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Plant Species Abundance and Diversity at Scrap Metal Dumpsites in Abuja Municipality and Environs, Nigeria: Implications for Phytoremediation

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ABSTRACT

Environmental pollution is on the increase in urban areas of many low-and-middle income countries in recent years due to anthropogenic activities, including multiplication of poorly managed dumpsites. Scrap metal dumpsites, in particular, have been associated with heavy metal contamination of soil, with attendant impact on plant health and biodiversity. However, plants growing at scrap metal dumpsites may also have potential for phytoremediation. This study was designed to investigate plant diversity and abundance at scrap metal dumpsites within Abuja municipality and environs, with the aim of assessing how these dumpsites influence the diversity and abundance of local plant communities. Plants were collected at five major scrap metal dumpsites within Abuja municipality and environs using strategic quadrat sampling. Species abundance and diversity were determined, and data were analyzed using one-way ANOVA, with significance at $p<0.05$. Twenty-seven plant species belonging to 25 genera in 13 families were identified. Family Asteraceae, with seven plant species, had the highest number of species, while *Ageratum conyzoides* L. had the highest relative importance values of 15.91%. Species richness of the five study locations ranged from 4 for Gwagwalada to 17 for Kugbo. Species richness of study sites were generally statistically lower than that of the control site ($p<0.05$). Highest diversity index of 2.631 was obtained at the study site in Kugbo. These findings underscore the resilience and adaptability of plants at these polluted environments, indicating that despite being exposed to anthropogenic disturbance, these sites provided habitats for colonization by some plants that are potentially useful for phytoremediation.

Keywords: Plant species, scrap metal dumpsites, biodiversity, Abuja metropolis, Federal Capital Territory Nigeria

Highlights

- Plant species belonging to 25 genera in 13 families were identified at scrap metal dumpsites within Abuja municipality and environs, Nigeria
- *Ageratum conyzoides* L. (Family Asteraceae), had the highest relative importance value (RIV) among identified plants.
- Dominant plants species identified at the scrap metal dumpsites may have potential for phytoremediation of heavy metal-polluted soil

INTRODUCTION

Urbanization and industrialization have led to the proliferation of scrap metal dumpsites in many developing countries, including Nigeria [1, 2]. These dumpsites, often unregulated or at best, poorly regulated, serve as repositories for various metal wastes such as used old automobiles, other automotive scraps, construction

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beams, pipes, wiring, and electrical scraps [3, 4]. Over time, the degradation of these materials can release heavy metals into the surrounding environment, posing significant ecological and health risks [1]. The presence of heavy metals in soil can adversely affect plant communities by altering species composition, reducing biodiversity, and inhibiting seed germination and growth [5, 6]. However, some plant species have demonstrated resilience in such contaminated environments, potentially serving as bioindicators or agents for phytoremediation [7, 8].

Previous studies in the south-south geopolitical region of Nigeria, which is characterized by mangrove forests and equatorial rain forest, have assessed the floristic composition and diversity of dumpsites in various regions [9]. For instance, research conducted in Port Harcourt revealed significant differences between the floristic compositions of soil seed banks in solid waste dumpsites compared to control sites, indicating the impact of waste accumulation on plant diversity [10]. Similarly, an assessment in Benin City identified specific plant species around scrap metal dump sites that could be utilized for phytoremediation efforts [11].

However, there remains a paucity of information regarding the floristic composition and diversity of scrap metal dumpsites in the northern part of the country, including Abuja in the Federal Capital Territory (FCT) of Nigeria. Given the rapid urbanization and industrial activities in Abuja and its environs, it is crucial to understand how these dumpsites influence local plant communities. Since plants at such sites may have potential for phytoremediation of heavy-metal polluted soil, the use of Abuja and environs as the study area is strategic considering its close proximity to and similar savannah vegetation to Nasarawa State, an hotspot for mining activities with the official slogan "Home of Solid Minerals." This study therefore aims to identify plant species present at selected scrap metal dumpsites in Abuja Metropolis and environs, and investigate their abundance and diversity.

MATERIALS AND METHODS

Study Area, Study Design, and Sampling Stations

This study area was Abuja and environs, Federal Capital Territory (FCT), Nigeria. The FCT is located centrally in the country, in the Guinea savanna zone within the North-central region, between latitude 8° 25" and 9° 25" North of the Equator and longitude 6° 45" and 7° 45" East of the Greenwich. The FCT shares land borders with Niger, Kaduna, Nasarawa, and Kogi States and occupies an area of about 8,000 square kilometers [12]. The climate of the FCT is characterized by a tropical wet and dry season, with mean annual rainfall of about 1,631.7 mm and annual mean temperature ranging between 25.8°C and 30.2°C.

Stratified random sampling was applied to select three major scrap metal dumpsites from Apo, Kugbo, and Kado within Abuja Municipality and two others from Mpape and Gwagwalada, making a total of five dumpsites. At each selected dumpsite, quadrats were laid using the strategic quadrat random sampling method. Each sampling station (scrap metal dumpsite) was subdivided into four (4) plots, and samples collected from these plots were combined into one homogeneous sample as previously described [13]. Major dumpsites were identified based on size, age, intensity of metal waste deposition, and presence of metal-related activities such as automobiles and battery repairs, sales of vehicle spare parts, and dismemberment of condemned automobiles and other metalwork (locally referred to as "pantaker"). A site with no history of scrap metal dumping was selected as the control site. Geographic coordinates of dumpsites and the control site were taken using GPS Coordinates® (Finacept Company, USA), and these are shown in Table 1.

Table 1: Description and geographical coordinates of study locations and the control site

Location/Description	**Geographical Coordinates**
Apo Main Scrap Metal Site, Abuja Municipal	N08^0 56' 52.722" E07^0 28' 48.684"
Kugbo Mechanic Market Scrap Metal Site, Abuja Municipal	N09^0 01'16.170" E07^0 33' 21.252"
Kado Scrap Metal Dumpsite, Abuja Municipal	N09^0 07' 1.752" E07^0 27' 6.732"
Mpape Main Pantaker, Area 1 junction, Mpape, Bwari Area Council	N09^0 07' 59.658" E07^0 29' 41.400"
Gwagwalada Main Pantaker, Along Zuba-Gwagwalada Expressway	N08^0 56' 59.172" E07^0 06' 24.846"
Control Site, FCT College of Education, Gwagwalada Area Council	N09^0 05' 5.886" E07^0 12' 48.480"

Plant Sampling and Identification

Sampling was done between August and November, 2023. Plants were sampled within a 3m radius of the core of each scrap metal dump site, using a 1m by 1m quadrat, based on strategic quadrat random sampling method [11]. Plant species were identified, counted, and those which were not readily identified onsite were taken to the herbarium for further identification. Digital pictures of each plant were also taken. Plants were identified and classified based on taxonomic keys using field guides and flora databases [14, 15].

Plant Species Abundance, Diversity and Community Similarity

Plant species composition and abundance were described using a species checklist. Frequency (F) (%), relative frequency (Rf) (%), density (D), relative density (Rd) (%), and relative importance value (RIV) (%) were estimated as previously described [16] as follows:

$$\text{Frequency} = \frac{\text{Total number of quadrats in which a species occurs}}{\text{Total number of quadrats sampled}} \times 100$$

$$\text{Relative frequency} = \frac{\text{Frequency of a species}}{\sum \text{Frequencies of all species}} \times 100$$

$$\text{Density} = \frac{\text{Total number of individuals of a species}}{\text{Area sampled}}$$

$$\text{Relative density} = \frac{\text{Density of a species}}{\sum \text{Densities of all species}} \times 100$$

$$\text{RIV} = \frac{\text{Relative frequency + Relative density}}{2}$$

Shannon-Wiener's diversity index (H'), species richness (S), and Pielou's evenness index (J) were computed for each sampling station and the control site as previously described.[11]

Shannon-Wiener's diversity index: $\boldsymbol{H' = -\sum [(ni/Ni) \times \ln (ni/Ni)]}$

where n_i is the number of individuals of each species, N is the total number of individuals (or amount) for the site, and ln is the natural log of the number.

Pielou's evenness index: $\boldsymbol{J' = H'/\ln S}$

where $\boldsymbol{H'}$ is Shannon-Wiener's diversity index and ln$S$ is the natural logarithm of species richness. Jaccard index of community similarity (J) was used for pairwise comparison of the six area councils and the control site.

Jaccard index of community similarity: $\boldsymbol{J = C / (A + B + C)}$

where A and B are the total number of species in community A and B, respectively and C is the number of species common to both A and B [16].

Data Analysis

Data obtained were entered into an Excel spreadsheet (Microsoft Office 2013, Redmond, Washington, USA) and analyzed using IBM SPSS Statistics for Windows, Version 29 (IBM Corp., Armonk, New York, USA). Plant diversity indices at scrap metal dumpsites were statistically compared to those at the control site using one-way analysis of variance (ANOVA) at a significance level of $p < 0.05$, with Tukey's HSD test used for post hoc comparisons.

RESULTS

Floristic Composition of Scrap Metal Dumpsites in Abuja Municipality and Environs, and Plant Species Relative Importance

Twenty-seven plant species belonging to 25 genera in 13 families were identified during this study at five scrap metal dumpsites distributed across Abuja Municipal Area and its environs. Figure 1 summarizes the proportional representation of plant families identified, while Table 2 shows the plant species categorized by their families. Family Asteraceae, with seven plant species, had the highest number of species, followed by Poaceae and Malvaceae each with three species.

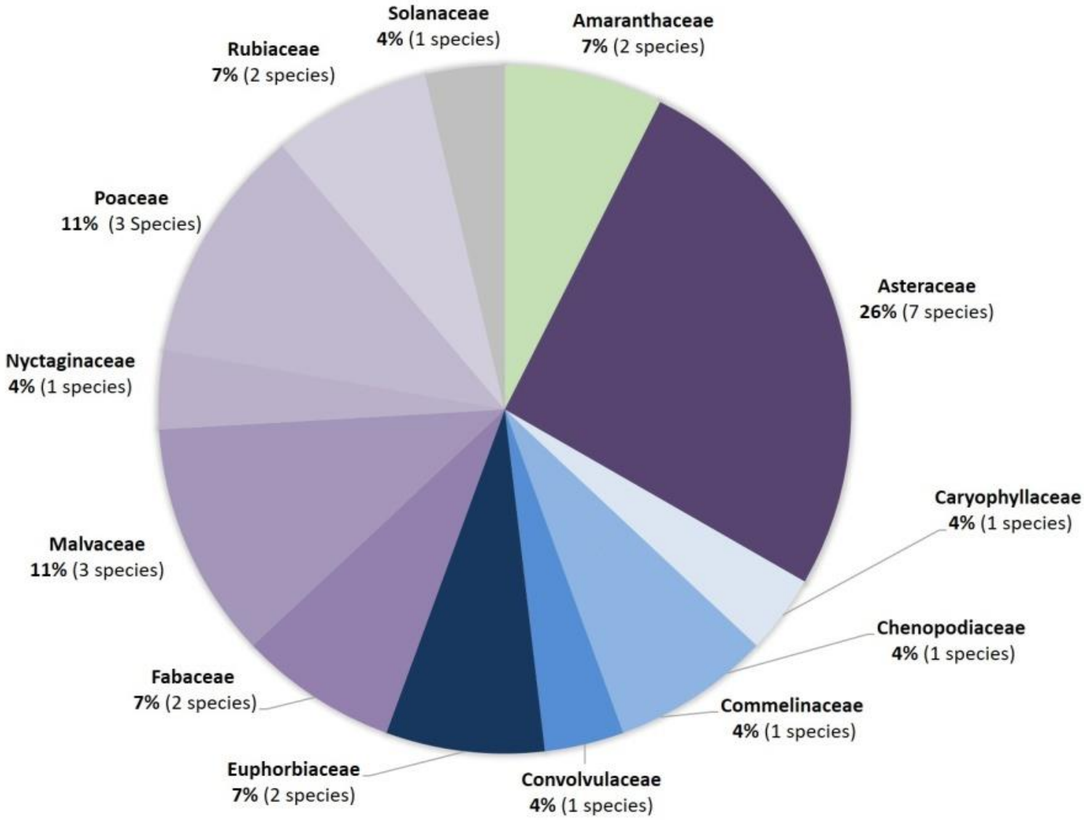

Figure 1: Percentage representation of plant families identified

Table 2: Families and species of plants identified during the study

S. No	Family Name	Genus	Species
1.	Amaranthaceae	*Gomphrena*	*Gomphrena serrata*
		Amaranthus	*Amaranthus spinosus*
2.	Asteraceae	*Ageratum*	*Ageratum conyzoides*
		Laggera	*Laggera crispata*
		Acmella	*Acmella paniculata*
		Tridax	*Tridax procumbens*
		Tithonia	*Tithonia diversifolia*
		Chromolaena	*Chromolaena odorata*
		Synedrella	*Synedrella nodiflora*
3.	Caryophyllaceae	*Sagina*	*Sagina procumbens*
4.	Chenopodiaceae	*Dysphania*	*Dysphania ambrosioides*
5.	Commelinaceae	*Commelina*	*Commelina benghalensis*
6.	Convolvulaceae	*Ipomoea*	*Ipomoea triloba*
7.	Euphorbiaceae	*Euphorbia*	*Euphorbia hirta*
			Euphorbia hyssopifolia

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8.	Fabaceae	*Calopogonium*	*Calopogonium mucunoides*
		Indigofera	*Indigofera hirsuta*
9.	Malvaceae	*Sida*	*Sida acuta*
			Sida rhombifolia
		Corchorus	*Corchorus olitorius*
10.	Nyctaginaceae	*Boerhavia*	*Boerhavia erecta*
11.	Poaceae	*Digitaria*	*Digitaria sanguinalis*
		Eleusine	*Eleusine indica*
		Setaria	*Setaria helvola*
12.	Rubiaceae	*Mitracarpus*	*Mitracarpus hirtus*
		Richardia	*Richardia grandiflora*
13.	Solanaceae	*Solanum*	*Solanum nigrum*

Table 3, which reveals the plant species abundance parameters during the study, shows that the site at Kugbo had the highest number of plant species. The table also shows that only *Ageratum conyzoides*, *Eleusine indica*, *Richardia grandiflora* and *Setaria helvola* had a frequency value of 100.0% at study sites in Apo, Mpape, Gwagwalada, and Kado, respectively.

Table 3: Plant species distribution and abundance at five scrap metal dumpsites in Abuja municipality and environs

S.No	Species	Apo				Kugbo				Kado				Mpape				Gwagwalada			
		F (%)	Rf (%)	D	Rd (%)	F (%)	Rf (%)	D	Rd (%)	F (%)	Rf (%)	D	Rd (%)	F (%)	Rf (%)	D	Rd (%)	F (%)	Rf (%)	D	Rd (%)
1	*Acmella paniculata*	-	-	-	-	50.00	6.25	0.75	4.62	-	-	-	-	-	-	-	-	-	-	-	-
2	*Ageratum conyzoides*	100.00	44.44	4.75	59.38	75.00	9.38	1.50	9.23	75.00	16.67	1.75	14.29	-	-	-	-	75.00	30.00	2.25	36.00
3	*Amaranthus spinosus*	-	-	-	-	50.00	6.25	0.50	3.08	25.00	5.56	1.25	10.20	50.00	13.33	4.00	20.00	-	-	-	-
4	*Boerhavia erecta*	-	-	-	-	50.00	6.25	0.50	3.08	75.00	16.67	0.75	6.12	25.00	6.67	0.50	2.50	-	-	-	-
5	*Calopogonium mucunoides*	-	-	-	-	-	-	-	-	75.00	16.67	1.50	12.24	-	-	-	-	-	-	-	-
6	*Chromolaena odorata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50.00	20.00	1.00	16.00
7	*Commelina benghalensis*	-	-	-	-	-	-	-	-	25.00	5.56	0.25	2.04	25.00	6.67	1.50	7.50	-	-	-	-
8	*Corchorus olitorius*	-	-	-	-	75.00	9.38	1.75	10.77	-	-	-	-	-	-	-	-	-	-	-	-
9	*Digitaria sanguinalis*	-	-	-	-	25.00	3.13	0.25	1.54	-	-	-	-	75.00	20.00	2.50	12.50	-	-	-	-
10	*Dysphania ambrosioides*	-	-	-	-	50.00	6.25	1.50	9.23	25.00	5.56	0.25	2.04	-	-	-	-	-	-	-	-
11	*Eleusine indica*	25.00	11.11	1.00	12.50	50.00	6.25	1.50	9.23	-	-	-	-	100.00	26.67	6.00	30.00	25.00	10.00	1.00	16.00
12	*Euphorbia hirta*	-	-	-	-	75.00	9.38	2.00	12.31	-	-	-	-	-	-	-	-	-	-	-	-
13	*Euphorbia hyssopifolia*	-	-	-	-	75.00	9.38	1.50	9.23	-	-	-	-	-	-	-	-	-	-	-	-
14	*Gomphrena serrata*	-	-	-	-	-	-	-	-	50.00	11.11	1.50	12.24	-	-	-	-	-	-	-	-
15	*Indigofera hirsuta*	-	-	-	-	50.00	6.25	0.50	3.08	-	-	-	-	-	-	-	-	-	-	-	-
16	*Ipomoea triloba*	-	-	-	-	25.00	3.13	0.25	1.54	-	-	-	-	-	-	-	-	-	-	-	-
17	*Laggera crispate*	-	-	-	-	25.00	3.13	0.75	4.62	-	-	-	-	25.00	6.67	0.75	3.75	-	-	-	-
18	*Mitracarpus*	-	-	-	-	25.00	3.13	1.00	6.15	-	-	-	-	-	-	-	-	-	-	-	-

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	hirtus .																				
19	*Richardia grandiflora*	-	-	-	-	-	-	-	-	-	-	-	-	25.00	6.67	2.75	13.75	100.00	40.00	2.00	32.00
20	*Sagina procumbens*	-	-	-	-	25.00	3.13	0.25	1.54	-	-	-	-	-	-	-	-	-	-	-	-
21	*Setaria helvola*	-	-	-	-	-	-	-	-	100.00	22.22	5.00	40.82	-	-	-	-	-	-	-	-
22	*Sida acuta*	25.00	11.11	0.75	9.38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	*Sida rhombifolia*	25.00	11.11	0.75	9.38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24	*Solanum nigrum*	-	-	-	-	25.00	3.13	0.25	1.54	-	-	-	-	25.00	6.67	1.00	5.00	-	-	-	-
25	*Synedrella nodiflora*	50.00	22.22	0.75	9.38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26	*Tithonia diversifolia*	-	-	-	-	50.00	6.25	1.50	9.23	-	-	-	-	-	-	-	-	-	-	-	-
27	*Tridax procumbens*	-	-	-	-	-	-	-	-	-	-	-	-	25.00	6.67	1.00	5.00	-	-	-	-

The overall relative importance values (RIVs) of identified plants at scrap metal dumpsites during the study ranged from 0.79% for *Ipomoea triloba* (Genus *Ipomoea*, Family Convolvulaceae) and *Sagina procumbens* (Genus *Sagina*, Family Caryophyllaceae) to 15.91% for *Ageratum conyzoides* (Genus *Ageratum*, Family Asteraceae). These results are presented in Table 4. Figure 2 is a chart showing the relative importance values of identified plant species, indicating that about 26.0% of plant species encountered had RIV above 4.0%.

Table 4: Relative importance values (RIVs) of plant species at scrap metal dumpsites and the control site

S. No	Species	Relative Importance Value (RIV) (%)						
		Apo	Kugbo	Kado	Mpape	Gwagwalada	All Study Locations	Control Site
1	*Acmella paniculata*	-	5.43	-	-	-	1.79	5.96
2	*Ageratum conyzoides*	51.91	9.30	15.48	-	33.00	15.91	7.53
3	*Amaranthus spinosus*	-	4.66	7.88	16.67	-	7.56	-
4	*Boerhavia erecta*	-	4.66	11.39	4.58	-	4.97	3.03
5	*Calopogonium mucunoides*	-	-	14.46	-	-	2.98	3.66
6	*Chromolaena odorata*	-	-	-	-	18.00	1.99	6.27
7	*Commelina benghalensis*	-	-	3.80	7.08	-	2.58	3.03
8	*Corchorus olitorius*	-	10.07	-	-	-	3.18	-
9	*Digitaria sanguinalis*	-	2.33	-	16.25	-	4.57	2.93
10	*Dysphania ambrosioides*	-	7.74	3.80	-	-	3.18	4.28
11	*Eleusine indica*	11.81	7.74	-	28.33	13.00	12.33	4.28
12	*Euphorbia hirta*	-	10.84	-	-	-	3.38	7.31
13	*Euphorbia hyssopifolia*	-	9.30	-	-	-	2.98	1.36
14	*Gomphrena serrata*	-	-	11.68	-	-	2.39	7.21
15	*Indigofera hirsuta*	-	4.66	-	-	-	1.59	1.67
16	*Ipomoea triloba*	-	2.33	-	-	-	0.79	-
17	*Laggera crispate*	-	3.87	-	5.21	-	2.39	-
18	*Mitracarpus hirtus .*	-	4.64	-	-	-	1.39	4.38
19	*Richardia grandiflora*	-	-	-	10.21	36.00	6.76	3.66
20	*Sagina procumbens*	-	2.33	-	-	-	0.79	3.03

21	*Setaria helvola*	-	-	31.52	-	-	6.37	5.96
22	*Sida acuta*	10.24	-	-	-	-	1.19	1.36
23	*Sida rhombifolia*	10.24	-	-	-	-	1.19	3.03
24	*Solanum nigrum*	-	2.33	-	5.83	-	2.19	-
25	*Synedrella nodiflora*	15.80	-	-	-	-	1.79	3.66
26	*Tithonia diversifolia*	-	7.74	-	-	-	2.39	-
27	*Tridax procumbens*	-	-	-	5.83	-	1.39	16.43

- Not present

* Three additional plant species (*Acacia ataxacantha, Aeschynomene histrix, and Desmodium adscendes*) were found only at the control site

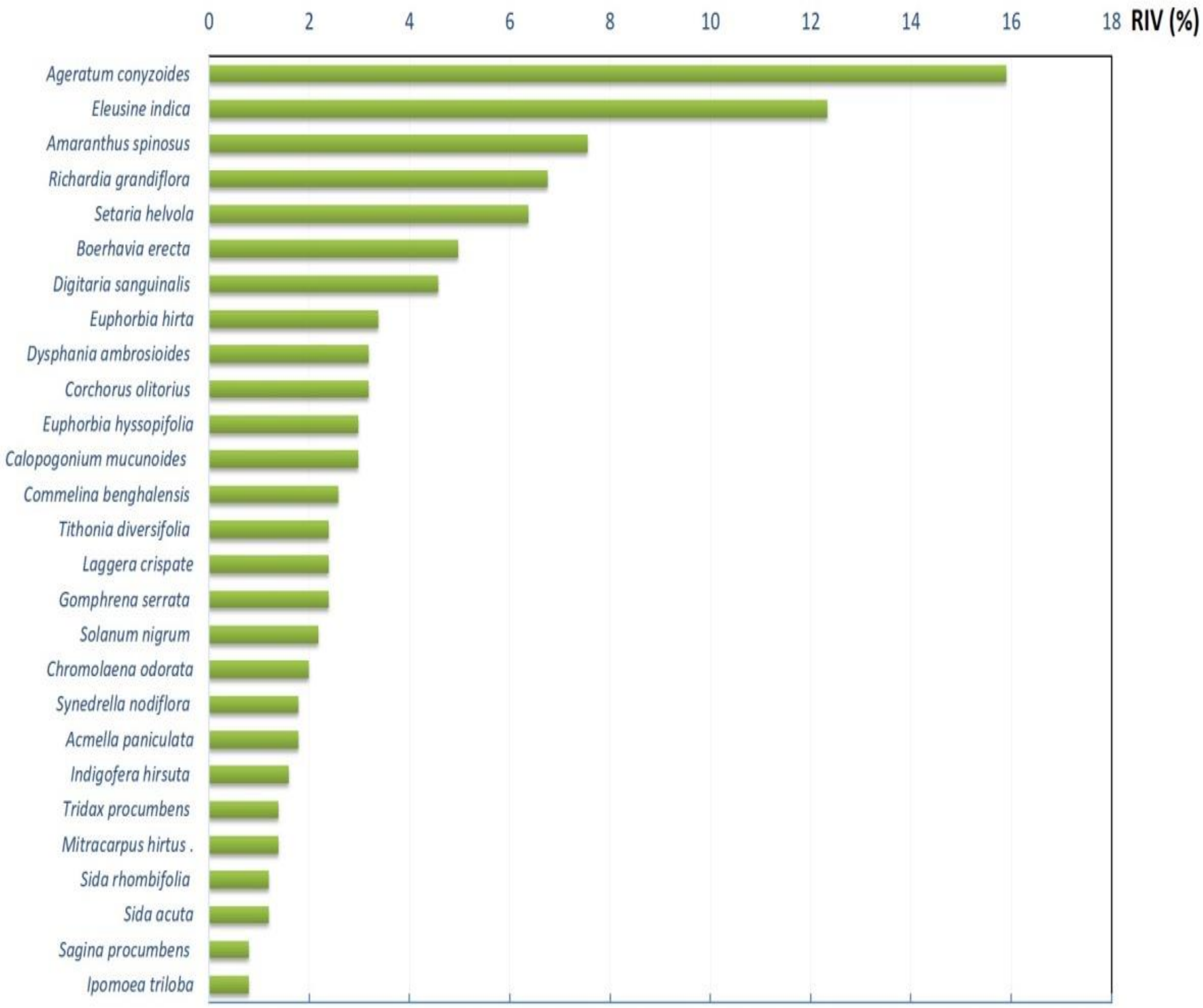

Figure 2: Chart showing the relative importance values of identified plant species

Species Richness, Similarity Levels, and Floral Diversity of Sampling Locations

The species richness of the five study locations ranged from 4 for Gwagwalada to 17 for Kugbo. Pairwise comparison based on Jaccard index of community similarity (*J*) revealed that the similarity level varied widely across study locations, with Apo and Gwagwalada, Kugbo and Mpape, and Kado and Mpape having the highest *J* values of 0.40, 0.35, and 0.33, respectively, indicating moderate to low levels of community similarity across the locations. These findings are presented in Figure 3.

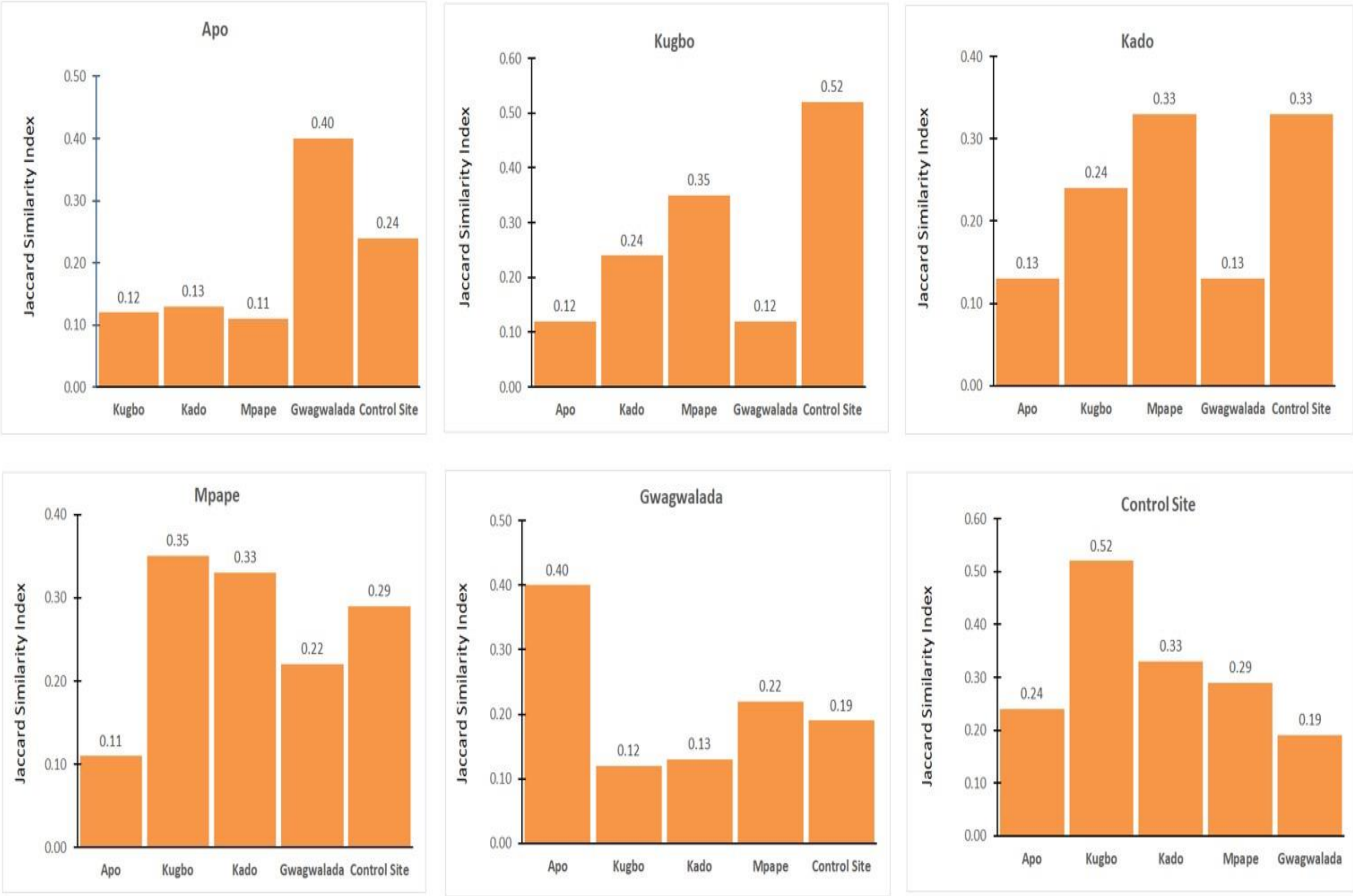

Figure 3: Jaccard index of similarity in the floristic composition of study locations and the control site

Shannon-Wiener index of species diversity and species evenness obtained for the five locations are presented in Table 5, which reveals that Kugbo Mechanic Market Pantaker and Mpape Main Pantaker with the highest species richness also had the highest Shannon-Wiener indices of 2.631 and 1.925, respectively, while Apo Main Pantaker had the least (1.235). Species richness of the control site and those of scrap metal dumpsites were statistically different ($p < 0.05$), while Pielou's evenness and Shannon-Wiener indices of the control and sampling sites were statistically similar.

Table 5: Species richness, species evenness, and Shannon-Wiener diversity index for the study locations and control site

Study Location	**Species Richness***	**Pielou's Evenness Index**	**Shannon-Wiener Index**
Apo Main Pantaker	5	0.768	1.235
Kugbo Mechanic Market Pantaker	17	0.929	2.631
Kado Scrap Metal Dumpsite	8	0.828	1.721
Mpape Main Pantaker	9	0.876	1.925
Gwagwalada Main Pantaker	4	0.951	1.319
Control Site	20	0.861	2.578

*Species richness of the control site and those of scrap metal dumpsites were statistically different ($p < 0.05$)

Figure 4 is a combination chart (bar chart and line graph) which highlights the direct relationship between values obtained during the study for species richness and Shannon-Wiener index of diversity.

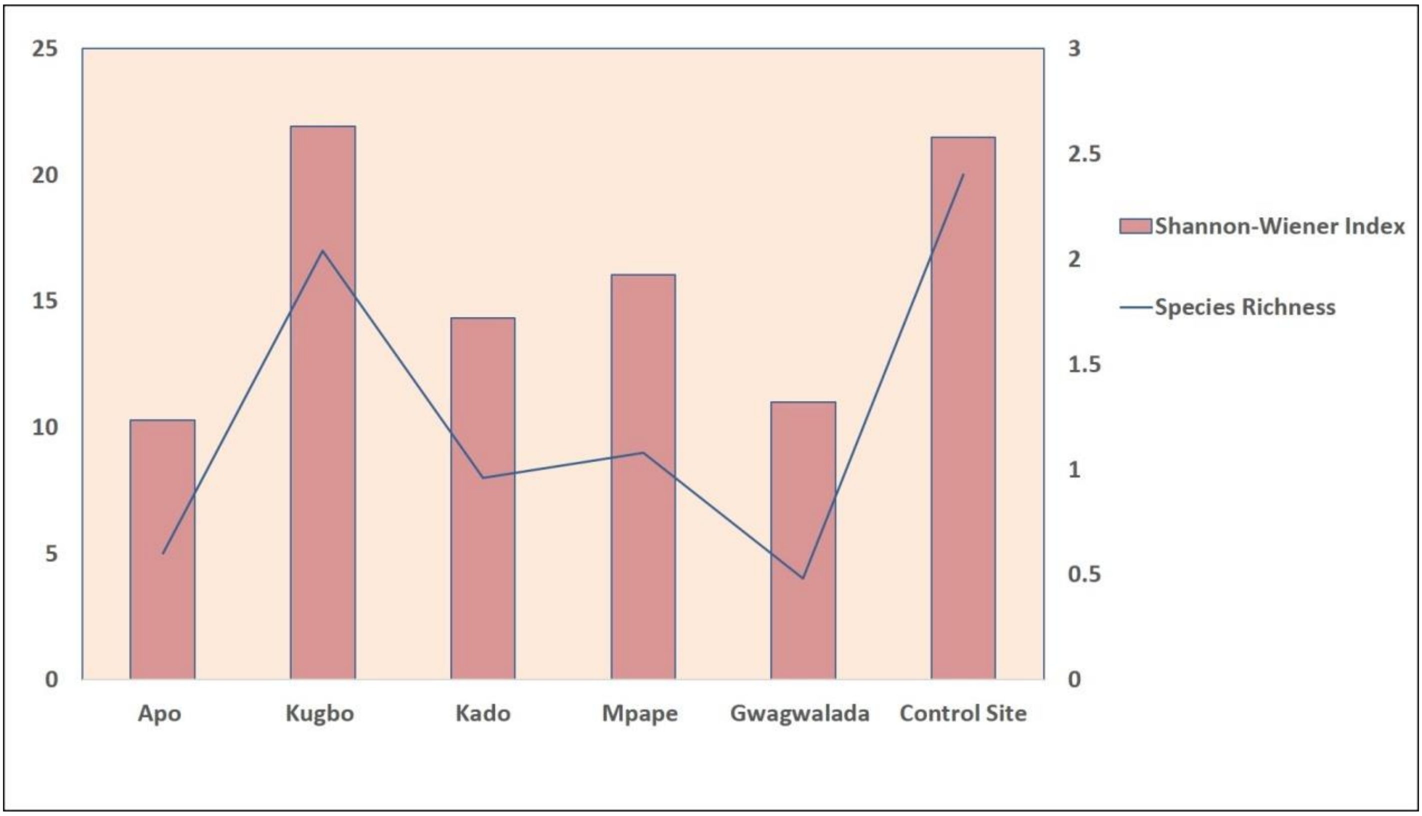

Figure 4: Comparison of plant species richness and Shannon-Wiener diversity index of study locations

DISCUSSION

Plants growing in heavy metal-contaminated soils can have properties which make them useful for phytoremediation, such as the ability to uptake heavy metals from the environment and accumulate them in their shoots and other tissues [17, 18]. During this study, which investigated the floristic composition and abundance, relative importance, and diversity of plant species within scrap metal dumpsites Abuja municipality and environs, 27 plant species belonging to 25 genera in 13 families were identified. The heterogeneity of the flora community at these scrap metal dumpsites aligns with studies suggesting that plant communities in disturbed environments often exhibit diversity as a means of enhancing soil restoration [19].

The observed preponderance of plants within the Asteraceae and Poaceae families reflects the resilience and adaptability of these plant taxa in disturbed environments such as scrap metal dumpsites. The family Asteraceae, commonly known as the sunflower or daisy family, with more than 23000 species, is known for its extensive species diversity among angiosperms [20]. The preponderance of Asteraceae in the present study aligns with a previous study which reported this family as a characteristic group in degraded or anthropogenically altered habitats due to their high seed dispersal capabilities and tolerance to environmental stress [21]. The family is also reported to include genera with potential phytotoxic, allelopathic activities, including genus *Acmella* which was one of the Asteraceae genera identified in the present study, leading to their enhanced survival as a result of suppressive effects on the growth of other plant species [22, 23]. Similarly, plants in the Poaceae family have been reported to be highly adaptable to nutrient-poor soils and are known to be dominant in grassland vegetations [24-26].

The adaptation and tolerance of families Asteraceae and Poaceae to environmental conditions at the scrap metal dumpsites during this study was further supported by the fact that *Ageratum conyzoides* and *Eleusine indica*, the two most-ubiquitous plant species, identified in four of the five study locations, belonged to families Asteraceae and Poaceae, respectively. The relatively higher RIVs obtained for *Ageratum conyzoides* (15.91) and *Eleusine indica* (12.33) further suggest their significant role in shaping vegetation structure at scrap metal dumpsites in FCT, Nigeria. These findings suggest that these species likely possess ecological traits that confer a competitive advantage, such as high reproductive rates and tolerance to heavy metal contamination. This is similar to previous studies which reported the heavy metal hyperaccumulating properties of these plant species [27-29]. In contrast, species such as *Ipomoea triloba* and *Sagina procumbens* with the lowest average densities and RIVs, may represent less competitive species within these degraded ecosystems. This is different from findings from a study which included *Ipomoea triloba* among dominant species on an old waste dumpsite in Abidjan, Côte d'Ivoire and another which described *S. procumbens* as a species adaptable to waste ground [30, 31].

Species richness varied significantly across the study locations, with Kugbo exhibiting the highest richness (17 species) and Gwagwalada showing the least (4 species). These disparities could reflect differences in anthropogenic pressures and microclimatic conditions across the study locations, considering that Gwagwalada Area Council had the highest average maximum temperature and the least total precipitation during this study. This is similar to previous findings which revealed that herbaceous plant species richness was affected by precipitation and temperature, and that these are two key climatic drivers of species richness, evenness, and plant coverage [32, 33].

Similar to previous reports [34, 35], the statistically lower species richness ($p < 0.05$) at scrap metal dumpsites compared to the control site highlights the impact of anthropogenic activities on plant species diversity. However, the similarity in Pielou's evenness and Shannon-Wiener indices between the control and sampling sites suggests that while species richness was generally reduced at these scrap metal dumpsites, the relative abundance distribution of species remains consistent, likely due to the dominance of resilient plant species. The moderate to low levels of community similarity among the study locations, as shown by Jaccard index values obtained, further indicate that most of the locations had a relatively highly diverse plant populations.

The presence of diverse plant species at these scrap metal dumpsites indicates that these sites, despite their anthropogenic disturbance, provide habitats for plant colonization and succession. However, the dominance of stress-tolerant species such as *Eleusine indica* and *Ageratum conyzoides* raises concerns about long-term soil quality and ecological health. Studies have shown that such species can indicate high levels of heavy metal contamination and soil degradation. Nonetheless, the potential use of these plants in phytoremediation strategies presents a significant opportunity for ecological restoration. For instance, *Ageratum conyzoides* has been reported to accumulate heavy metals such as lead, making it a candidate for remediating contaminated soils [36]. While we hope to further investigate the metallophytic properties and phytoremediation potential of dominant species identified, findings from this study have provided key insights into plant species with potential for phytoremediation in the study area and environs. These findings could be useful for mitigating the adverse environmental impacts of heavy metal pollution in mining communities of North-central Nigeria.

CONCLUSION

This study, which describes the floristic composition and spatial characteristics of plants within scrap metal dumpsites at five locations in Abuja municipality and environs in the Federal Capital Territory of Nigeria, underscores the diversity, resilience and adaptability of plant communities at these polluted environments. The considerable plant species diversity observed indicates that these sites, despite their anthropogenic disturbance, provide habitats for plant colonization and succession, with potential for phytoremediation. However, the dominance of stress-tolerant species such as *Eleusine indica* and *Ageratum conyzoides* raises concerns about long-term soil quality and ecological health. Future research should explore the phytoremediation potential of identified dominant plant species and assess the long-term impacts of scrap metal dumpsites on plant diversity and soil and plant health.

LIMITATIONS OF THE STUDY

This study investigated plant species abundance and diversity at scrap metal dumpsites within Abuja municipality and environs, without inclusion of rural areas of the Federal Capital Territory (FCT). We recommend that future studies should be designed to target the six area councils in the FCT and include urban, periurban, and rural areas. Since the aim of this study was to elucidate plant species abundance and diversity at scrap metal dumpsites, heavy metal analysis of identified plant species was not conducted. Future studies may include this to further understand the impact of scrap metal dumping on soil and plant health in the study area.

Authors Contributions

Conceptualization (CYA, RWN); Literature search and field investigation (CYA); Supervision (RWN, GOO, MSD); Methodology and validation (CYA, RWN, GOO, MSD); Writing – original draft (CYA); Writing – review and editing (CYA); Data analysis (CYA); Resources (CYA). All authors have made significant contributions to this study and have approved the final manuscript.

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Conflict of Interest

The authors declare no conflict of interest.

Data Availability Statement

Additional supporting data are available upon formal and reasonable request made to the corresponding author.

Ethics Statement

This study, and its findings, is original and all cited publications have been referenced. Permission was obtained from relevant authorities at each sampling site before conducting field surveys.

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