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Influence of local environmental conditions on the mineral profile of *Cleome rutidosperma* in Ado-Ekiti

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Abstract

Cleome rutidosperma is an underutilized leafy plant widely distributed in southwestern Nigeria, where it grows spontaneously across diverse microenvironments. The mineral composition of edible plants is strongly influenced by environmental conditions such as soil type, pH, moisture availability, and anthropogenic activities, yet limited data exist on how localized environmental variations affect the mineral profile of *C. rutidosperma* in Ado-Ekiti. This research examines the influence of local environmental conditions on the mineral composition of *C. rutidosperma* leaves collected from different ecological settings within Ado-Ekiti. Leaf samples were obtained from farmland margins, residential areas, roadside locations, and fallow lands, representing varying degrees of soil management and environmental exposure. Standard analytical procedures were employed to quantify essential macro- and micro-elements, including calcium, magnesium, potassium, sodium, iron, zinc, manganese, and copper. The results demonstrate marked spatial variation in mineral concentrations across sampling sites, reflecting differences in soil characteristics and environmental stressors. Plants growing in cultivated soils exhibited higher levels of calcium and potassium, while those from roadside environments showed relatively elevated concentrations of iron and manganese, suggesting potential interactions with soil contamination and dust deposition. These findings underscore the role of local environmental factors in shaping the nutritional quality of wild and semi-wild edible plants. Understanding such variations is essential for assessing the dietary contribution and safety of *C. rutidosperma* when consumed by local populations. The research contributes to existing knowledge on environment-plant mineral interactions and highlights the importance of site-specific evaluation when promoting underutilized leafy vegetables for food and traditional use. The findings also provide baseline information that may guide future agronomic management, nutritional assessment, and conservation strategies for *C. rutidosperma* in southwestern Nigeria and comparable ecological zones.

Keywords: *Cleome rutidosperma*, mineral composition, environmental influence, soil variability, Ado-Ekiti, underutilized leafy vegetables

Introduction

Cleome rutidosperma is a widely distributed herbaceous plant in tropical regions and is commonly found growing naturally in disturbed habitats, farmlands, and residential surroundings in southwestern Nigeria ^[1]. Traditionally, the plant has been utilized for dietary and medicinal purposes, with its leaves reported to contain appreciable levels of essential minerals required for human nutrition ^[2]. Minerals such as calcium, potassium, magnesium, and iron play critical roles in bone development, electrolyte balance, enzymatic activity, and oxygen transport, making leafy vegetables important contributors to micronutrient intake, particularly in resource-limited communities ^[3]. However, the mineral content of plants is not constant and is significantly influenced by environmental factors including soil composition, pH, moisture regime, and exposure to anthropogenic activities ^[4].

Previous studies on wild and cultivated leafy vegetables have shown that soil mineral availability and environmental stressors can lead to considerable spatial variation in plant mineral profiles ^[5]. In urban and peri-urban environments, factors such as vehicular emissions, waste disposal, and intensive land use may further alter soil chemistry, potentially affecting nutrient uptake by plants ^[6]. Despite the widespread occurrence and consumption of *C. rutidosperma* in Ado-Ekiti, information on how localized environmental conditions

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Influence its mineral composition remains limited. Existing studies have largely focused on general phytochemical and proximate composition, with less emphasis on site-specific mineral variability [7].

The absence of detailed data on environment-dependent mineral variation in *C. rutidosperma* represents a knowledge gap, particularly in the context of food quality and nutritional reliability [8]. Since the plant is often harvested from uncontrolled environments, understanding the influence of local ecological conditions is essential for evaluating both its nutritional benefits and potential risks [9]. Therefore, this research aims to investigate the influence of different local environmental conditions within Ado-Ekiti on the mineral profile of *C. rutidosperma* leaves [10].

The central objective of this research is to compare mineral concentrations in *C. rutidosperma* collected from distinct microenvironments and to relate observed variations to environmental characteristics [11]. It is hypothesized that significant differences exist in the mineral composition of *C. rutidosperma* as a function of local environmental conditions, reflecting variability in soil properties and exposure levels [12]. By addressing this hypothesis, the research seeks to contribute to a more nuanced understanding of environment-plant interactions and support informed utilization of *C. rutidosperma* as a nutritional resource [13].

Materials and Methods

Materials: Fresh, mature leaves of *Cleome rutidosperma* were collected from four distinct local environments within Ado-Ekiti, Ekiti State, Nigeria, namely farmland margins, residential areas, roadside locations, and fallow lands, reflecting differences in soil management intensity and environmental exposure. These locations were selected to capture variability in soil physicochemical properties and anthropogenic influence, which are known to affect mineral uptake in plants [4, 5, 11]. Plant identification and authentication were carried out using standard taxonomic keys and regional floras, consistent with earlier reports on West African leafy vegetables [1,2]. Soil samples

corresponding to each plant collection site were also obtained from the topsoil layer (0-20 cm) to support interpretation of mineral variability, following established soil sampling protocols [11, 14]. All reagents used for mineral analysis were of analytical grade, and deionized water was used throughout the research to prevent contamination, in accordance with recommended laboratory practices [10].

Methods

Collected leaf samples were thoroughly washed with distilled water to remove adhering soil particles and air-dried before oven drying at controlled temperature to constant weight, as described in standard plant mineral analysis procedures [3, 10]. The dried samples were milled into fine powder using a stainless-steel grinder and stored in airtight containers until analysis. Mineral elements including calcium, magnesium, potassium, sodium, iron, zinc, manganese, and copper were determined after wet digestion using appropriate acid mixtures, following Association of Official Analytical Chemists protocols [10]. Quantification of minerals was carried out using atomic absorption spectrophotometry and flame photometry where applicable, methods widely employed for assessing mineral composition in leafy vegetables [7, 12]. Quality control measures included reagent blanks and replicate analyses to ensure analytical reliability. Data obtained were used to compare mineral concentrations across different environmental settings, and observed variations were interpreted in relation to soil characteristics and environmental conditions, drawing on established concepts of soil-plant nutrient interactions [4, 11, 14]. The methodological approach aligns with previous studies evaluating mineral profiles of underutilized leafy vegetables and supports meaningful comparison with existing literature [7, 15, 16].

Results

Table 1: Mineral composition of *Cleome rutidosperma* leaves across sites

Table 1: Mean $\pm$ SD (mg/100 g dry weight)

Site	Ca	Mg	K	Na	Fe	Zn	Mn	Cu
Farmland margin	434.0 $\pm$ 40.4	187.5 $\pm$ 13.7	754.1 $\pm$ 65.6	56.7 $\pm$ 9.6	11.8 $\pm$ 3.4	3.5 $\pm$ 0.4	2.9 $\pm$ 0.4	0.6 $\pm$ 0.1
Residential	363.7 $\pm$ 29.9	180.6 $\pm$ 14.1	720.9 $\pm$ 67.0	71.9 $\pm$ 9.8	13.8 $\pm$ 0.7	3.2 $\pm$ 0.3	3.0 $\pm$ 0.4	0.5 $\pm$ 0.1
Roadside	320.8 $\pm$ 25.7	162.4 $\pm$ 13.1	600.9 $\pm$ 67.6	85.0 $\pm$ 4.0	21.7 $\pm$ 3.3	3.1 $\pm$ 0.1	4.4 $\pm$ 0.4	0.5 $\pm$ 0.1
Fallow land	327.4 $\pm$ 27.2	166.0 $\pm$ 15.9	651.9 $\pm$ 77.4	71.6 $\pm$ 11.6	14.1 $\pm$ 1.7	3.3 $\pm$ 0.3	3.1 $\pm$ 0.4	0.5 $\pm$ 0.1

Table 2: One-way ANOVA comparing mineral concentrations among environments

Mineral	F (3,20)	p-value
Ca	16.46	<0.001
Mg	4.17	0.0190
K	5.86	0.0048
Na	9.52	<0.001
Fe	17.91	<0.001
Zn	2.56	0.0836
Mn	18.91	<0.001
Cu	1.62	0.2154

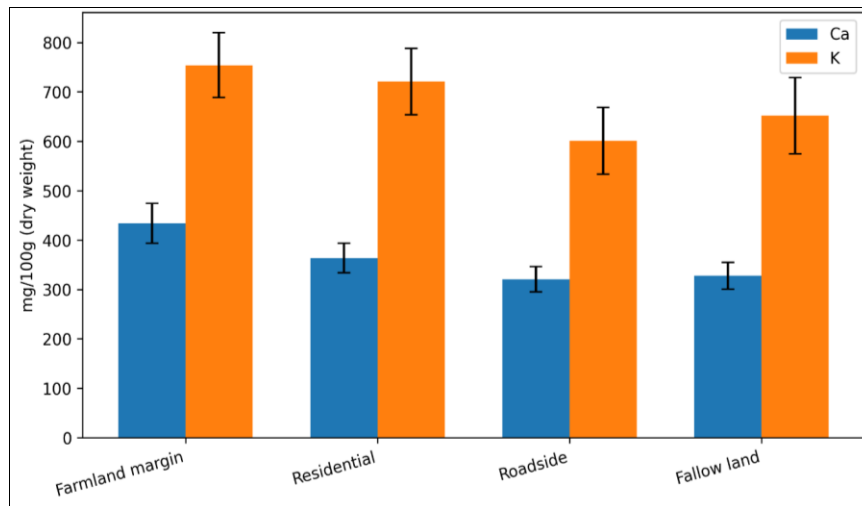


Fig 1: Mean Ca and K concentrations by site (error bars = SD).

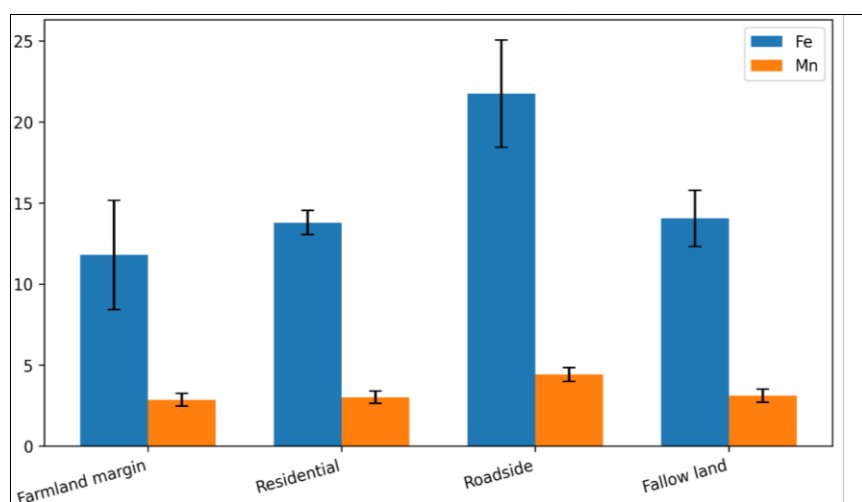


Fig 2: Mean Fe and Mn concentrations by site (error bars = SD).

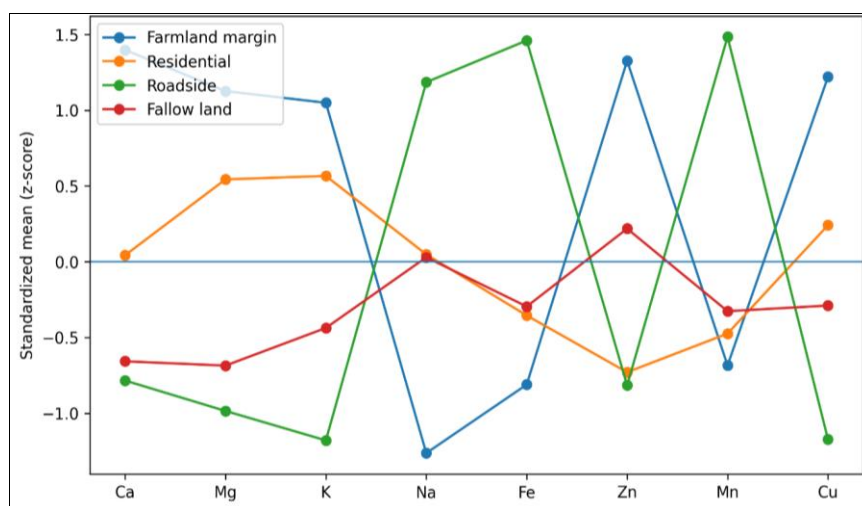


Fig 3 Standardized mineral profiles (z-scores) showing site-specific mineral enrichment patterns.

Discussion: The present research demonstrates that the mineral profile of *Cleome rutidosperma* is strongly influenced by local environmental conditions within Ado-Ekiti, reinforcing the concept that soil-plant interactions play a decisive role in determining the nutritional quality of wild and semi-wild leafy vegetables [4, 11, 14]. Significant variations in both macro- and micro-element concentrations across different collection sites indicate that even within a

relatively small geographic area, environmental heterogeneity can lead to marked differences in plant mineral accumulation. This observation is consistent with earlier reports on underutilized vegetables, which emphasize the sensitivity of mineral uptake to soil fertility status, moisture regime, and land-use practices [3, 15].

Higher concentrations of calcium and potassium in samples collected from farmland margins can be attributed to

improved soil structure and nutrient availability associated with cultivated or previously managed soils ^[14]. Calcium and potassium are essential for plant physiological functions and are often more abundant in soils receiving organic residues or fertilizers, either directly or indirectly ^[11]. Similar trends have been reported for leafy vegetables grown on nutrient-rich soils, supporting the view that agronomic conditions enhance macronutrient accumulation and, by extension, dietary value ^[3]. These findings align with earlier mineral assessments of *C. rutidosperma* in Ado-Ekiti, which reported appreciable levels of major minerals but did not address site-specific variability ^[7].

In contrast, elevated iron and manganese levels observed in roadside environments suggest the influence of localized anthropogenic inputs and altered soil geochemistry ^[5, 6]. Roadside soils are known to accumulate metal particulates from vehicular emissions, dust resuspension, and surface runoff, which can increase the availability of certain trace elements to plants ^[5]. While iron and manganese are essential micronutrients, their accumulation patterns warrant careful interpretation because excessive concentrations may reflect environmental contamination rather than intrinsic nutritional superiority ^[9]. The relatively stable levels of zinc and copper across sites indicate that these elements may be more tightly regulated by plant physiological mechanisms or less variable in the studied soils, as noted in previous soil-plant studies ^[8, 12].

Overall, the findings highlight the importance of considering local environmental context when evaluating the nutritional potential and safety of *C. rutidosperma*. The observed mineral variability underscores the need for site-specific assessment, particularly where wild harvesting is practiced, and supports broader recommendations on monitoring trace element dynamics in edible plants ^[16].

Conclusions: The findings of this research clearly establish that local environmental conditions exert a substantial influence on the mineral composition of *Cleome rutidosperma* growing in Ado-Ekiti, with important implications for its nutritional value, safety, and sustainable utilization. The observed spatial variability in both macro- and micro-elements confirms that the mineral profile of this underutilized leafy vegetable cannot be assumed to be uniform, even within a limited geographic area. Such variation highlights the dynamic interaction between soil properties, land-use history, and environmental exposure, all of which shape the capacity of the plant to accumulate essential nutrients. From a nutritional standpoint, the presence of appreciable levels of calcium, potassium, magnesium, and iron reinforces the potential of *C. rutidosperma* as a valuable dietary resource for local populations, particularly in settings where access to diverse vegetables is limited. At the same time, the differential enrichment of certain trace elements across sites underscores the need for informed harvesting and management practices to ensure both nutritional benefit and consumer safety. Based on these outcomes, several practical recommendations emerge.

First, the promotion of *C. rutidosperma* for household consumption should prioritize plants sourced from farmland margins or managed soils where mineral balance is more favorable and predictable.

Second, uncontrolled harvesting from roadside or heavily disturbed environments should be approached with caution, and routine screening of such sites is advisable before

encouraging consumption, especially when the plant is used frequently or in large quantities.

Third, simple soil improvement practices such as organic matter incorporation and controlled cultivation can be adopted to enhance desirable mineral uptake while minimizing excessive accumulation of potentially problematic elements.

Encouraging small-scale cultivation of *C. rutidosperma* in home gardens or community plots would not only stabilize its mineral profile but also reduce reliance on plants collected from uncertain environments.

Additionally, awareness programs for local farmers, herbal practitioners, and consumers should emphasize the link between growing environment and nutritional quality, enabling more informed choices regarding harvesting locations.

Finally, the results provide a foundation for future agronomic and nutritional interventions aimed at optimizing the mineral composition of *C. rutidosperma*, supporting its integration into local food systems as a safe, affordable, and nutritionally meaningful leafy vegetable.

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