

Nutrient Stoichiometry and Habitat Preference in *Gnetum* Species.

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ABSTRACT

Comparative studies on the chemical compositions of *Gnetum africana* and *Gnetum bulchozianum* leaves in relation to habitat preference were studied in Ibesikpo Asutan Local Government Area. The mineral elements analyzed from the leaf tissues of these plants included P, K, Ca, Na and Mg. The results revealed that the Calcium (8.10 ± 0.09 mg/kg) and potassium (38.91 ± 0.12 mg/kg) concentrations in *Gnetum africana* were significantly ($P < 0.05$) higher than concentration values of *Gnetum bulchozianum* which were (6.12 ± 0.08 mg/kg) and (32.80 ± 0.56 mg/kg) respectively. On the contrary Sodium (16.21 ± 0.73 mg/kg), Magnesium (6.82 ± 1.20 mg/kg) and Phosphorus (3.62 ± 0.01 mg/kg) in *Gnetum bulchozianum* differed significantly in concentration values present in *Gnetum africana* (15.82 ± 0.06 mg/kg, 5.23 ± 0.03 mg/kg and 2.31 ± 0.10 mg/kg). Statistical comparison of the pedological indices of the soils of the habitats harbouring this species revealed that the habitats did not differ significantly. The study also showed that both species prefer weakly acidic, well drained, sandy loam soils, enriched with phosphorus. The result of this research thus lends weight to the practice of agronomy and conservation of this threatened plant.

Keywords: *Gnetum africana*, *Gnetum bulchozianum*, Habitat, Nutrient and Stoichiometry

INTRODUCTION

Gnetum is the lone genus in the family Gnetaceae. There are about thirty species in the genus, which occurs throughout the tropics in Asia, South America (Mialoundama and Paulet, 1986) and in Central Africa (Watt and Breyer-Brandwijk, 1962). The majority of the species of *Gnetum* are lianas. The plants are dioecious, with the male plants producing catkins of stamens and the females catkins of ovules barely protected by an envelope (Letouzey, 1986). There are two species of *Gnetum* in Africa, *G. africana* and *G. bulchozianum* and they are distributed in the humid tropical forests from Nigeria through Cameroon, Central African Republic, Gabon, Democratic Republic of Congo to Angola (Mialoundama, 1993). Both species are understory lianas, although in some cases some individuals have been found to scramble into the crowns of emergent trees (author, pers. obs.). These two species are very similar and can only be distinguished

by the shape of the leaves and characters of the male reproductive parts (Lowe, 1984). Generally, informations on the proximate, nutrient and antinutrient compositions of *Gnetum* species as a vital plant resource has been properly documented in literature but such information in relation to the rhizopheric nutrient status and its environmental distribution is scarce. This research will be carried out in order to elucidate such environmental relations in the study area. Also, in view of the conservation status of this plant, which at present is considered vulnerable, information on the habitat preference of *Gnetum africana* and *Gnetum bluchozianum* becomes imperative if its extinction must be prevented.

MATERIALS AND METHODS

Description of Study Area

This research was carried out In *Gnetum* farms within Uyo the capital city of Akwa Ibom State, Nigeria. Uyo lies between latitude 5.02°N-6.10°N and longitude 7.92°E-9.48°E within South-South, Nigeria. It has an average temperature of 25.1-27.8°C and an annual rainfall range of 33-37.8mm with the land mass of 115km² and the population of 1,400 million persons/km². The Local Government Area is geographically bounded on the East by Uruan Local Government Area, Abak Local Government Area in the West, Ibiono Ibom Local Government Area in the North and Ibesikpo Asutan Local Government Area by the South.

Wet digestion of sample: For wet digestion of sample, The digest was stored and used for mineral determinations (AOAC, 2003)

Determination of Plant Mineral Elements

The plant (leaves and stem) samples for mineral analysis were digested using the dry ashing method. The digest was frozen in plain sample bottles and transferred to Akwa Ibom State Ministry of Science and technology laboratory, Uyo Local Government Area, Akwa Ibom State. Mineral contents: calcium (Ca), magnesium (Mg), potassium (K) and iron (Fe) of plant samples were determined by atomic absorption spectrophotometer (AAS), flame photometry and spectrophotometry according to the methods of AOAC (2003).

Determination of phosphorus (P): The grounded plant material was mixed with surbonxo reagents and phosphate standard and was allowed to stand for ten minutes at room temperature (32°C). Increasing reaction and phosphomolybdate was determined at the expiration of ten minutes. The reaction of the phosphate ion with molybdate produced molybdate this was reduced to molybdenum photometrically. The readings of the phosphorus were recorded. Calculation of phosphorus: The calculations for the total mineral intake involve the same procedure as given in Atomic Absorption Spectrophotometer (AOAC, 2003).

Physicochemical Analysis of Soil Samples

Soil samples were analyzed following the standard procedures outlined by the Association of Official Analytical Chemist (APHA, 1998). Soil pH were measured using Beckman’s glass electrode pH meter (Meclean, 1965). Organic Carbon by the Walkey Black wet oxidation method (Jackson, 1962), available Phosphorus by Bray P-1 method (Jackson, 1962). The total Nitrogen content was determined by Micro-Kjeldahl method (Jackobson, 1992). Soil particle size distribution was determined by the hydrometer method (Udo and Ogunwale, 1986) using mechanical shaker, and sodium hexametaphosphate as physical and chemical dispersant. Exchange Acidity was determined by titration with 1N KCl (Kamprath, 1967). Total Exchangeable Bases were determined after extraction with 1M NH₄OAc (One molar ammonium acetate solution). Total Exchangeable Bases were

determined by EDTA titration method while sodium and Potassium were determined by photometry method. The Effective Cation Exchange Capacity (ECEC) was calculated by the summation method (that is summing up of the Exchangeable Bases and Exchange Acidity (EA). Base Saturation was calculated by dividing total Exchangeable Bases by ECEC multiplied by 100.

RESULTS

Table 1 shows the nutrient profile of *Gnetum* species harvested from homestead gardens in Uyo metropolis.

Table 1: Mean (\pm S.E) Nutrient Profile Studied Plants (*Gnetum* species)

Nutrient	Unit	<i>G. Africana</i>	<i>G. bulchozianum</i>
P	mg/kg	2.31 \pm 0.10	3.62 \pm 0.01
Ca	mg/kg	8.10 \pm 0.09	6.12 \pm 0.08
Mg	mg/kg	5.23 \pm 0.03	6.82 \pm 1.20
Na	mg/kg	15.82 \pm 0.06	16.21 \pm 0.73
K	mg/kg	38.91 \pm 0.12	32.80 \pm 0.56

Table 2 shows the means of the physicochemical properties of the habitats of the species.

Table 2: Mean (\pm S.E) Physical and Chemical Properties of Habitat of *Gnetum* species

Parameter	Unit	<i>G. africanum</i>	<i>G. bulchozianum</i>
pH		5.81 \pm 0.063	5.77 \pm 0.55
Ec	Ds/m	0.114 \pm 0.010	0.06 \pm 0.0009
Organic matter	%	6.27 \pm 0.021	6.61 \pm 0.15
Total N	%	0.16 \pm 0.000	0.17 \pm 0.0003
Av. P	mg/kg	12.41 \pm 0.820	14.29 \pm 1.49
Moisture content	%	10.07 \pm 0.025	10.65 \pm 0.103
Ca	cmol/kg	4.08 \pm 0.509	5.52 \pm 0.51
Mg	cmol/kg	1.40 \pm 0.070	1.85 \pm 0.18
Na	cmol/kg	0.18 \pm 0.003	0.12 \pm 0.0007
K	cmol/kg	0.18 \pm 0.000	0.28 \pm 0.04
EA	cmol/kg	2.33 \pm 0.049	2.41 \pm 0.06
E.C.E.C	cmol/kg	8.51 \pm 0.774	10.12 \pm 0.57
Base Saturation	%	72.06 \pm 3.120	75.91 \pm 1.95
Sand	%	82.60 \pm 0.282	80.60 \pm 0.28
Silt	%	6.00 \pm 0.707	5.85 \pm 0.67
Clay	%	11.4 \pm 0.42	13.55 \pm 0.389

DISCUSSION

The result of the chemical compositions of *Gnetum africana* and *Gnetum bulchozianum* leaves are presented in Table 1. The mineral elements analyzed from the leaf tissues of these plants included P, K, Ca, Na and Mg. This result posits that *Gnetum africana* and *Gnetum bulchozianum* have a rich nutrient profile. This result lends credence to earlier reports by Oyenuga and Fetuga, (1975) that the potentials of food material depends primarily on its nutrients or elemental composition and that vegetables have been known to add good flavor, taste and a

reasonable amount of protein, vitamin and mineral nutrients to diets. Sheelar et al. (2004) and Kubmarawa (2009) in confirming this opined that vegetable are good sources of nutrients and that there are indispensable in the maintenance of good health and prevention of diseases. They further stressed that vegetables are rich sources of beta-carotene, vitamins and calcium. This is evident in this work as the latter (calcium) ranks as one of the most abundant mineral element in these two species of *Gnetum*. Antia et al. (2006) had reported that the elemental composition of leaves of *Ipomea batatas* were 4.23 mg/kg

for Na and 4.5 mg/kg for Ca. Though *Ipomea batatas* leaves are edible, the result of this work thus makes it clear that under ideal conditions *G.* species are a better vegetable source for calcium and magnesium than *Ipomea batatas*. Calcium occupies a cardinal position in human nutrition since it has been implicated in the formation and proper functioning of the teeth and bones (Soetan et al., 2010). Elsewhere, Ibok, et al, (2008) confirmed the role of calcium in helping to build up strong bones and teeth and so advocated the consumption of sweet potato and moringa leaves in order to supplement daily calcium requirements of each individual. This research thus adds *Gnetum* species to the list of supplements such as these.

It is a clear fact that Potassium is one of the most abundant mineral in Nigerian agricultural products (Oshodi et al., 1999). This trend is observed in this work. The next mineral to Potassium in terms of value is Phosphorus, which is vital in bone formation (Adetuyi and Akpambang, 2005), as well as sodium. *Gnetum* species can be employed as a source Sodium and Potassium. Also it is on record that high amount of potassium and magnesium may help to lower blood pressure (Otsuki et al., 2010). Owing to our findings, these *Gnetum* species could be employed as a dietary supplement for hypertensive patients.

The physicochemical properties were summarized in Table 2. The pH values in the habitats wherein these plants grow were 5.8 and 5.7 respectively suggesting that both *Gnetum africana* and *Gnetum bulchozianum* grow well in weakly acidic soils. Ubom et

al, (2012) while studying the soil-vegetation relationships in fresh water swamp forest had reported a similar pH of 5.12. This therefore suggests that both *Gnetum africana* and *Gnetum bulchozianum* could have been present as non-timber resources of this forest ecosystem. Alloway and Ayres (1997) reported that soil pH, nature of soil and climatic changes were a part of the cluster of factors which affect the rate of uptake of nutrients by plants. As witnessed in this work, the fair pH recorded is believed to contribute to the healthy nature of the *Gnetum* stands observed in this study. Also, mobility of metals and other ions has been shown to decrease with increasing soil pH due to precipitation of hydroxides, carbonates or formation of insoluble organic complexes (Smith et al., 1996), hence the fair pH values observed in the present study is believed to enhance moderate mobility of metals in the soil.

Aruah (2006) posited that generally, at an electrical conductivity above 2 or 3 Scm^{-1} depending on soil type and crops grown, salt content in the soil will inhibit plant growth. This is evident in this work as the electrical conductivity falls below this limit (it ranged from 0.11 Scm^{-1} in the first site to 0.12 Scm^{-1} in the second site.) thus enhancing a luxuriant plant growth in the farms. The organic matter content of plant habitats were higher than those reported for garden soils. This could probably result from organic manuring practiced by the local farmers and (or) due to fast rate of litter generation and subsequent decomposition in the habitat as compared to that of garden soils which was reported by

Mbong et al. (2013) . Researchers have shown that among other factors such as presence of dolomite and phosphates, organic matter in soils reduce the concentration of metals by precipitation, adsorption and complexation (Mench *et al.*, 1994) and thus making them unavailable to the plants. In the present study, the soils

were observed to have high levels of organic matter and available phosphorus (phosphates) which is believed to reduce the concentrations of the toxic metals like Pb and Cd absorbed by plants from the soils and thus preserving the leaves very wholesome for consumption.

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