M3- accession 1 (Odo-Ere) and manure rate 3 (30 t ha^{-1}); G2M1- accession 2 (Okoloke) and manure rate 1 (0 t ha^{-1}), G2M2- accession 2 (Okoloke) and manure rate 2 (15 t ha^{-1}), G2M3- accession 2 (Okoloke) and manure rate 3 (30 t ha^{-1})

The main effect of accession and poultry manure rates on vitamin constituents of Baobab leaves is shown in Table 3. Vitamin B_{12} was not significantly ($p > 0.05$) influenced by the accessions but all other vitamin traits assayed varied statistically. Interestingly, vitamin B_6, E and carotenoids were more concentrated in the leaves from Okoloke accession with respective values of 2.28, 12.33 and 124.40 mg/100g in comparison with the values (0.54, 8.89 and 81.10 mg/100g) recorded in Odo-Ere accession. Poultry manure application rates only influenced vitamin B_6 and carotenoids. Noteworthy is that application of 30 t ha^{-1} of PM increased the contents of vitamin B_6 (1.77 mg/100g) and carotenoids (118.30 mg/100g) while leaf samples from plants that received no PM gave the least of 0.77 and 81.70 mg/100g, respectively.

Table 4 presents the main effect of accession and poultry manure rates on anti-nutrient contents of Baobab leaves. All the anti-nutrient traits evaluated except cyanogenic glycosides, saponin and tannin showed a significant response to accession. Odo-Ere had higher accumulation of flavonoids, oxalate and phytate with respective values of 25.33, 66.70 and 2.54 mg/100g compared to 19.22, 36.70 and 1.56 mg/100g recorded from Okoloke accession. Conversely, leaves of accession sourced from Okoloke had a higher phenol content of 146.00 mg/100g relative to 50.00 mg/100g obtained in the Odo-Ere accession.

Poultry manure application rates only exerted a significant influence on phenol and saponin. The concentration of phenol (187.00 mg/100g) was highest with the application of poultry manure at the rate of 30 t ha^{-1} while 15 t ha^{-1} had the least value at 34.00 mg/100g. Plants that were not treated with PM and plants that were fertilized with 15 t ha^{-1} of PM took the lead with respect to saponin content (0.11 mg/100g) while plants grown with 30 t ha^{-1} of PM gave the least value of 0.07 mg/100g. The biplot (Figure 4) showed the interaction of accession and poultry manure rates on anti-nutrient contents of the leaves of Baobab. The biplot revealed that Odo-Ere accession grown without poultry manure application contained more flavonoids. Similarly, leaves from Odo-Ere that were treated with 30 t ha^{-1} had oxalate and phytate contents. Cyanogenic content was higher in Odo-Ere accession grown with 15 t ha^{-1}. Okoloke accession that was treated with 15 t ha^{-1} had more concentrations of tannin and saponin. The biplot analysis of the proximate traits explained 76.9% of the total variation among the accessions and poultry manure, mineral and vitamin contents explained 75.7% of the total variation while anti-nutrient contents explained 87.2%.

DISCUSSION

Proximate analysis is an important index to classify the nutritional component of a food material. Accession differed significantly on carbohydrate, moisture and protein contents. Previous work of Ibrahim *et al.* (2014) reported genetic diversity in nutritional traits in Baobab leaves. A study (Ndubuaku *et al.*, 2015)

Table 3: Main effect of accession and poultry manure rates on vitamin constituents (mg/100g) of Baobab leaves

Accession	B_{12}	B_6	E	Carotenoids
Odo-Ere	0.04	0.54	8.89	81.10
Okoloke	0.04	2.28	12.33	124.40
SEM	0.013	0.198	1.246	11.34
Manure rates (t ha^{-1})				
0	0.04	0.77	9.50	81.70
15	0.04	1.69	10.17	108.30
30	0.04	1.77	12.17	118.30
SEM	0.016	0.242	1.526	13.89

Ns=non-significant

Table 4: Main effect of accession and poultry manure rates on anti-nutrient contents (mg/100g) of Baobab leaves

Accession	Cya.Gly	Flavonoids	Oxalate	Phenol	Phytate	Saponin	Tannin
Odo-Ere	0.02	25.33	66.70	50.00	2.54	0.10	5.35
Okoloke	0.02	19.22	36.70	146.00	1.56	0.09	5.66
SEM	0.008	1.837	11.73	39.00	0.219	0.012	0.429
Manure rates (t ha^{-1})							
0	0.02	24.00	42.20	73.00	2.06	0.11	5.52
15	0.02	20.83	61.50	34.00	2.15	0.11	5.91
30	0.02	22.00	51.40	187.00	1.93	0.07	5.09
SEM	0.009	2.250	14.37	47.80	0.269	0.014	0.525

Cya_Gly.= cyanogenic glycosides and Ns=non-significant

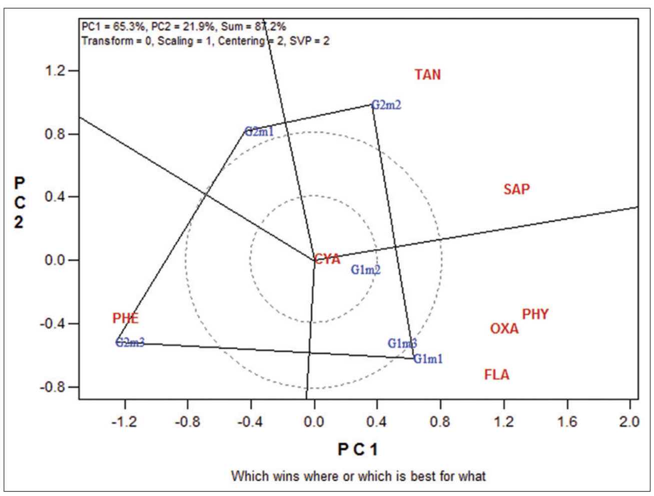


Figure 4: Biplot analysis showing the interaction of accession and poultry manure rates on anti-nutrient contents of the leaves of Baobab. Anti-nutrient code: CYA-cyanogenic glycosides, FLA-flavonoids, OXA-oxalate, PHE-phenol, PHY-phytate, SAP- saponin and TAN- tannin. Accession and manure code: G1M1- accession 1 (Odo-Ere) and manure rate 1 (0 t ha^{-1}), G1M2- accession 1 (Odo-Ere) and manure rate 2 (15 t ha^{-1}), G1M3- accession 1 (Odo-Ere) and manure rate 3 (30 t ha^{-1}); G2M1- accession 2 (Okoloke) and manure rate 1 (0 t ha^{-1}), G2M2- accession 2 (Okoloke) and manure rate 2 (15 t ha^{-1}), G2M3- accession 2 (Okoloke) and manure rate 3 (30 t ha^{-1})

revealed non-significant effect of accession on some proximate components of *Moringa* leaves in Nsukka. Earlier reports from Enoch *et al.* (2020) observed higher content of protein and ash (38.18 and 11.00%, respectively) when compared with the values obtained in this work. However, values of 37.30, 3.50, 1.00, and 9.02%, respectively for carbohydrate, fat, fiber and moisture were lower than the values recorded in this current study. Also, Ibrahim *et al.* (2014) reported lower values for fat, ash, protein, fibre and carbohydrate contents in the range 0.24-1.10%, 0.65-1.44%, 3.88-5.64%, 1.60-2.60%, 12.82-17.92%, respectively as against the values recorded in this study. The high carbohydrate content in Baobab leaves indicated that it was a good source of energy. The protein content detected in this study showed that Baobab leaves could be a potential source of protein for rural dwellers. According to Arowora *et al.* (2018), they calculated that without considering the conversion factor or the effect of processing, the consumption of 20 g of dry leaf material would cover 10 to 16% of the protein recommended daily intake for children. The variability in proximate attributes obtained by the various workers could be due to genetic diversity and environmental influence. The study by Olajide *et al.* (2020) reported variability in the proximate composition of 10 accessions of African walnut which suggested the probable roles of genetic diversity and variability in soils the accessions grew on.

The different poultry manure application rates on proximate composition showed a significant effect only on moisture content. These findings disagreed with the report of Ndubuaku *et al.* (2015) who observed non-significant influence of PM rates on all the proximate compositions in leaf of *Moringa* in Nsukka. The values of ash (6.53%), carbohydrate (44.13%), fat (0.20%) and protein (12.57%) reported by Ndubuaku *et al.* (2015) in PM treated *Moringa* leaves from Nsukka were generally lower than the values reported in this work except for fiber (15.99%) and moisture content (28.58%) where their values were higher than ours. Mineral contents in Baobab leaf did not vary with the accessions indicating that Baobab leaves obtained irrespective of the locations may provide sufficient amounts of minerals. The results obtained in this study are similar to those of Compaore *et al.* (2011) who did not find statistical differences in proximate and elemental nutrient content in pulps of *Parkia biglobosa* and *Adansonia digitata* across geographical regions of Burkina Faso. However, mineral values obtained in this work with those of a few other workers revealed some disparities. The calcium and iron values obtained in this work were higher than (0.780 and 3.640 mg/L) reported by Enoch *et al.* (2020) in Baobab leaves from Adamawa State, Nigeria. Another work of Arowora *et al.* (2018) reported higher value for calcium (415.63 mg/100g), iron (10.93 mg/100g) and zinc (8.32 mg/100g) in Baobab leaves from Taraba State, Nigeria than the values obtained in this work. The variation observed in mineral contents may be due to genetic makeup and environmental differences. Differences in nutritive values may be attributed to differences in plant variety, climatic and geographical differences (Egbekun & Ehieze, 1997). The potential of Baobab to address malnourishment challenges is traceable to the various metabolic, structural and physiological roles played by minerals and other types of nutrients. Absence or insufficient amounts of these substances in the body normally trigger deficiency diseases with devastating effects on human and animal health (Stevens *et al.*, 2021).

Most of the mineral contents varied with the poultry manure application rates. Observation from Ndubuaku *et al.* (2015) showed a non-significant effect of PM on the chemical, proximate and vitamin compositions of *Moringa* leaves in Nsukka which negates the results of this study. The results also disagreed with the work of Demir *et al.* (2010) who also obtained non-significant effects of PM on N, Mg and Mo concentrations of tomato leaves and fruits. The values for iron, iodine and zinc obtained in this work were higher than (62.20, 1.10 and 2.86 ppm) those reported by Ndubuaku *et al.* (2015) in *Moringa* leaves grown with PM in Nsukka. Accessional differences were observed in the vitamin contents of the Baobab leaves. Results of Stevens *et al.* (2021) reported accessional variation in vitamin contents in *Moringa* leaves from Nsukka. Variability in the accessions regarding vitamin contents implies that industrial exploitation of this species is necessary. As observed, vitamins B_6, E and carotenoids were more concentrated in the leaves collected from the Okoloke accession. As reported by Stevens *et al.* (2021) in the leaves of *Moringa* from Nsukka found higher value of vitamin B_{12} (0.08% against 0.04 mg/100g obtained in this study) but vitamins B_6 (0.06%), E (0.10%) and carotenoids (0.06%) were lower than the values obtained in this work. The values for vitamin B_6, E and carotenoid obtained in this work were higher than (1.16, 1.12 and 0.64 ppm) as reported by Ndubuaku *et al.* (2015) in succulent leaves of *Moringa* from Nsukka. The genetic and environmental effects might have caused the differences in vitamin compositions of Baobab leaves assayed. The differences obtained in the nutrient contents by the various researchers could be attributed to the locational and environmental variations (Ndubuaku *et al.*, 2015).

Poultry manure application rates differed with vitamin B_6 and carotenoids. Studies of Ndubuaku *et al.* (2015) reported non-significant effect of PM on the vitamin compositions of *Moringa* leaves in Nsukka. The result of this work disagreed with the work of Demir *et al.* (2010) who also reported non-significant effects of PM on N, Mg and Mo contents of tomato leaves and fruits. Also, Ndubuaku *et al.* (2015) found lower values (1.07, 0.99 and 0.58 ppm) for vitamin B_6, E and carotenoid, respectively in leaves of poultry manure-treated *Moringa* plants from Nsukka.

The result of the anti-nutrient analysis of Baobab leaves showed the presence of flavonoids, tannins, glycosides and phenol this observation is similar to the report by Diplocka *et al.* (1998). Accessional differences were obtained with respect to some anti-nutrient contents assayed in Baobab leaves. The value for phenol (124.36 mg/100g) was lower but tannins (31.43 mg/100g), flavonoids (63.43 mg/100g) and glycosides (14.63 mg/100g) as reported by Arowora *et al.* (2018) in Baobab leaves from Taraba state, Nigeria were higher than those obtained in this present study. Previous work of Ogbaga *et al.* (2017) reported higher saponin (0.25%) in the sun-dried leaves of Baobab from Abuja, Nigeria than the value obtained in this work, the value of their flavonoids (0.12%) was far lower than ours. Genetic and location (environment) effects might be responsible for the differences in the composition of some anti-nutrient contents. Earlier studies as reported by Olajide *et al.* (2020) observed variability in some phytochemical contents of 10 accessions of African walnut which suggested the probable roles of genetic diversity and variability in soils the accessions grew on. The higher values of the anti-nutrient contents (phenol, flavonoids, oxalate and saponins) obtained in the poultry manure-treated Baobab leaves indicated a positive impact of poultry manure on the quantity of the anti-nutrient in the plants. Poultry manure probably contained substances which could have contributed to the increase in the anti-nutrient contents of the Baobab leaves. The report of Ndubuaku *et al.* (2015) revealed higher values for oxalates (2.91 g 100 g^{-1}), phytate (9.41 g 100 g^{-1}), tannin (6.23 g 100 g^{-1}) and saponin (4.63 g 100 g^{-1}) in *Moringa* leaves treated with poultry manure in Nsukka when compared with the results obtained in this study. The concentration phytate was within the tolerable limit of 9.22-5.72% Okon and Akpanyung (2005) but oxalate, phenol, saponin and tannin were above the tolerable limits of 5% (Caser, 2003), 2% (Michałowicz & Duda, 2007), 0.2% (AOAC, 2005) and 3.3% (Elfadi *et al.*, 2013), respectively. Since the leaves are not eaten raw, the anti-nutrient contents may be significantly reduced by heat during the cooking process. The boiling of plant parts in water reduced the poisonous effect of anti-nutrients and assists to increase their consumption (Khan *et al.*, 2015).

CONCLUSION

This study established remarkable accessional variation in anti-nutrient, vitamin and proximate contents in Baobab leaves. Odo-Ere had higher values of flavonoids, oxalate and phytate while concentrations of carbohydrates, protein, phenol, vitamin B_6, E, carotenoids and lowest moisture content were attributed to Okoloke accession which suggests the need for selection. This information could provide the basis for the selection of the species for optimum nutrition and health of the populations. Poultry manure application increased some anti-nutrient, vitamin and proximate contents of Baobab leaves, the exception was in minerals where 0 t ha^{-1} topped. This shows the superlative impact poultry manure application could have on anti-nutrient, vitamin and proximate concentration.

ACKNOWLEDGMENT

This work was supported by the Tertiary Education Trust Fund (TETFUND) under 2016/2017 Academic Staff Training and Development.

DECLARATION OF INTEREST STATEMENT

The authors have not declared any conflict of interests.

REFERENCES

Abiona, D., Adedapo, Z., & Suleiman M. (2015). Proximate analysis, phytochemical screening and antimicrobial activity of Baobab (*Adansonia digitata*) leaves. *IOSR Journal of Applied Chemistry, 8*(5), 60-65.

Ahodegnon, D. K., Gnansounou, M., Bogninou, R. G. S, Kanfon, E. R., Chabi, B., Agbangnan Dossa, P. C., Anago, E. A., Ahoussi, E., Wotto, V., & Sohounhloue, D. C. K. (2018). Biochemical profile and antioxidant activity of *Parkia biglobosa* and *Tamarindus indica* fruits acclimated in Benin. *International Journal of Advanced Research, 6*(11), 702-711. https://doi.org/10.21474/IJAR01/8050

Angiosperm Phylogeny Group II. (2003). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. *Botanical Journal of the Linnean Society, 141*(4), 399-436. https://doi.org/10.1046/j.1095-8339.2003.t01-1-00158.x

Annenber, F. (2010). *How to plant and grow moringa*. Retrieved from http://www.miracletrees.org/growing moringa

AOAC. (2005). *Official Methods of Analysis*. (18th ed.). Gaithersburg, MD,

USA: Association of Official Analytical Chemists.
AOAC. (2007). *Official Methods of Analysis.* (18th ed.). Gaithersburg, MD, USA: Association of Official Analytical Chemists.
Arowora, K. A., Ojochenemi, E. Y., Christopher, S., Terungwa, J. I., & Kenneth, C. U. (2018). Chemical Composition of Baobab Leaves and Fractionation of its Ethanolic Extract Using Column Chromatography. *International Journal of Science and Research, 8*(7), 812-821.
Caser, M. (2003). *Low oxalate diet.* Pittsburgh, USA: University of Pittsburgh Medical Center Information for Patients.
Compaore, W. R., Nikiema, P. A., Bassole, H. I. N., Savadogo, A., Mouecoucou, J., Hounhouigan D. J., & Traore, S. A. (2011). Chemical composition and antioxidative properties of seeds of *Moringa oleifera,* and pulps of *Parkia biglobosa* and *Adansonia digitata* commonly used in food fortification in Burkina Faso. *Current Research Journal of Biological Sciences, 3*(1), 64-72.
Demir, K., Salin, O., Kadioglu, Y. K., Pilbeam, D. J., & Gunes, A. (2010). Essential and non-essential element composition of tomato plants fertilized with poultry manure. *Scientia Horticulturae, 127*(1), 16-22. https://doi.org/10.1016/j.scienta.2010.08.009
Diplocka, A. T., Charuleux, J.-L., Crozier-Willi, G., Kok, F.J., Rice-Evans, C., Roberfroid, M., Stahl, W., & Viña-Ribes, J. (1998). Functional food science and defense against reactive oxidative species. *British Journal of Nutrition, 80*(S1), S77-S112. https://doi.org/10.1079/bjn19980106
Egbekun, M. K., & Ehieze, M. U. (1997). Proximate composition and functional properties of full- fat and defatted beniseed (*Sesamum indicum* L.) flour. *Plant Foods for Human Nutrition, 51*, 35-41. https://doi.org/10.1023/A:1007966103484
Elfadi, A. G., Sabahelkhier, M. K., Rayan, M. Y., Daa, M. O., Nagla, A. H., & Israa, S. B. (2013). Effect of Tannin and Plant Tannins on some Organs and Physic-Chemical Characters of Diabetic Wistar Rat. *International Journal of Advanced Research, 1*(10), 165-170.
Enoch, B. B., Abubakar, I. M., Sakiyo, D. C., & Bashiloni, N. (2020). Comparative analysis of nutritional contents in the leaf, pulp and seed of *Adansonia digitata* L. consumed in Adamawa State, Nigeria. *African Journal of Food Science, 14*(8), 215-221. https://doi.org/10.5897/AJFS2020.1962
Enzonga, J., Jean, P. L. O. Y. O., Arielle, M., & Mvoula, T. (2019). Biochemical characterization of four less exploited edible fruits in Congo-Brazzaville: *Passiflora edulisf. Flavicarpa, Aframomum alboviolaceum, Saba comorensis* and *Clitandra cymulosa*. *African Journal of Agricultural Research, 14*(34), 1913-1920.
FAO, (1988). *Traditional food plants.* (pp. 63-67). Rome: Food and Agriculture Organisation of the United Nations. https://doi.org/10.18356/01e48aac-en
Gebauer, J., El-Siddig, K., & Ebert, G. (2002). Baobab (*Adansonia digitata* L.): A review on a multipurpose tree with promising future in the Sudan. *Gartenbauwissenschaft, 67*(4), 155-160.
Harborne, J. B. (1973). *Phytochemical methods*: *A guide to modern techniques of plant analysis*. London: Chapman and Hall Ltd*.*
Husseini, R., Mahunu, G. K., Wireku, P., & Dzomeku, I. K. (2016). Response of growth and leaf yield of *Adansonia digitata* seedlings to soil amendments and harvesting regimes. *Journal of Multidisciplinary Engineering Science and Technology, 3*(12), 6114-6119.
Ibrahim, A., Usman, A., Yahaya, A. I., Umar, M. L., Halilu, A., Abubakar, H., Kwanashie, A. J., Mahadi, M. A., & Ibrahim, B. (2014). Genetic diversity for nutritional traits in the leaves of baobab, *Adansonia digitata*. *African Journal of Biotechnology, 13*(2), 301-306.
Khan, Z. I., Ahmad, K., Zafar, A., Bashir, H., Hussain, A., Huma, Z., Shad, H. A., Sher, M., Hussain, G., Noorka, I. R., Akram, N. A., Ashraf, M., Arshad, F., Mustafa, I., Tufarelli, V., Fracchiolla, M., & Cazzato, E. (2015). Assessment of Poisonous and Anti-Nutritional Compounds in Wild Edible Forages Consumed by Ruminant Species. *Journal of Environmental Science and Technology, 8*(3), 91-101. https://doi.org/10.3923/jest.2015.91.101
Mahgoub, M. E. (2014). Phytochemical Study of the Leaves of *Adansonia digitata.* Masters Dissertation, Sudan University of Science and Technology.
Michałowicz, J., & Duda, W. (2007). Phenols – Sources and Toxicity. *Polish Journal of Environmental Study, 16*(3), 347-362.
Ndubuaku, U. M., Uchenna, N. V., Baiyeri, K. P., & Ukonze, J. (2015). Anti-nutrient, vitamin and other phytochemical compositions of old and succulent moringa (*Moringa oleifera* Lam) leaves as influenced by poultry manure application. *African Journal of Biotechnology, 14*(32), 2501-2509. https://doi.org/10.5897/AJB2015.14848
Ogbaga, C. C., Fatima, A. N., Olatunbosun, O. A., & Onyinye, F. N. (2017). Phytochemical, elemental and proximate analyses of stored, sun-dried and shadedried baobab (*Adansonia digitata*) leaves. International Conference on Electronics, Computer and Computation (pp. 1-5). IEEE. https://doi.org/10.1109/ICECCO.2017.8333339
Okon, E. U., & Akpanyung, E. O. (2005). Nutrition and anti-nutrition in selected brands of malt drinks produced in Nigeria. *Pakistan Journal of Nutrition, 4*(5), 352-355.
Olajide, K., Baiyeri, K. P., & Ndubuaku, U. M. (2020). Nutritional Diversity in Accessions of African walnut (*Plukenetia conophora L.*) Sourced from Southwestern Nigeria as Influenced by Collection Center and Processing. *Journal of Tropical Agriculture, Food, Environment and Extension, 19*(4), 24-29.
Sibibe, M., & Williams, J. T. (2002). *Baobab* (*Adansonia digitata*): Fruits for the future (pp. 14-16). Southampton, UK: International Centre for Underutilised Crops.
Singh, S. K. (2010). *Effect of fertility levels, plant population and detasseling on the growth yield and quality of babycorn (Zea mays L.).* Doctoral Dissertation, Banaras Hindu University.
Stephenson, L. S., Latham, M. C., & Ottesen, E. A. (2000). Malnutrition and parasitic helminth infections. *Parasitology, 121*, S23-S38. https://doi.org/10.1017/s0031182000006491
Stevens, C. G., Ugese, F. D., & Baiyeri K. P. (2021). Variations in mineral and vitamin content of *Moringa oleifera* provenances across Nigeria. *Forests, Trees and Livelihoods, 30*(2), 106-115. https://doi.org/10.1080/14728028.2021.1878061