The Bioscientist Journal Vol. 14 (1): 1 – 10, March 2026
Journal of the Faculty of Biosciences, Nnamdi Azikiwe University, Awka, Nigeria
Available online at http://www.bioscientistjournal.com
DOI 10.54117/the_bioscientist.v14i1.200



Full Length Research Article

Bioindicator Potential of *Calatropis procera* and *Azadirachta indica* Leaf Epidermal Traits for Monitoring Cement Dust Pollution

*** [1]Kachi, J. B., [1]Olaomi, A. A., [1]Shuaibu, V., [2]Abah, J. P. And [3]Alege, G. O.**

[1]Department of Biology, Federal University Lokoja, Kogi State, Nigeria
[2]Department of Biological Sciences, KolaDaisi University, Ibadan, Oyo State, Nigeria
[3]Department of Biotechnology, Federal University Lokoja, Kogi State, Nigeria

***Corresponding Author**: jolly.kachi@fulokoja.edu.ng

Article History: *Received: 1st November, 2025 Accepted: 27th February, 2026*

Abstract

Airborne particulate pollution from cement industries represents a significant environmental stressor, adversely affecting plant physiology and altering leaf epidermal traits that serve as reliable biomarkers of pollution impact. This study investigated the effects of cement dust pollution on the leaf epidermal indices of *Calotropis procera* and *Azadirachta indica* collected from the vicinity of the Dangote Cement Company in Obajana, Kogi State. Epidermal peels were obtained using both chemical and mechanical methods, prepared on slides, and examined under a light microscope. The epidermal cells were analyzed for stomatal index, length, and breadth. Results revealed that the abaxial leaf surface of *A. indica* at the polluted site exhibited reductions in epidermal cell number (95.50), stomatal number (27.20), stomatal length (1.52), and stomatal breadth (1.42), compared with 103.30, 54.00, 1.80, and 1.58, respectively, at the control site, with differences being statistically significant ($p < 0.05$). Similarly, *C. procera* leaves showed marked modifications, including reduced epidermal cells (78.70), stomatal number (12.30), and stomatal breadth (1.26) on the abaxial surface, compared with 112.10, 40.60, and 1.44, respectively, at the control site, which were significantly different ($p < 0.05$). These alterations in epidermal indices of *A. indica* and *C. procera* highlight their potential as sensitive biomarkers for monitoring the impacts of cement dust and other airborne pollutants on living organisms.

Keywords: *Azadirachta indica,* Bioindicator plants, Cement dust pollution, *Calotropis procera*, Stomatal index

Introduction

Cement production is a vital economic activity that significantly contributes to infrastructure development, particularly in developing nations. However, the environmental ramifications of this industry, particularly dust pollution, have

garnered increasing attention due to their adverse effects on both ecosystems and human health (Eze *et al*., 2018a; Kumar *et al*., 2020a). The Dangote Cement factory in Obajana, Kogi State, Nigeria, stands as a pivotal case study for understanding these impacts, as it is one of the largest cement manufacturers in Africa. The emissions from this facility, characterized by high levels of particulate matter, have raised concerns regarding their implications for local flora and fauna (Adeyemi *et al*., 2021a).

Dust pollution from cement factories is primarily composed of fine particulate matter, which can settle on vegetation, leading to various physiological disturbances (Sharma *et al*., 2019a). This pollution not only hampers photosynthesis by obstructing light absorption but also alters leaf morphology, which can be quantitatively assessed through leaf epidermal indices such as stomatal density, epidermal cell size, and trichome density (Nwankwo *et al*., 2022a). Notably, the leaf epidermal characteristics of economically significant plants like *Calotropis procera* and *Azadirachta indica* are of particular interest in this study, as both species play crucial roles in local economies and ecosystems.

Calotropis procera is known for its medicinal properties and utility in traditional practices, while *Azadirachta indica*, commonly referred to as neem, is renowned for its pest-repellent qualities and is extensively utilized in agriculture (Ghosh *et al*., 2020a; Raghavendra *et al*., 2021). The perturbation of leaf epidermal indices caused by dust pollution poses a significant threat to the health and productivity of these plants, thereby affecting their economic viability and the livelihoods dependent on them. Also, *C. procera* and *A. indica* are not only integral components of the local ecosystem but also hold substantial economic value, with *C. procera* recognized for its medicinal properties (Ghosh *et al*., 2020a) and *A. indica* widely used for its pesticidal qualities in agriculture (Raghavendra *et al*., 2021).

Understanding the impact of cement dust on these species is crucial for preserving both biodiversity and local livelihoods. Cement dust pollution is a well-documented environmental stressor that adversely affects plant physiology and morphology, as it can impede photosynthesis and alter leaf epidermal structures, ultimately reducing plant productivity (Kumar *et al*., 2020a). Moreover, the Dangote Cement factory in Obajana, Kogi State, Nigeria, presents a compelling case study due to its scale and potential environmental impact. Documenting the specific effects of the factory's emissions on local vegetation is essential for informing environmental management strategies and mitigating adverse consequences (Adeyemi *et al*., 2021a). Consequently, this study investigated the effects of cement dust pollution on the leaf epidermal indices of *C. procera* and *A. indica* around the Dangote Cement factory in Obajana, Kogi state, Nigeria, with the hope of contributing to the understanding of how industrial activities impact local biodiversity and productivity.

Materials and Methods

Study Area

The Dangote Cement Company, located in the main town of Obajana within Lokoja Local Government Area, Kogi State, Nigeria, was used as the study area (Figure 1). It is situated within the coordinates: latitude 7º 55′ 11″N and longitude 6º 25′ 47″ E. It is the largest in Sub-Saharan Africa with 10.25 million metric tonnes per annum (mmtpa) capacity across three lines. The plant has 13.25mt of capacity across four lines; it relies on Gas, Coal, and Low Pour Fuel Oil (LPFO) for power. The limestone and additives are sourced from the Obajana mines (Adeyemi *et al*., 2021a).

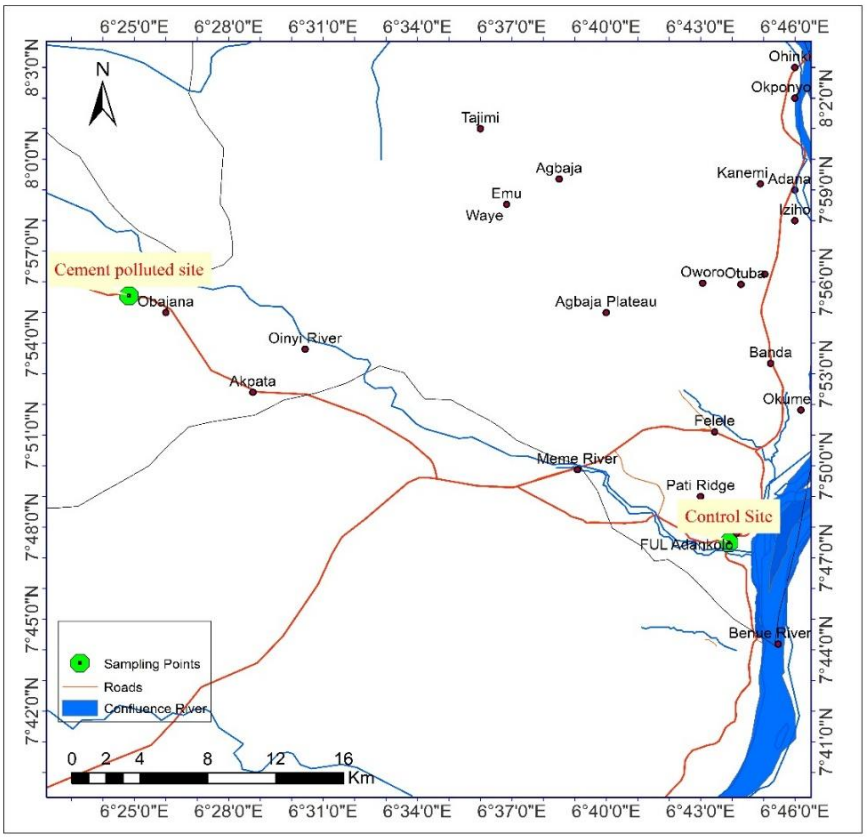


Figure 1: Map of the study area showing the sampling points at Obajana Cement Industry and Federal University Lokoja, Adankolo Campus (Geographic Information System Laboratory-Federal University Lokoja, 2025).

Sample Collection and Preservation

Fresh leaf samples of *A. indica* and *C. procera* were collected from within the vicinity of the Dangote Cement Factory, with location coordinates of latitude 7º 55′ 33″ N and longitude 6º 24′ 50″ E. Samples were also collected from the Biological Garden of the Federal University, Lokoja, Kogi State (Adankolo Campus), which served as the control, within the coordinates of latitude 7º 47′ 30″ N and longitude 6º 43′ 54″ E (Figure 1). The leaves were collected in a heat-proof polythene bag and transported to the Herbarium Unit of the Federal University, Lokoja, for proper identification and validation, with voucher numbers FULH 0041 and FULH 0131 for *A. indica* and *C. procera,* respectively. After identification, the plants were taken to the Laboratory in the Department of Biological Sciences for processing and analysis.

Leaf Epidermal Peeling Techniques

Both chemical and mechanical leaf epidermal peeling methods were used in this study to achieve optimum results. The sampled leaves were rinsed and preserved in 50% ethanol for 24 hours before processing. The abaxial (lower surface) and adaxial (upper surface) surfaces of the leaf samples were obtained using standard methods described by Adedeji and Jewoola (2008) and Tiwari and Pandey (2017).

Chemically, fresh leaf tissue surfaces (abaxial and adaxial) were cut into segments in glass Petri dishes, and then submerged in a macerating solution (10% nitric acid) for 5 to 10 minutes to digest the mesophyll tissue while preserving the epidermis. The resulting tissues were then washed with distilled water to remove any remaining chemicals, and the clear epidermis was gently peeled off with a fine

camel brush and placed on a slide with a cover slip and examined for detailed analysis of the epidermis and stomatal features (Adedeji and Jewoola, 2008).

Mechanically, the foliar epidermis of the adaxial (upper surface) and abaxial (lower surface) of the leaf samples was prepared using the impression technique. The leaf samples were washed with water and allowed to dry. Nail varnish was applied with a camel hairbrush on small sections of the leaf samples' adaxial and abaxial surfaces and left for about 10 minutes. The epidermal strips of the leaf samples were gently scraped using cellotape, placed on a clean slide, and covered with a cover slip (Tiwari and Pandey, 2017).

Slide Preparation of Specimens

The epidermal peels were immersed in 5% hypochlorite solution for 3minutes to clear off debris and wash away pigments, rinsed in clean water, and stained in 0.1% safranin for 3 minutes. 10% glycerol was applied to the glass slide, and the stained specimen was mounted on it; the preparation was carefully covered with a cover slip to prevent air bubbles. The slide cover slip was sealed using nail varnish, before examination using a microscope (Adedeji and Jewoola, 2008).

Measurements and Data Analysis

The slides were prepared and viewed using the light microscope under 40× magnification. The number of stomata, epidermal cells, stomata length, and width were counted per square millimeter area. The stomata index was calculated by dividing the number of stomata by the number of stomata plus the number of epidermal cells × 100, as shown below:

$$Stomata\ Index = \frac{Number\ of Stomata}{Number\ of\ Stomata + Number\ of\ Epidermal\ Cell} \times 100$$

The student's paired t-test at a significance level of $p \leq 0.05$ was used to analyse the results obtained for the mean values of stomata data (index, length, and breadth) from the study sites. All analysis was performed using version 27 of the Statistical Package for Social Sciences (SPSS) software.

Results

Table 1 shows the mean number of epidermal cells, stomata count, and the length and breadth of stomata on the adaxial and abaxial leaf surfaces of *A. indica* and *C. procera* from polluted (Obajana) and control sites. The number of epidermal cells on the abaxial leaf surface of *A. indica* was significantly lower at the polluted site compared to the control site (control = 103.30, Obajana = 95.50, p = 0.01). However, the reduction of epidermal cells on the adaxial leaf surface of *A. indica* was not significantly different (control = 98.50, Obajana = 87.90, p = 0.06). Furthermore, the stomata count (control = 54.00, Obajana = 27.20) and stomata length (control = 1.80, Obajana = 1.52) on the abaxial leaf surfaces of *A. indica* from both sites were significantly different (p = 0.0001). For *C. procera*, both the abaxial and adaxial leaf surfaces responded similarly. The epidermal cell count (control = 100.30, Obajana = 76.20) and number of stomata (control = 47.30, Obajana = 11.70) on the adaxial surfaces from both sites were significantly different (p = 0.0001). Conversely, the length of stomata (control = 1.44, Obajana = 1.22) on the adaxial leaf surfaces was not significantly different (p = 0.051). The same pattern of changes in epidermal indices was observed in the abaxial leaf surfaces of *C. procera*.

Table 2 shows the stomata index of the adaxial and abaxial leaf surfaces of *A. indica* and *C. procera* from the polluted and control sites. The stomata index of the adaxial surfaces of *A. indica* from both sites showed that the polluted site had a higher number of stomata (20.0) than the control site (14.6). Conversely, the stomata index of the abaxial surfaces of *A. indica* from both sites indicated that the control site had a higher stomata count (34.3) than

the polluted site, with a value of 22.2. Interestingly, the adaxial and abaxial leaf surfaces of *C. procera*, revealed values of stomata index that were higher in the control site than in the polluted sites, which was contrary to the trend observed in *A. indica.*

Plate 1 shows photomicrographs that summarize leaf epidermal features of *A. indica* and *C. procera* from control and cement dust-impacted sites. In *A. indica*, the adaxial surface at the control site showed typical epidermal cells and stomata of normal dimensions (A), whereas the polluted site exhibited a conspicuous reduction in stomatal size on the adaxial surface (B). On the abaxial surface, control leaves again displayed a normal epidermis (C), while polluted leaves presented numerous but smaller stomata (D). In *C. procera*, both adaxial and abaxial surfaces at the control site showed the expected anomocytic stomatal complexes, with guard cells bordered by ordinary epidermal cells without distinct subsidiaries (E, F). By contrast, leaves from the polluted site displayed stressed, frequently clogged stomatal pores on both surfaces (G, H), an epidermal response consistent with impaired gas exchange and potential disruption of normal physiological function.

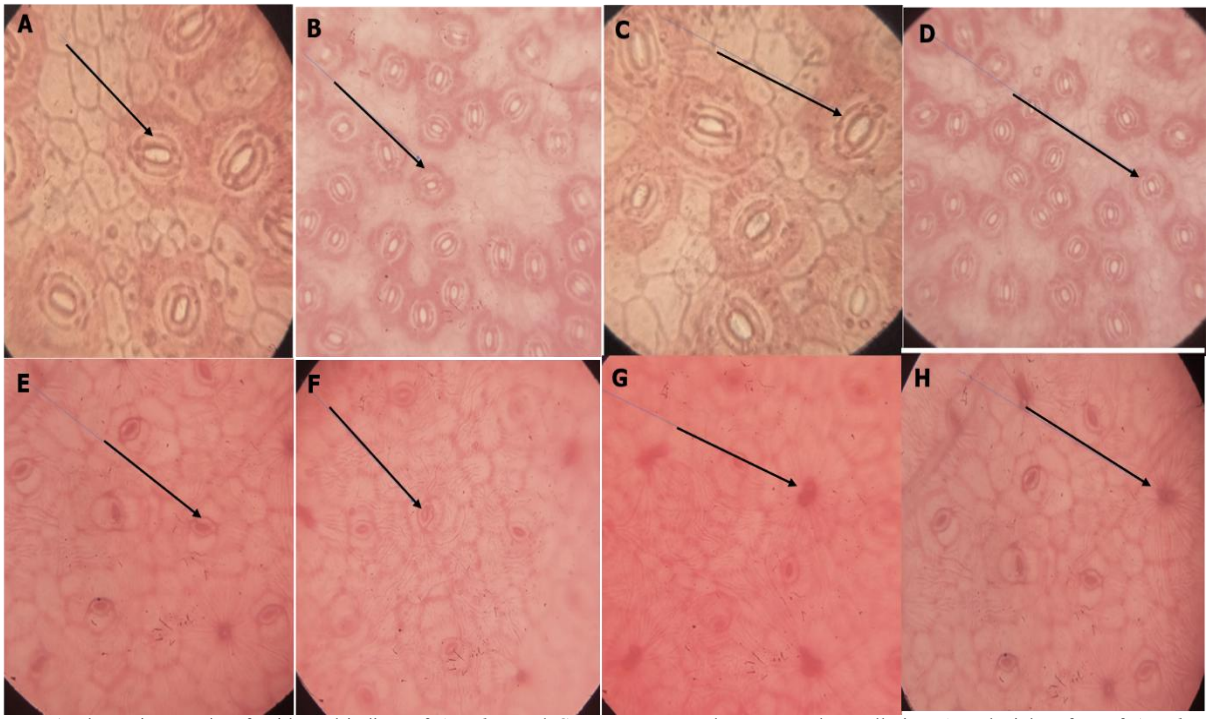


Plate 1: Photomicrographs of epidermal indices of *A. indica* and *C. procera* exposed to cement dust pollution. **A:** Adaxial surface of *A. indica* from the control site with normal stomata and epidermal cells, **B:** Adaxial surface of *A. indica* from the cement-dust polluted site with decreased stomata size, **C:** Abaxial surface of *A. indica* from the control site with normal stomata and epidermal cells, **D:** Abaxial surface of *A. indica* from the cement dust polluted site with numerous and decreased stomata sizes, **E:** Adaxial surface *of C. procera* from the control site with normal anomocytic stomata, **F:** Abaxial surface of *C. procera* from the control site with normal anomocytic stomata complex, **G:** Adaxial surface of *C. procera* from the polluted site with clogged stomata, **H:** Abaxial surface of *C. procera* from the polluted site with a stressed, clogged stomata.

Table 1: Mean measurement of leaf epidermal indices of plant leaf samples

Sample	Site	No. of Epidermal cells		No. of stomata		Length of stomata		Breath of stomata	
		Adaxial	**Abaxial**	**Adaxial**	**Abaxial**	**Adaxial**	**Abaxial**	**Adaxial**	**Abaxial**
Azadirachta indica	Control	98.50	103.30^{a}	16.90	54.00^{a}	1.54	1.80^{a}	1.24^{b}	1.58^{a}
	Obajana	87.90	95.50^{b}	22.00	27.20^{b}	1.58	1.52^{b}	1.42^{a}	1.42^{b}
p- value		0.06^{ns}	0.01^{s}	0.09^{ns}	0.0001^{s}	0.48^{ns}	0.0001^{s}	0.001^{s}	0.001^{s}
Calotropis procera	Control	100.30^{a}	112.10^{a}	47.30^{a}	40.60^{a}	1.58	1.52	1.44^{a}	1.44
	Obajana	76.20^{b}	78.70^{b}	11.70^{b}	12.30^{b}	1.46	1.50	1.22^{b}	1.26
p-value		0.0001^{s}	0.0001^{s}	0.001^{s}	0.0001^{s}	0.051^{ns}	0.44^{ns}	0.03^{s}	0.0001^{s}

Means with different superscripts in a column are significantly different p-value ≤ 0.05. "ns" = No Significance; "s" = Significant

Table 2: Stomata index of adaxial and abaxial surfaces of plant leaf samples

Sample	Location	Adaxial	Abaxial
Azadirachta indica	Control	14.6	34.3
	Obajana	20.0	22.2
Calotropis procera	Control	32.0	26.5
	Obajana	13.3	13.5

Discussion

The current study examined the impacts of cement dust pollution on the leaf epidermal indices of *C. procera* and *A. indica* around the Dangote Cement factory in Obajana, Kogi State, Nigeria. The results showed significant changes in the epidermal traits of *C. procera*, while *A. indica* proved to be resilient against the pollution, displaying no notable differences in its leaf epidermal features. The observed modifications in *C. procera*, such as shorter stomatal length and higher stomatal frequency, agree with previous research indicating that dust pollution can cause physiological stress in plants (Sharma *et al*., 2019b; Kumar *et al*., 2020b). This aligns with the findings of Eze *et al*. (2018b), who reported that particulate matter from industrial emissions negatively affects leaf morphology and ultimately impairs photosynthesis and plant health.

The differing responses of leaf epidermal characteristics in *A. indica* and *C. procera* to cement dust pollution align with recent research findings (Shakeel *et al*., 2025; Nsor *et al*., 2025; Miralles-Pérez *et al*., 2025). The changes seen in *C. procera*, such as a smaller stomatal size and a higher stomatal density, show the species adaptation when it comes to dealing with particulate stress. These changes are in line with micro-morphological studies done in polluted industrial settings, where plants that are exposed to pollutants often show changes in the structure of their epidermal tissues. For instance, studies conducted at mining locations have demonstrated that exposure to various airborne metals can modify stomatal attributes, such as diminished pore sizes and increased stomatal density. These changes are frequently interpreted as compensatory mechanisms that enable plants to regulate gas exchange more effectively when normal stomatal functioning is impaired by chemical toxicity or particulate obstruction (Shakeel *et al*., 2025). Consequently, we reasoned that the responses observed in *C. procera* in this study substantiate the broader understanding that stomatal plasticity functions as a vital adaptive strategy for plants inhabiting polluted environments.

The significant changes observed in *A. indica* suggest a potential adaptive response to cement dust pollution. Similar findings were reported by Nwankwo *et al*. (2022b), who observed that certain species exhibit resilience against environmental stressors due to their physiological and morphological adaptations. The stomatal indices recorded in this study indicate a shift in stomatal density, which could enhance the plant's ability to regulate gas exchange under stressful conditions (Raghavendra *et al*., 2021). *A. indica* has been reported to have high air pollution tolerance index (APTI) values and robust physiological traits in contaminated environments, making it the best-performing species for urban pollution control (Nkansah *et al*., 2025). The species' ability to maintain normal stomatal architecture under cement dust exposure in this study is in agreement with previous findings of Nkansah *et al*. (2025), suggesting that neem has morphological and biochemical features that mitigate the deleterious impact of particulate deposition, such as thick cuticles, heavy epicuticular wax deposition, and strong

antioxidative systems (Nkansah *et al*., 2025).

The variations in epidermal cell counts and stomatal indices in *C. procera* support the hypothesis that dust pollution serves as a biological stressor, corroborating the conclusions of Ghosh *et al*. (2020b) that environmental pollutants can modify leaf structures, affecting plant survival and productivity. Furthermore, the tetracytic stomata complex observed in *Calotropis procera* aligns with findings by Adedeji and Jewoola (2008), indicating that this morphological feature may be a response mechanism to enhance water retention and minimize transpiration in polluted environments.

The implications of these findings are profound, as they highlight the potential use of *C. procera* as a bioindicator species for monitoring environmental pollution in industrial zones. This is particularly relevant considering the studies by Adeyemi *et al*. (2021b) and Kumar *et al*. (2020), who emphasized the need for effective environmental management strategies to mitigate the impacts of industrial activities on local biodiversity.

Furthermore, other studies have documented the detrimental effects of cement dust on various plant species. For example, Meena *et al*. (2020) highlighted that cement dust pollution significantly affects leaf morphology and physiology in diverse plant species, leading to decreased growth and productivity. Similarly, Singh *et al*. (2021) found that industrial pollutants negatively impact leaf structure and function, which may compromise the ecological balance. The implications of these findings underscore the potential use of *C. procera* as a bioindicator species for monitoring environmental pollution in industrial zones. This is particularly relevant given the studies by Kumar *et al*. (2020a) and Sharma *et al*. (2019b), which highlighted the need for effective environmental management strategies to mitigate the impacts of industrial activities on local biodiversity. Additionally, the findings of Ogundare *et al*. (2021) support the notion that assessing leaf structural changes can provide insights into the health of local ecosystems affected by pollution. The differential responses of *C. procera* and *Azadirachta indica* to cement dust pollution underscore the complex interactions between environmental stressors and plant physiology.

Conclusion

Our findings show that cement dust from the Dangote Cement plant in Obajana (Kogi State, Nigeria) clearly affects *C. procera*: its leaves develop smaller but more numerous stomata, a change that can restrict normal gas exchange. In contrast, *A. indica* maintains largely normal leaf structure across sites, suggesting greater tolerance to the same conditions. This difference points to species-specific sensitivity to particulate pollution and highlights *C. procera* as a potential, locally available bioindicator for industrial air quality. Furthermore, the work underscores how routine cement production can quietly reshape plant function and, over time, influence the stability of nearby ecosystems. Based on these results, we recommend regular biomonitoring that prioritizes available plants like *C. procera* alongside on-site dust controls such as water spraying on haul roads, enclosure of dust-generating steps, and vegetative buffer belts to help protect biodiversity and local livelihoods.

Acknowledgements

The authors would like to express their profound gratitude to the Department of Biology, Federal University Lokoja, for providing the enabling environment to conduct this research. We would also like to thank Mr Gbenga Akanni, the head of the Herbarium Unit of the Department, for helping in the confirmation of the plant species used in this study.

Authors' contributions

Kachi, J.B. and Shuaibu,V. designed the study and collected the samples; Shuaibu, V. performed the experiment; Kachi, J.B. wrote the initial draft of the manuscript; Olaomi, AA., and Abah, J.P. critically revised the manuscript; Alege, G.O. conducted the statistical analysis. All authors read and approved the final manuscript.

Conflict of interest

The authors declare there is no conflict of interest related to this work.

Funding source

There was no funding for this research.

References

Adedeji, O. B. and Jewoola, O. A. (2008). Effects of industrial pollution on the leaf epidermal characteristics of some plant species in Nigeria. *Journal of Environmental Science and Technology*. 2(2):8-12.

Adeyemi, A. A., Oke, O. L. and Ajayi, A. A. (2021a). Air quality assessment around cement factories in Nigeria: A case study of Dangote Cement, Obajana. *Environmental Monitoring and Assessment*. 193(4):1-15.

Adeyemi, A. A., Ogunwande, I. J. and Eze, A. (2021b). Impact of cement dust pollution on the morphology and anatomy of selected plant species. *Environmental Monitoring and Assessment*. 193(7):1-11.

Eze, P. M., Onyekwelu, J. C. and Akinyemi, O. (2018a). The impact of dust pollution on plant health in urban areas: A review. *Environmental Science and Pollution Research*. 25(5):4572-4581.

Eze, A., Ogbonna, O. O. and Okwuosa, C. (2018b). Physiological and morphological responses of plants to cement dust pollution in Nigeria. *Journal of Pollution Effects and Control*. 6(1):1-7.

Ghosh, S., Kumar, A. and Soni, K. (2020a). Medicinal properties and economic importance of *Calotropis procera*: A review. *Journal of Medicinal Plants Research*. 14(3):45-54.

Ghosh, S., Chatterjee, S. and Ghosh, D. (2020b). The impact of environmental pollutants on the leaf structure of *Calotropis procera*. *Environmental Science and Pollution Research*. 27(8):8503-8510.

Kumar, A., Sharma, A. and Gupta, R. K. (2020a). Environmental impact of cement dust pollution on plant growth and development. *Journal of Environmental Management*. 261:110222.

Kumar, S., Kumar, P. and Singh, R. (2020b). Role of leaf epidermal characteristics in plant responses to air pollution. *Plant Physiology and Biochemistry*. 157:292-301.

Meena, S. K., Kumar, A. and Yadav, S. (2020). Impact of cement dust pollution on morphological and physiological characteristics of plants. *Environmental Science and Pollution Research*. 27(15):18479-18491.

Miralles-Pérez, B., Andrés-Camacho, C., Fernández-Espinosa, A. J. and Rossini-Oliva, S. (2025). Particulate matter and potentially toxic element content in urban ornamental plant species to assess pollutants trapping capacity. *Journal of Environmental Management.* 374:124058.

Nkansah, F. K., Belford, E. J. D. and Hogarh, J. N. (2025). Evaluation of urban tree species for air pollution control: integrating air pollution

tolerance index (APTI), anticipated performance index (API), and socioeconomic value in Ghana's Central Region. *Research Square,* 1-13. https://doi.org/10.21203/rs.3.rs-5813394/v1

Nsor, C. A., Joseph, F., Usim, N. J., Elaigwu, A. M., Oride, M. G., Patrick, D. and Abubakar, B. (2025). The effects of cement particulate discharge on two trees and a common shrub in Ashaka, Gombe State. *FUDMA Journal of Sciences*. 9(12):217–224.

Nwankwo, E. N., Eze, P. M. and Ugochukwu, E. F. (2022a). Impact of air pollution on leaf epidermal characteristics of economically important plants. *International Journal of Environmental Science and Technology*. 19(1):123-134.

Nwankwo, A., Eze, A. and Ugochukwu, N. (2022b). The effects of particulate matter on leaf morphology: A review. *International Journal of Environmental Research and Public Health*. 19(5):3050.

Ogundare, F. O., Oyekunle, J. A. and Ojo, O. O. (2021). Assessing the ecological impacts of industrial pollution through leaf structural changes: A case study. *Applied Ecology and Environmental Research*. 19(1):103-114.

Raghavendra, A. S., Babu, R. R. and Rao, P. M. (2021). Neem: A natural pesticide and its economic significance. *Pest Management Science*. 77(5):2381-2390.

Shakeel, T., Shah, G. M., Zeb, B. S., Gul, I., Irshad, M. and Zafar, H. (2025). Phytomining potential, micro-morphological assessment, and air pollution tolerance index of plant species in multi-metals contaminated soapstone and crushing stone mines. *Science of The Total Environment.* 975:179228.

Sharma, G., Singh, R. and Kumar, S. (2019a). Impact of cement dust on the morphology of *Azadirachta indica* and *Calotropis procera*. *Plant Science Today*. 6(2):130-135.

Sharma, S., Singh, R. and Gupta, A. (2019b). Effects of particulate matter pollution on leaf morphology and physiology of plants: A review. *Environmental Science and Pollution Research*. 26(16):16516-16529.

Singh, R., Kumar, S. and Meena, S. K. (2021). Effects of industrial pollutants on plant structure and function: A review. *Journal of Environmental Management*. 287:112308.

Tiwari, P. and Pandey, S. (2017). Impact of cement dust pollution on leaf anatomical features of *Lantana camara* and *Calotropis procera*. *Current Science International.* 6:34-40.