

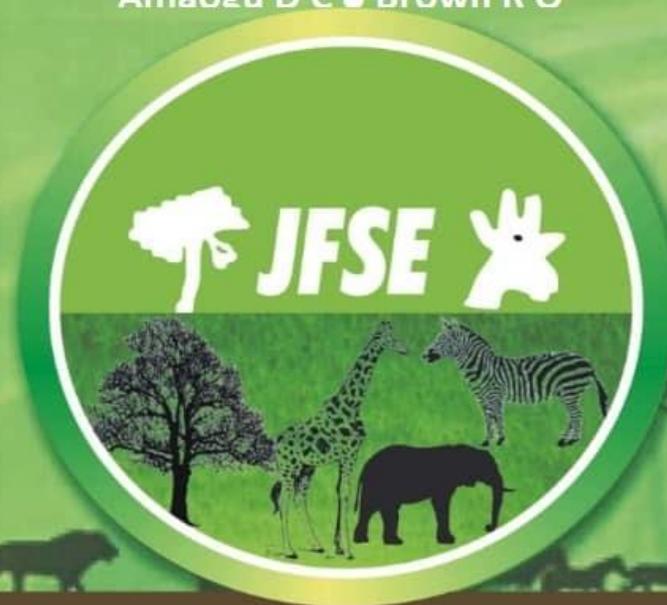


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**Why is Wood-Feeder, *Apate terebrans* Attacking Only *Terminalia mantaly* in the Midst of Susceptible Urban Tree Species in Nigeria? Evaluation of Wood Feeding Shift Hypotheses**

Adedeji G A ● Aiyeloja A A ● Egubogo A C ●  
Amaogu D C ● Brown R O



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Maiduguri, Nigeria

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## WHY IS WOOD-FEEDER, *APATE TEREBRANS* ATTACKING ONLY *TERMINALIA MANTALY* IN THE MIDST OF SUSCEPTIBLE URBAN TREE SPECIES IN NIGERIA? EVALUATION OF WOOD FEEDING SHIFT HYPOTHESES

ADEDEJI G A<sup>a\*</sup> • AIYELOJA A A<sup>a</sup> • EGUBOGO A C<sup>a</sup> • AMAOGU D C<sup>b</sup> • BROWN R O<sup>a</sup>

<sup>a</sup> Department of Forestry and Wildlife Management, University of Port Harcourt, Nigeria

<sup>b</sup> Department of Agricultural and Forestry Engineering, University of Lleida, Catalonia, Spain

\*Corresponding Author: [gabriel.adedeji@uniport.edu.ng](mailto:gabriel.adedeji@uniport.edu.ng)

**ABSTRACT:** The wood-feeding shift hypotheses (WFSH) posit that *Apate terebrans* may not shift ( $H_0$ ) or shift ( $H_1$ ) feeding on *Terminalia mantaly* in the midst of susceptible species. The WFSH was tested by feeding preference, moisture contents, and chemical elements evaluations of 5 popular urban forest species with and without *T. mantaly* wood samples under laboratory conditions. *Spondias mombin* was most preferred followed by *T. mantaly*, and *Gmelina arborea*. *Delonix regia* and *Azadirachta indica* were less-preferred and *Tectona grandis* was not preferred. The mean moisture content (MC) of the wood samples (WS) ranged from  $115.16 \pm 4.32\%$  (*D. regia*) to  $79.70 \pm 2.24\%$  (*T. grandis*). The Particle-Induced X-ray Emission (PIXE) analysis revealed common seven-element [Magnesium (Mg), Aluminum (Al), Phosphorus (P), Sulfur (S), Iron (Fe), Potassium (K), Calcium (Ca)] among the WS. Al~S and MC~K revealed a significant highest relationship for element-wise and MC~element relationship, respectively at  $p < 0.01$ . The results of this study supported the alternative hypothesis ( $H_1$ ) that there is a shift in the feeding preferences of *A. terebrans*. We inferred that *S. mombin* and/or *G. arborea* trees may likely be the next shift hosts of *A. terebrans*. The highest concentrations of Al, P, S, Fe, and K in *S. mombin* might be responsible for its highest feeding preference by *A. terebrans*.

**Key words:** *Apate terebrans*, chemical elements, feeding preferences, moisture contents, plant hosts

### 1. INTRODUCTION

*Apate terebrans* Pallas, 1772 (Coleoptera: Bostrichidae) is a polyphagous wood-feeding insect pest of global importance due to the serious damage it causes to woody trees including agricultural crops. Across the globe, this species is one of the major pests of some of the most

economically important agricultural crops; *Theobroma cacao*, *Citrus spp.*, *Anacardium occidentale* (Hill and Waller, 1988; Agboton *et al.*, 2014), and forest crops; *Azadirachta indica*, *Khaya spp.*, *Tectona grandis* (Atuahene, 1976; FAO, 2007, de Souza *et al.*, 2009). *A. terebrans* is a primary insect pest, whose adults infest mainly wood of healthy trees causing serious mechanical

damage and the death of trees (Peacock, 1913; Vasconcelos *et al.*, 2014). The adults live and feed on living wood but the oviposition by females is done on dead wood (Atuahene, 1976; Agboton *et al.*, 2017).

The survey of literature revealed several hosts of *A. terebrans* worldwide with a history of three species: *Delonix regia* (Peacock, 1913); *A. indica* (Akanbi and Ladipo, 1988); *Terminalia mantaly* (Adedeji *et al.*, 2018) in Nigeria. The report of *A. terebrans* in Nigeria was probably first dated 1867 by Murray (1867), though the wood species on which the beetle was found was not documented. The resurgence of *A. terebrans* since 2015, as a principal and important pest of *T. mantaly*, is of great environmental concern in Nigeria (Adedeji *et al.*, 2021) with quick killing impact due to yearly repeated attacks (Adedeji *et al.*, 2022). *T. mantaly* has not only been one of the highly hazardous urban trees causing human death in Malaysia (Hassan *et al.*, 2017), but also represents a national threat to human, wood-based industries, cash, and food securities in Nigeria due to its characters and its potential associated entomological problems (Adedeji *et al.*, 2022).

While the plant's feeding hosts reported in Nigeria and elsewhere are well established in Nigeria landscapes, the infestation of only *T. mantaly* in the midst of susceptible species remains unclear. *T. mantaly* is native to Madagascar (Omole and Moshood, 2014), a hotspot origin of Bostrichidae worldwide (Borowski, 2021). Thus, the current resurgence of *A. terebrans* is thought to be largely due to the trade of importing seedlings or planting stocks of *T. mantaly* from Madagascar. Nigeria, being one of the most importing countries of inputs globally and the utilisation of *T. mantaly* as one of the popular ornamental trees (Oyerinde *et al.*, 2018; Ancha *et al.*, 2019; Eguakun and Ishiekwene, 2021) has come with a serious entomological problem (Adedeji *et al.*, 2021). The tendency of polyphagous insects to restrict their feeding to a specific host and really act as oligophages in the presence of other feeding hosts has been attributed to the population advantage of such specific host (Fox and Morrow, 1981). As unchecked, the increasing building up of *A. terebrans* population might reach a threshold for shifting host. Understanding why a particular woody tree species become successful host of polyphagous insect pests in the midst of many susceptible species is an important research interest in wood degradation and invasion/chemical ecology (Zhang *et al.*, 2013; Conchou *et al.*, 2017). The concurrent infestation of multiple trees including *T. mantaly* in the neighbouring country, the Republic of Benin has been documented (Agboton *et al.*, 2014). While wood is a nutritionally valuable plant material for xylem-feeding insects, its levels of moisture and chemical nutrients are important cues to its preferences (Beyaert *et al.*, 2010).

With the current situation, the anticipated population explosion may cause a shift of hosts. Understanding the likely next host(s) is important in environments, where multiples of the environmental trees are on the red list of *A. terebrans* attacks. The study that seeks to understand the likelihood of the next shift host is crucial for tree health and biosecurity in Nigeria. Hence, it was hypothesized that *A. terebrans* would not shift ( $H_0$ ) or shift ( $H_1$ ) feeding on *T. mantaly* in the midst of susceptible species. Moisture content (MC) and chemical elements were then evaluated to further elucidate their roles in feeding preference(s) occurring in the model beetle.

## 2. METHODS AND MATERIALS

### 2.1 Laboratory Feeding Preference Trials

For wood feeding preference, choice-feeding method was adopted. Six popular urban woody tree species (*A. indica*, *D. regia*, *G. arborea*, *T. grandis*, *T. mantaly* and *S. mombin*) were selected. *S. mombin* was included due to its susceptibility to wood-girdler, *Analeptes trifasciata* (Figure 1) The wood feeding preference trials were experimented under laboratory conditions (temperature  $26\pm 2^\circ\text{C}$  in  $75\pm 5\%$  relative humidity) at the Analytical Wood Laboratory Unit of the Department of Forestry and Wildlife Management, UNIPORT for a duration of four weeks. Two types of experimental trials were performed: 1) with green wood samples, and 2) with oven-dry wood samples (with and without *T. mantaly*).

For first trial, green wood samples were used. Six freshly selected wood species of the same length (8cm) but variable sizes ranging between 8.96 cm and 10.4 cm in circumference were placed into 75cl glass bottles fitted with ventilated lids. Four adults of *A. terebrans* collected from *T. mantaly* were released into the bottle containing green samples of the six selected wood species. This experiment was replicated twice as **W<sub>1.1</sub>** and **W<sub>1.2</sub>**. Under the first trial, another experiment was conducted with the exclusion of reference wood, *T. mantaly*. In this experiment, five wood species were employed but with similar procedures and replication as **W<sub>t1.1</sub>** and **W<sub>t1.2</sub>**.

For the second trial, oven-dried wood species were used. In this case, the stem bark of the wood samples was removed, oven dried at  $105^\circ\text{C}$  for 16 hours, and conditioned at room temperature prior to test. Similarly, four adults of *A. terebrans* collected from *T. mantaly* were released into the bottle containing oven dried samples of the six selected wood species. The experiment was repeated twice with inclusion of *T. mantaly* (**W<sub>2.1</sub>** and **W<sub>2.2</sub>**) and with exclusion of *T. mantaly* (**W<sub>t2.1</sub>** and **W<sub>t2.2</sub>**).

## 2.2 Moisture Contents (MC) Evaluation

Fresh twigs of similar length (6 cm) with circumferences ranging between 7.60 cm and 8.87 cm were harvested, both ends sealed with nylon cello-tape, and taken to laboratory for the measurement of green weight. Six replicates for each of the selected wood species were used for the estimation of the mean MC. The samples were oven dried at 105°C to a constant weight. The MC and its coefficient of variation (CV) were evaluated by equations (1) and 2, respectively:

$$MC = \frac{GW-OW}{OW} \times 100\% \quad (1)$$

Where;

MC (%)

GW = green weight (g)

OW = oven dry weight (g)

$$CV = \frac{SD}{X} \times 100\% \quad (2)$$

Where;

CV (%)

SD = Standard deviation

X = Mean (%)

## 2.3 PIXE Elementals Analysis of the Wood Samples

The Particle-Induced X-ray Emission (PIXE) elementals analysis of wood species samples was carried out as describe by Ofodile *et al.* (2021). The dried wood samples were ground, mixed with 10% by weight of ultra-pure graphite powder to produce thick pellets of 13mm diameter without a binder. The analysis was performed on a NEC 5SDH 1.7MV Pelletron Accelerator equipped with a radiofrequency charge exchange ion source, 2.5 MeV proton beam analysis (IBA) facility. The end-station consists of an Aluminium chamber of about 150cm diameter and 180 cm height. It has four ports and a window. Port 1 at 165° is for the RBS detector, port 2 at 135° is for PIXE detector, and port 3 at 30° is for the ERDA detector, the window at 0° is for observing the beam position and the size, while port 4 at 270° is for PIGE. The chamber has a sample ladder that can carry 11 (eleven) 13mm diameter samples.

The end-station has a turbo pump and a variable beam collimator to regulate beam size, and an isolation valve. Apple leaves standard (NIST 1515) was used for determination of the H-value which was subsequently used for analysing the gallstone samples and to assure the accuracy of the experimental procedure. The measurements were carried out with a beam spot of 4mm in diameter and a low beam current of 3-6nA. The irradiation was about 10 – 20 minutes. A Canberra Si (Li) detector model ESLX 30 – 150, beryllium thickness of

25µm, with full width half maximum (FWHM) of 150eV at 5.9keV, with the associated pulse processing electronics, and a Canberra Genie 2000 (3.1) MCA card interfaced to a PC were used for the X-rays data acquisition. With respect to the beam director, the sample's normal was located at 0° and the Si (Li) detector at 45°. The PIXE set-up was calibrated using some pure element standards and NIST geological standard, NBS278. The computer code GUPIXWIN-4 was used for the analysis of the PIXE data. This provided non-linear least square fitting of the spectrum, together with subsequent conversion of the fitted X-ray peak intensities into elemental concentrations, utilising fundamental parameter method for quantitative analysis.



Figure 1: *Analeptes trifasciata* girdling *S. mombin*

## 2.4 Statistical Analyses

Feeding preference of *A. terebrans* on selected wood species was qualitatively analyzed and visually categorized into superficial feeding, in-depths feeding and no feeding. A one-way analysis of variance (ANOVA) was employed in determining moisture content differences amongst the wood species at 0.05 levels of significance and means separated using Fisher's least significant difference (LSD). Also, one-way ANOVA was used in evaluating the concentration of essential nutrient elements among the selected species. In assessing the underlying relationship between moisture content and elements, principal component analysis (PCA) was carried out along with Pearson's correlation with significance considered at 0.05 and 0.01 levels. One-way ANOVA and LSD post hoc test was done using IBM SPSS (v. 4.1.1) while R software version 4.1.1 was used for PCA and plot3D package (v. 1.4) for PCA visualization, correlation matrix of elements and moisture content was produced using R software base package.

### 3. RESULTS AND DISCUSSION

#### 3.1 Feeding Preference

As shown in Table 1, and Figures 2-4, the wood-feeding results indicated broad preferences, reaffirming *A. terebrans* as a polyphagous wood-feeder. The unsatisfactory results from using green wood samples informed the second trial experiments employing oven-dry wood specimens. Both at the green and dry states, wood-feeding preferences were found in all the wood species samples except *Tectona grandis* (Table 1) indicating its non-preference. The wood-feeding preferences were classical: in-depth feeding reflecting high preference (Figures 2-4); superficial feeding reflecting less preference; and no feeding reflecting non-preference (Table 1). *A. terebrans* showed a high preference for *S. mombin*, *T. mantaly*, and *G. arborea* wood species with in-depths feeding of 2.7cm, 2.6cm, and 1.2cm, respectively (Figures 2-4). Less preference was shown for *A. indica* and *D. regia*, and non-preference was shown for *T. grandis* (Table 1). Test wood species at green state experiments were found with massive colonization of unidentified fungi and then infestation of *Drosophila melanogaster*. This situation was probably responsible for the only superficial feeding patterns

found and presented in Table 1. Also, the death of all the samples of *A. terebrans* occurred within two weeks of the experimental period of four-week.

Wood being one of the most important resources in providing both food and habitat for multigenerational development and reproduction of many wood-feeding insects (Highley, 2004; Ulyshen and Sobotnik, 2018), *T. grandis* was not preferred and was wholly avoided by *A. terebrans* throughout the experimental trials. Although *T. grandis* at the nursery/tending field stage has been listed as feeding host plant of this beetle in Benin, Ghana, and Zambia (Graziosi *et al.*, 2019), its non-selection for feeding in this study may be probably due to the age variability of the selected samples. Less preference and death of *A. terebrans* found within two weeks when green wood samples were used may be due to the development of unidentified fungi growth on wood samples. This further confirms the adult beetle as a serious pest avoiding decaying or weak wood samples (trees) but prefers healthy ones. The in-depth feeding preferences exhibited by *A. terebrans* to *S. mombin* and *G. arborea* highlights the hosts' shifting potential of the beetle for a highly utilised timber and urban tree species in Nigeria. The highest concentrations of Al, P, S, Fe and K in *S. mombin* (Table 4) might be the cue responsible for its highest feeding preference.

Table 1: Feeding preference of *A. terebrans* on selected susceptible wood species

Experiments	Levels of feeding at green state					
	<i>A. indica</i>	<i>D. regia</i>	<i>G. arborea</i>	<i>S. mombin</i>	<i>T. grandis</i>	<i>T. mantaly</i>
1						
W <sub>1.1</sub>	x	*	x	x	x	*
W <sub>1.2</sub>	x	*	x	x	x	*
Wt <sub>1.1</sub>	x	*	*	x	x	-
Wt <sub>1.2</sub>	x	*	x	x	x	-
2	Levels of feeding at dry state					
W <sub>2.1</sub>	*	*	x	**	x	*
W <sub>2.2</sub>	*	*	x	*	x	**
Wt <sub>2.1</sub>	x	X	*	*	x	-
Wt <sub>2.2</sub>	x	X	**	*	x	-

Note: \*Superficial feeding, \*\* In-depths feeding, x No feeding, - Not included, W (with *T. mantaly*) Wt (without *T. mantaly*)

Figure 2: In-depth feeding on *S. mombin* by *A. terebrans*Figure 3: In-depth feeding on *T. mantaly* by *A. terebrans*Figure 4: In-depth feeding on *G. arborea* by *A. terebrans*

### 3.2 Moisture Content (MC) and Chemical Elements

The mean MC of the tested wood species samples ranged from  $79.70 \pm 2.24\%$  to  $115.16 \pm 4.32\%$  with significant

differences. The highest coefficient of variation for MC was found in *Gmelina arborea*. The total chemical elements varied considerably (Table 3) with seven essential elements (Mg, Al, P, S, Fe, K, Ca) common in all the tested wood species (Table 4). The essential elements constituted the largest quantitative component of the elemental composition of wood species associated with *A. terebrans* nutrition. The principal component (PC) analysis was performed on essential elemental composition and moisture content (MC) ( $n = 8$ ) of six (6) selected wood species. Explained variability for the first three PCs cumulated at 90.11% with PC1 explaining 48.33%, PC2 26.31% and PC3 15.47%. Elements with high loading score which are best explained by PC1 include P, S, Fe, and K, PC2 and were well defined by Mg and MC. Ca had similar loading magnitude for PC2 and PC3 while Al was the most effective variable for PC3 (Figure 5). Mg was significantly correlated with Ca (0.74) and MC (-0.52), Al, S, Fe and K all exhibited positive correlation with each or with  $r > 0.4$ . MC was also observed to be significantly correlated with Fe and K while Fe was also correlated with Ca (Table 5).

The importance of the high MC and availability of chemical elements for *A. terebrans* nutrition has been demonstrated in this study. The common elements found in this study showed the greater potential of nutrient requirements of *A. terebrans* for growth and development. Moisture content loading score on the components was more in PC2 (0.53) with Mg (-0.63) and Ca (-0.48) on the negative side of PC2. This grouping of MC, Mg, and Ca indicates an important factor in *A. terebrans* nutrition. Correlation analysis also corroborates the positions of major contributors in PC2 with MC negatively correlated with Mg and Ca while Mg and Ca are strongly correlated with each other. Mg and Ca are essential for insect development and play an important role in their physiological and metabolism (Clark 1958). Magnesium has been used by humans as a laxative (Vu *et al.* 2000) and various sources of the element have been found to increase the moisture content of excreta in birds (Van der Hoeven-Hangoor *et al.* 2013). Excessive intake of Mg and Ca gets excreted in form of magnesium and calcium carbonate (Clark 1958) in some insects. Potential shifts identified for *A. terebrans* were *S. mombin* and *G. arborea* which had similar means of magnesium concentration which were the lowest of the selected wood species and both with the lower moisture content of  $110.17 \pm 5.51$  and  $80.53 \pm 11.30$  than the model species (*T. mantaly* =  $111.83 \pm 6.74$ ). While high concentration of K is also known for its tolerance role in plants against stress (Kabay, 2022), MC~K significant highest relationship for MC~element wise (Table 5) result found in this study suggest that *D. regia*, *T. mantaly*, and *S. mombin* may be more resilient to insect feeding attack than *A. indica*, *G. arborea* and *T. grandis*.

These results have a bearing on understanding the feeding behaviours of *A. terebrans* and factors influencing the selection of healthy living trees as feeding hosts.

Table 2: Moisture content of selected wood species samples

Species	Mean MC $\pm$ SD (%)	Range (%)	CV (%)
<i>Delonix regia</i>	115.16 $\pm$ 4.32 <sup>a</sup>	107.89 – 119.79	3.75
<i>Terminalia mantaly</i>	111.83 $\pm$ 6.74 <sup>a</sup>	103.06 – 121.52	6.03
<i>Spondias mombin</i>	110.17 $\pm$ 5.51 <sup>a</sup>	100.00 – 114.63	5.00
<i>Azadirachta indica</i>	90.01 $\pm$ 9.96 <sup>b</sup>	76.09 – 100.00	11.07
<i>Gmelina arborea</i>	80.53 $\pm$ 11.30 <sup>c</sup>	70.33 – 101.22	14.03
<i>Tectona grandis</i>	79.70 $\pm$ 2.24 <sup>c</sup>	76.25 – 83.33	2.81

Table 3: Total elemental composition in selected wood species samples

Elem ents	Concentrations (mg/kg) Mean $\pm$ S.E					
	<i>A. indica</i>	<i>D. regia</i>	<i>G. arborea</i>	<i>T. grandis</i>	<i>T. mantaly</i>	<i>S. mombin</i>
Mg	1133.60 $\pm$ 65.46	1040.80 $\pm$ 55.45	710.95 $\pm$ 43.59	2730.55 $\pm$ 56.46	701.95 $\pm$ 23.38	808.90 $\pm$ 127.53
Al	164.30 $\pm$ 19.07	98.65 $\pm$ 7.38	116.20 $\pm$ 19.49	121.80 $\pm$ 7.92	102.65 $\pm$ 18.89	173.55 $\pm$ 27.62
Si	270.60 $\pm$ 11.73	153.90 $\pm$ 7.03	207.55 $\pm$ 31.84	286.35 $\pm$ 20.66	132.10 $\pm$ 4.44	319.15 $\pm$ 57.13
P	1116.40 $\pm$ 66.66	1455.30 $\pm$ 15.93	514.35 $\pm$ 8.99	1062.45 $\pm$ 9.43	494.00 $\pm$ 51.86	1914.85 $\pm$ 578.75
S	970.05 $\pm$ 24.01	519.45 $\pm$ 8.22	633.60 $\pm$ 32.54	727.45 $\pm$ 43.70	516.25 $\pm$ 11.04	1097.70 $\pm$ 240.41
K	4928.50 $\pm$ 58.38	6850.90 $\pm$ 11.95	3166.90 $\pm$ 109.85	4258.90 $\pm$ 221.49	7439.40 $\pm$ 38.35	12183.25 $\pm$ 2698.54
Ca	4769.30 $\pm$ 223.05	3874.30 $\pm$ 391.60	2912.55 $\pm$ 122.86	13725.60 $\pm$ 505.79	8615.35 $\pm$ 1019.93	7835.75 $\pm$ 1907.02
Fe	186.80 $\pm$ 21.74	196.35 $\pm$ 4.82	90.00 $\pm$ 10.38	165.80 $\pm$ 21.33	221.65 $\pm$ 9.80	224.90 $\pm$ 54.94
Cr	32.70 $\pm$ 4.53	30.45 $\pm$ 3.21	18.65 $\pm$ 2.42	ND	43.40 $\pm$ 2.93	ND
Cl	1384.60 $\pm$ 82.94	628.60 $\pm$ 7.09	ND	ND	1823.40 $\pm$ 50.89	1619.65 $\pm$ 355.03
Mn	ND	ND	25.55 $\pm$ 1.94	ND	ND	ND
Zn	ND	ND	19.85 $\pm$ 3.20	ND	ND	ND

Table 4: Comparison of common essential elements among the selected wood species samples

Elem ents	Concentration (mg/kg) Mean $\pm$ S.E					
	<i>A. indica</i>	<i>D. regia</i>	<i>G. arborea</i>	<i>T. grandis</i>	<i>T. mantaly</i>	<i>S. mombin</i>
Mg	1133.60 $\pm$ 65.46 <sup>b</sup>	1040.80 $\pm$ 55.45 <sup>b</sup>	710.95 $\pm$ 43.59 <sup>c</sup>	2730.55 $\pm$ 56.46 <sup>a</sup>	701.95 $\pm$ 23.38 <sup>c</sup>	808.90 $\pm$ 127.53 <sup>c</sup>
Al	164.30 $\pm$ 19.07 <sup>a</sup>	98.65 $\pm$ 7.38 <sup>b</sup>	116.20 $\pm$ 19.49 <sup>ab</sup>	121.80 $\pm$ 7.92 <sup>ab</sup>	102.65 $\pm$ 18.89 <sup>b</sup>	173.55 $\pm$ 27.62 <sup>a</sup>
P	1116.40 $\pm$ 66.66 <sup>bc</sup>	1455.30 $\pm$ 15.93 <sup>ab</sup>	514.35 $\pm$ 8.99 <sup>c</sup>	1062.45 $\pm$ 9.43 <sup>bc</sup>	494.00 $\pm$ 51.86 <sup>c</sup>	1914.85 $\pm$ 578.75 <sup>a</sup>
S	970.05 $\pm$ 24.01 <sup>ab</sup>	519.45 $\pm$ 8.22 <sup>c</sup>	633.60 $\pm$ 32.54 <sup>c</sup>	727.45 $\pm$ 43.70 <sup>bc</sup>	516.25 $\pm$ 11.04 <sup>c</sup>	1097.70 $\pm$ 240.41 <sup>a</sup>
Fe	186.80 $\pm$ 21.74 <sup>a</sup>	196.35 $\pm$ 4.82 <sup>a</sup>	90.00 $\pm$ 10.38 <sup>b</sup>	165.80 $\pm$ 21.33 <sup>ab</sup>	221.65 $\pm$ 9.80 <sup>a</sup>	224.90 $\pm$ 54.94 <sup>a</sup>
K	4928.50 $\pm$ 58.38 <sup>bc</sup>	6850.90 $\pm$ 11.95 <sup>b</sup>	3166.90 $\pm$ 109.85 <sup>c</sup>	4258.90 $\pm$ 221.49 <sup>bc</sup>	7439.40 $\pm$ 38.35 <sup>b</sup>	12183.25 $\pm$ 2698.54 <sup>a</sup>
Ca	4769.30 $\pm$ 223.05 <sup>c</sup>	3874.30 $\pm$ 391.60 <sup>c</sup>	2912.55 $\pm$ 122.86 <sup>c</sup>	13725.60 $\pm$ 505.79 <sup>a</sup>	8615.35 $\pm$ 1019.93 <sup>b</sup>	7835.75 $\pm$ 1907.02 <sup>b</sup>

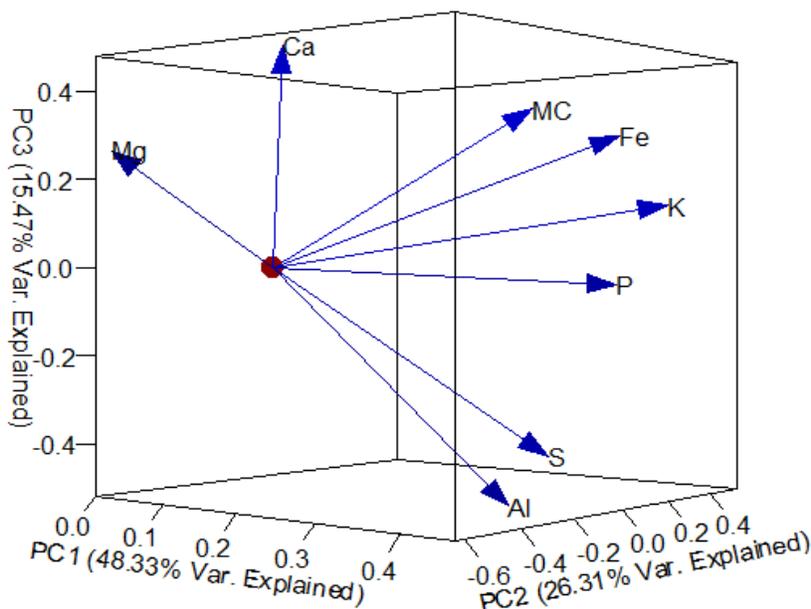


Figure 5: Plot of loadings of components 1, 2 and 3

Table 5: Correlation matrix for the essential element-wise and MC~element

	Mg	Al	P	S	Fe	K	Ca	MC
Mg	1.00							
Al	0.03	1.00						
P	0.14	0.59**	1.00					
S	0.10	0.82**	0.76**	1.00				
Fe	0.02	0.44*	0.68**	0.54**	1.00			
K	-0.22	0.47*	0.80**	0.62**	0.78**	1.00		
Ca	0.74**	0.12	0.27	0.26	0.42*	0.27	1.00	
MC	-0.52**	-0.07	0.32	-0.09	0.55**	0.64**	-0.15	1.00

\*p<0.05; \*\*p<0.01

4. CONCLUSIONS

1. While it has been hypothesized that *A. terebrans* would not shift ( $H_0$ ) or shift ( $H_1$ ) feeding on *T. mantaly* in the midst of susceptible species, the study shows that there is a shift in feeding preferences of *A. terebrans* thus supporting the alternative hypothesis ( $H_1$ ).
2. The interplay of MC, Mg, and Ca were major contributors to the second component explaining 26.31% of the variation in the nutritional constituent of the selected wood species.
3. From the wood-preference point of view, *S. mombin* and/or *G. arborea* trees may likely be the

next shift hosts of *A. terebrans* in Nigeria if the building up of the population remains unchecked.

4. The highest concentrations of Al, P, S, Fe, and K in *S. mombin* might be responsible for its highest feeding preference by *A. terebrans*.

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