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Studies on Morphological and Nutritional Characteristics of *Amaranthus hybridus* and *Amarathus spinosus* Utilize in Delta State

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Abstract

This study investigated and compared the morphological traits, mineral composition, proximate content, and phytochemical constituents of *Amaranthus hybridus* and *Amaranthus spinosus* cultivated in Agbor, Ika South Local Government Area, Delta State, Nigeria. Morphological characterization involved qualitative analysis of leaf attributes, revealing similarities in leaf colour and venation, but clear differences in leaf length, width, margin, shape, and laminar trichomes between the two species. Mineral profiling was conducted using atomic absorption spectrophotometry. Results showed that *A. hybridus* contained higher levels of calcium (3.31±0.25 mg/g), magnesium (3.16±0.34 mg/g), sodium (20.18±0.66 mg/g), potassium (7.65±0.45 mg/g), phosphorus (1.08±0.10 mg/g), iron (14.22±0.40 mg/g), manganese (9.05±0.20 mg/g), zinc (18.10±0.74 mg/g), and copper (2.12±0.10 mg/g) than *A. spinosus*. Proximate analysis using standard AOAC methods indicated that *A. hybridus* was superior in moisture (80.22±0.10%), crude fibre (1.76±0.25%), ash (2.30±0.38%), fat (5.77±0.21%), and protein (4.17±0.70%), whereas *A. spinosus* had a higher carbohydrate content (10.79±0.46%). Phytochemical screening via spectrophotometric assays revealed greater concentrations of tannins (9.30±0.12 g/100g), saponins (4.92±0.34 g/100g), and flavonoids (53.31±0.40 g/100g) in *A. hybridus*, while *A. spinosus* showed higher amounts of alkaloids (48.92±0.13 g/100g), oxalates (3.03±0.91 g/100g), glycosides (8.60±0.53 g/100g), and phenolics (14.25±0.42 g/100g). The findings affirm both species as rich sources of essential nutrients and bioactive compounds, supporting their dietary, medicinal, and industrial relevance.

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Introduction

The genus Amaranthus, commonly referred to as amaranths or pigweeds, consists of a diverse group of short-lived perennial and annual herbaceous plants that belong to the family Amaranthaceae. These plants are widely distributed across different agroecological zones of the world and are particularly valued in tropical and subtropical regions for their nutritional, medicinal, and agronomic importance (Topno, 2021; Ozimede *et al*., 2019). Globally, Amaranthus is reported to contain approximately 87 species, many of which are cultivated or naturalized in parts of Central and South America, Africa, Asia (notably China and India), and North America (Luis *et al*., 2018; Sukhorukov *et al*., 2021).

Morphologically, amaranths are characterized by their herbaceous nature, displaying growth forms ranging from prostrate to erect stems. The leaves are generally alternate, varying from ovate to linear in shape, with smooth margins and a notched or indented apex. Their flowers are imperfect and arranged in dense compound dichasia that form terminal or axillary inflorescences. The floral structures typically consist of three to five tepals and stamens, a feature common to monoecious plants (Xavier *et al*., 2019; Solís-Fernández *et al*., 2020; Moghadam *et al*., 2021).

Despite their utility, the taxonomy of Amaranthus remains challenging due to several complicating factors, including the presence of minute and often indistinct diagnostic features, wide geographical distribution, and a high degree of interspecific hybridization. These complexities make species-level identification difficult without detailed morphological and genetic analysis. Moreover, Amaranthus exhibits substantial genetic variability among its species. This variability is reflected in plant architecture, leaf and stem pigmentation, inflorescence structure, seed colour, protein content, yield potential, resistance to pests and diseases, and adaptability to diverse environmental conditions, including variations in soil type, pH, moisture content, and photoperiod (Olusanya, 2018; Lin *et al*., 2022; Baturaygil *et al*., 2022).

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The adaptability of amaranths to a broad spectrum of environmental conditions makes them well-suited to regions with marginal soils. They are known to thrive in loamy, sandy-loam, or silty-loam soils with high water-holding capacities and tolerate soil pH levels ranging from 4.5 to 8.0. This versatility allows their cultivation in both high and low fertility soils, making them an ideal crop for low-input farming systems, particularly in sub-Saharan Africa (Jimoh *et al*., 2019; Assad *et al*., 2017; Nazari *et al*., 2023; Zhong *et al*., 2019).

From a nutritional perspective, vegetable amaranths are highly esteemed for their rich micronutrient profiles. They contain significantly higher concentrations of essential minerals such as calcium, iron, phosphorus, and carotenoids compared to many commonly consumed leafy vegetables (Jiménez-Aguilar *et al*., 2017; Chunthawodtiporn *et al.*, 2022). This makes them an important dietary supplement in addressing micronutrient deficiencies, especially in resource-constrained settings. In addition to their nutritional value, several species of Amaranthus exhibit noteworthy pharmacological properties. For instance, *Amaranthus paniculatus* and *Amaranthus cruentus* have been identified as excellent sources of flavonoids; bioactive compounds known for their antioxidant, anti-inflammatory, and cardio-protective effects (Li, 2015). Beyond flavonoids, the seeds of amaranths contain other valuable phytochemicals and industrial components, such as anthocyanin pigments used in non-toxic dyes, microcrystalline starch applicable in food and industrial sectors, and squalene, a specialized lipid with wide usage in pharmaceuticals, cosmetics, and high-tech industries (Nunes *et al*., 2022).

Medical studies have further demonstrated that regular consumption of amaranth seeds or oil may provide health benefits such as lowering blood pressure and cholesterol levels, improving antioxidant status, and enhancing immune function. These attributes make amaranth a promising functional food for the prevention and management of cardiovascular diseases and metabolic disorders (Shoaei-Hagh *et al*., 2021; Chmelík *et al*., 2019). Beyond human consumption, amaranths are also used as livestock feed due to their relatively high protein quality. This dual-purpose nature enhances their value in integrated farming systems where both human food and animal feed are essential (Calabrò *et al*., 2022; Písaříková *et al*., 2018a). In many cultures, especially across West Africa, the leaves, tender shoots, and stems of amaranths are consumed as leafy vegetables, typically incorporated into soups, sauces, and stews (Ray and Ray, 2022).

Despite the considerable body of knowledge on the nutritional, phytochemical, and agronomic value of Amaranthus species, limited studies have explored in detail the comparative morphological and nutritional profiles of specific species, particularly *Amaranthus hybridus* and *Amaranthus spinosus*, in the context of specific agro-ecological zones such as Agbor in Ika South Local Government Area, Delta State, Nigeria. These two species are widely cultivated and consumed in the region, yet empirical data regarding their relative composition remains scarce. Therefore, this study aims to fill this knowledge gap by evaluating the morphological traits, mineral composition, proximate content, and phytochemical constituents of *A. hybridus* and *A. spinosus* cultivated in the study area. The findings will provide valuable insights into their comparative nutritional and medicinal potential and inform both local utilization and broader agricultural and health policy strategies

Materials and Methods

Study Area: The study was conducted in Agbor, Ika South Local Government Area, Delta State, Nigeria (6°15'50.7312" N, 6°12'6.7788" E), a semi-urban agricultural hub approximately 75 miles east of Benin City. Agbor lies within the tropical rainforest zone and experiences a distinct wet and dry season. Rainfall averages about 1905 mm annually, with a humid wet season from March to October and a dry season from November to February.

Fieldwork took place on selected smallholder farms where *Amaranthus hybridus* and *Amaranthus spinosus* are commonly cultivated. The field layout involved sampling from uniformly managed plots with similar soil types, agronomic practices, and organic inputs to ensure consistency in environmental conditions. The soils were primarily loamy to sandy-loam, slightly acidic (pH 5.8–6.5), and free of chemical fertilizers, making them suitable for leafy vegetable cultivation.

Delta State's agroecology supports a wide range of crops including cassava, yams, plantains, mangoes, and leafy greens. Agbor's status as a local food basket and its conducive climate and soil conditions made it an ideal location for assessing morphological and nutritional differences in domesticated Amaranthus species under field conditions

Collection of plant samples: Fresh samples of *Amaranthus hybridus* and *Amaranthus spinosus* were collected from actively cultivated farmlands within Agbor, Ika South Local Government Area, Delta State, Nigeria. The plants were carefully uprooted to retain their morphological integrity and transported in labeled polythene bags for analysis. Species identification and authentication were carried out by a taxonomist in the Department of Biological Sciences, University of Delta, Agbor, to ensure accurate classification

Morphological studies: Morphological characterization of *Amaranthus hybridus* and *Amaranthus spinosus* was carried out using the procedure described by Etukudo and Onu (2021). Features assessed included leaf length, leaf width, leaf shape, leaf margin, presence of trichomes on the lamina, venation pattern, leaf colour, and odour. Observations were made on fresh specimens to ensure accuracy and consistency in species comparison.

Mineral Analysis of *A. hybridus* and *A. spinosus* Leaves: The mineral nutrient content of the leaves of *Amaranthus hybridus* and *Amaranthus spinosus* was determined following standard procedures outlined by A.O.A.C. (1999). Fresh leaves were initially shade-dried for three days and then macerated into smaller fragments. These were subsequently oven-dried at 100 °C for four hours to eliminate residual moisture. The dried samples were ground into fine powder, and 2 grams of each were weighed into porcelain crucibles. The samples were subjected to dry ashing in a muffle furnace at 450 °C for six hours. The resulting ash was acid-digested using 15 ml of concentrated nitric acid (HNO_3) on a hot plate. After digestion, 20 ml of distilled water was added to each crucible to dilute the acid content. The mixtures were then filtered into 100 ml volumetric flasks and brought up to volume with distilled water. The digested and filtered solutions were analyzed for mineral content using Atomic Absorption Spectrophotometry (AAS). Each mineral element was detected at its specific wavelength, using appropriate lamps, electrical currents, and gas mixtures. Elements analyzed included calcium, magnesium, sodium, potassium, phosphorus, iron, manganese, zinc, and copper

Phytochemical and proximate analysis of Leaves of A. *hybridus* and *A. spinosus*: Phytochemical (alkaloid, tannin, flavonoid, saponin, oxalate, phenolics, and glycosides) and proximate (carbohydrate, fat, protein, fibre, ash and moisture) compositions in leaves of *A. hybridus* and *A. spinosus* were analyzed using standard procedures (A.O.A.C., 1999).

Results and Discussion

Morphological characteristics of *A. hybridus* and *A. spinosus*: The morphological characteristics of *Amaranthus hybridus* and *Amaranthus spinosus* are presented in Table 1. Both species exhibited notable similarities in certain features, particularly in leaf colour and venation patterns, indicating a degree of taxonomic closeness. However, significant variations were observed in other morphological parameters, including leaf length, leaf width, trichome distribution on the lamina, leaf margin type, and leaf shape. These differences serve as distinguishing traits that can be employed in species differentiation and classification (Table 1).

Morphological attributes have long been utilized as key indicators in the study of plant taxonomy, physiology, and floristics. Characteristics such as plant height, branching architecture, inflorescence type and size, seed size and colour, and time to maturity have proven useful in identifying intra- and interspecific variations, as well as understanding ecological adaptations (Kumar *et al.,* 2019; Iamonico *et al*., 2023; Etukudo *et al*., 2014). These features often reflect the genetic makeup and environmental responses of plant species, and are especially valuable when molecular data are limited or unavailable. In this study, focus was placed on a number of diagnostic foliar traits, including leaf length and width, shape, margin type, venation, colour, trichome presence on the lamina, and leaf odour. These parameters are widely recognized as practical taxonomic tools in plant identification and classification across various families, particularly in genera like Amaranthus, which are morphologically diverse and often taxonomically complex (Akinlabi and Oladipo, 2021; Adeniran *et al*., 2020).

Understanding these variations is not only crucial for accurate identification but also important in ecological studies, crop improvement, and conservation programs. For instance, differences in leaf surface features such as trichomes may reflect adaptations to environmental stressors, while variations in leaf size and shape can influence photosynthetic capacity and overall plant productivity. Hence, the morphological distinctions observed between *A. hybridus* and *A. spinosus* in this study provide valuable insights into their ecological roles, adaptive strategies, and taxonomic placement

Mineral elements in Leaves of *Amaranthus hybridus and Amaranthus spinosus*

The mineral compositions of *Amaranthus hybridus* and *Amaranthus spinosus* leaves are presented in Table 2. The results show that both species are rich sources of essential macro- and micro-minerals, although *A. hybridus* consistently recorded higher concentrations across all measured elements. Specifically, *A. hybridus* contained elevated levels of calcium (3.31 ± 0.25 mg/g), magnesium (3.16 ± 0.34 mg/g), sodium (20.18 ± 0.66 mg/g), potassium (7.65 ± 0.45 mg/g), phosphorus (1.08 ± 0.10 mg/g), iron (14.22 ± 0.40 mg/g), manganese (9.05 ± 0.20 mg/g), zinc

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(18.10 ± 0.74 mg/g), and copper (2.12 ± 0.10 mg/g) in comparison to *A. spinosus*. This significant mineral enrichment suggests that *A. hybridus* may be a more valuable leafy vegetable for nutritional interventions, particularly in mineral-deficient populations.

Minerals play critical roles in human nutrition and metabolic processes. Calcium, for example, is essential for bone formation, muscle contraction, and nerve transmission. The relatively high calcium content observed in *A. hybridus* corroborates earlier findings by Srivastava (2011), who noted that Amaranthus leaves contain up to three times more calcium than spinach and approximately 20 times more calcium and 7 times more iron than lettuce. Similarly, iron is vital for hemoglobin synthesis and oxygen transport, and its abundance in both species, especially *A. hybridus*, reinforces the role of amaranths in addressing iron-deficiency anemia, particularly among vulnerable groups such as children and pregnant women (Das *et al*., 2012).

Magnesium and potassium, also found in higher concentrations in *A. hybridus*, are vital for cardiovascular health, nerve function, and enzymatic activities. Zinc and copper are essential trace elements involved in immune function, wound healing, and antioxidative defense mechanisms (Randhawa *et al*., 2015). The presence of these minerals in substantial amounts supports the potential of Amaranthus species as functional foods capable of contributing to dietary mineral requirements.

Previous studies have consistently highlighted Amaranthus species as important sources of mineral nutrients. For instance, Maanchi *et al*. (2023) reported that Amaranthus seeds contain between 1300 to 2850 mg/kg of calcium, 72 to 174 mg/kg of iron, 2300 to 3360 mg/kg of magnesium, 160 to 480 mg/kg of sodium, and up to 40 mg/kg of zinc. These values reflect the general mineral richness of the genus and align with the findings of this study. Notably, Maanchi *et al*. (2023), further emphasized the importance of amaranth in addressing both macro- and micronutrient deficiencies, particularly in regions with poor dietary diversity or where access to animal-based food sources is limited. The comparative advantage of *A. hybridus* over *A. spinosus* in terms of mineral content could be attributed to genotypic differences, soil nutrient uptake efficiency, or variations in environmental factors such as soil type and microclimate in the cultivation area. Nevertheless, the findings from this study affirm the nutritional relevance of both species, with *A. hybridus* standing out as a superior source of dietary minerals.

Given the increasing interest in sustainable and plant-based sources of nutrition, especially in developing countries, promoting the consumption of mineral-rich vegetables like *A. hybridus* and *A. spinosus* could play a critical role in enhancing nutritional security. Their cultivation is not only economically viable but also environmentally friendly, requiring low input while yielding nutritionally dense biomass. The rich mineral profiles observed in both species highlight their relevance as nutritionally valuable leafy vegetables with potential applications in public health and nutrition (Velderrain-Rodriguez *et al*., 2014). The consistently higher concentrations of key elements such as calcium, iron, magnesium, and zinc in *A. hybridus* indicate its greater suitability for incorporation into dietary formulations and functional food products targeting mineral deficiency and malnutrition.

Proximate composition in leaves of Amaranthus hybridus and Amaranthus spinosus

The proximate composition of *Amaranthus hybridus* and *Amaranthus spinosus* leaves is presented in Table 3. The analysis revealed that *A. hybridus* exhibited higher values in most proximate parameters compared to *A. spinosus*, particularly in moisture content (80.22 ± 0.10%), crude fibre (1.76 ± 0.25%), crude ash (2.30 ± 0.38%), crude fat (5.77 ± 0.21%), and crude protein (4.17 ± 0.70%). Conversely, A. spinosus was found to contain a higher proportion of carbohydrates (10.79 ± 0.46%). These differences highlight the nutritional variation between the two species and provide insights into their potential uses in food systems and dietary planning.

Moisture content is an important parameter as it influences the perishability and shelf-life of leafy vegetables. The higher moisture content in *A. hybridus* suggests that it may be more prone to spoilage but also implies a higher potential for rehydration and softness, which is desirable in fresh vegetable preparations (Mishra *et al*., 2012). Crude fibre, essential for proper bowel function and digestive health, was more abundant in *A. hybridus*, underscoring its potential as a beneficial dietary component in fiber-deficient diets. Crude ash, an indicator of total mineral content, was also found to be higher in *A. hybridus*, which aligns with the mineral composition data (Table 2). This further supports its superior nutritional profile. Crude fat content, although relatively low in both species, was significantly higher in *A. hybridus*, making it a modest contributor to essential fatty acid intake. Importantly, crude protein levels, central to human nutrition, especially in regions facing protein-energy malnutrition, were greater in *A. hybridus*, suggesting it may be more suitable as a plant-based protein source.

On the other hand, the higher carbohydrate content observed in *A. spinosus* points to its potential role as an energy source. Carbohydrates are a vital

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macronutrient for metabolic energy, and while both species contribute modestly to caloric intake, *A. spinosus* may be particularly beneficial where higher carbohydrate content is nutritionally desirable.

The nutritional value of Amaranthus species has been widely recognized in literature. According to Uusiku et al. (2010), the energy content of Amaranthus leaves ranges between 27 to 53 kcal per 100 g of fresh leaves, with proximate compositions typically comprising 4–6 g of protein, 0.2–0.6 g of fat, and 4–7 g of carbohydrates. These ranges are consistent with the findings of this study and reinforce the significance of Amaranthus species in improving diet quality, especially in low-income communities. Beyond their leaves, Amaranthus seeds have also drawn attention for their superior nutritional content. Several studies (Esan *et al*., 2018; Písaříková *et al*., 2018b) have documented that Amaranthus seeds contain high-quality protein, with elevated levels of lysine (0.73–0.84% of total protein) and sulphur-containing amino acids such as methionine and cysteine—nutrients often deficient in conventional cereals. Although soybean remains richer in protein, Amaranthus serves as an excellent plant-based supplement that can help meet the protein requirements of rapidly growing populations, particularly in developing regions.

In terms of lipids, Amaranthus seeds have been shown to contain 6–20% fat, depending on species and environmental conditions (Petr *et al*., 2003). Importantly, the lipid profile of both seeds and leaves is predominantly made up of unsaturated fatty acids, including palmitic, oleic, linoleic, and linolenic acids, which are essential for cardiovascular health and anti-inflammatory functions (Kanbar *et al*., 2023). These beneficial lipids, though found in lower quantities in leaves compared to seeds, still contribute significantly to the nutritional quality of leafy amaranths. Overall, the proximate composition of *A. hybridus* and *A. spinosus* underscores their nutritional relevance. The superior content of protein, fibre, fat, and ash in *A. hybridus* makes it more nutritionally balanced, while the higher carbohydrate content in A. spinosus enhances its energy-yielding potential. These differences suggest that both species can complement each other in diet diversification strategies aimed at achieving balanced nutrition.

Table 1: Morphological characteristics of *A. hybridus* and *A. spinosus*

Parameters	*A. hybridus*	*A. spinosus*
Leaf colour	Green	Green
Leaf venation	Reticulate or net-like	Reticulate or net-like
Odour	Slightly musty	Earthly or slightly pungent
Leaf length (cm)	Ranged from 6-14	Ranged from 4-9
Leaf width (cm)	Ranged from 2-4	Ranged from 2-3
Trichomes of lamina	Absent	Present
Leaf margin	Entire or smooth	Serrated or toothed
Leaf shape	Simple, alternate and lanceolate to ovate shaped -	Lance- shaped

Table 2: Mineral elements in Leaves of *Amaranthus hybridus and Amaranthus spinosus*

Mineral elements (mg/g)	*Amaranthus hybridus*	*Amaranthus spinosus*
Calcium	3.31±0.25	2.40±0.22
Magnesium	3.16±0.34	3.03±0.40
Sodium	20.18±0.66	16.32±0.52
Potassium	7.65±0.45	6.14±0.50
Phosphorus	1.08±0.10	1.01±0.27
Iron	14.22±0.40	12.30±0.28
Manganese	9.05±0.20	8.63±0.50
Zinc	18.10±0.74	15.03±0.15
Copper	2.12±0.10	1.60±0.27

Mean ± standard error from 3 replicates

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Table 3: Proximate composition in Leaves of *Amaranthus hybridus and Amaranthus spinosus*

Proximate (%)	*Amaranthus hybridus*	*Amaranthus spinosus*
Moisture	80.22 ± 0.10	77.34 ± 0.12
Crude fibre	1.76 ± 0.25	1.20 ± 0.65
Crude ash	2.30 ± 0.38	1.85 ± 0.42
Crude fat	5.77 ± 0.21	5.02 ± 0.37
Crude protein	4.17±0.70	3.80 ± 0.19
Carbohydrate	5.78± 0.54	10.79 ± 0.46

Mean ± Standard error from three replicates

Phytochemical composition in leaves of *Amaranthus hybridus* and *Amaranthus spinosus*

The phytochemical composition of *Amaranthus hybridus* and *Amaranthus spinosus* is presented in Table 4. The analysis revealed that both species are rich in a range of bioactive compounds, although their relative concentrations varied significantly. A. hybridus showed markedly higher levels of tannins (9.30 ± 0.12 g/100 g), saponins (4.92 ± 0.34 g/100 g), and flavonoids (53.31 ± 0.40 g/100 g), all of which are known for their antioxidant, antimicrobial, and therapeutic benefits. On the other hand, *A. spinosus* had higher concentrations of alkaloids (48.92 ± 0.13 g/100 g), oxalates (3.03 ± 0.91 g/100 g), glycosides (8.60 ± 0.53 g/100 g), and phenolic compounds (14.25 ± 0.42 g/100 g), which contribute to the plant's bioactivity and pharmacological potential.

Phytochemicals are naturally occurring compounds in plants that often serve as defense mechanisms against pathogens, herbivores, and environmental stress. However, in human nutrition and medicine, they are increasingly recognized for their health-promoting properties. Tannins, for instance, possess astringent and antimicrobial properties and are effective in treating diarrhea and bleeding-related disorders (Ashok Kumar *et al*, 2011). Their abundance in *A. hybridus* suggests a potential role in gastrointestinal health and wound healing. Saponins are known to exhibit cholesterol-lowering, anti-inflammatory, and immune-boosting activities, while flavonoids function as powerful antioxidants, capable of scavenging free radicals and reducing oxidative stress (Sangameswaran, 2008).

Flavonoids, in particular, have been extensively studied for their cardioprotective, anti-inflammatory, and anticancer effects. The significantly higher flavonoid content in A. *hybridus* underscores its value as a functional food that may contribute to the prevention of chronic diseases such as cardiovascular disorders, diabetes, and certain cancers (Ashok *et al*., 2010).

Conversely, *A. spinosus* demonstrated a higher concentration of alkaloids, which are nitrogen-containing compounds known for their analgesic, anti-malarial, and antimicrobial properties. Although some alkaloids can be toxic at high levels, their controlled intake through dietary sources may provide therapeutic benefits. Oxalates, while commonly found in leafy vegetables, may pose a concern when consumed in excess due to their ability to bind calcium and form insoluble crystals, potentially leading to kidney stones. Nonetheless, their presence in moderate amounts, as observed in *A. spinosus*, is not typically harmful in balanced diets (Joshua *et al*., 2010).

Glycosides, also elevated in *A. spinosus*, have diverse pharmacological effects, including anti-inflammatory and cardioactive properties (Rastogi and Shukla, 2013). Similarly, phenolic compounds are well-documented antioxidants that protect against cellular damage, aging, and inflammation. Their higher concentration in A. spinosus contributes to its potential role in modulating oxidative stress and enhancing immune function. The presence of these phytochemicals aligns with earlier reports that highlight Amaranthus species as a promising source of medicinally relevant compounds. According to Pooja *et al*. (2023), Amaranthus leaves have been traditionally used in the prevention and treatment of a wide range of ailments, including bleeding tendencies, hypertension, diabetes, digestive disorders, liver diseases, skin infections, respiratory illnesses, and

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malnutrition-related conditions such as kwashiorkor and marasmus. Additionally, the leaves have shown efficacy in addressing HIV/AIDS-related immune dysfunction, premature aging, and wound healing (Khongsai *et al*., 2011).

The therapeutic efficacy of Amaranthus has also been supported by modern pharmacological studies. Bang *et al*. (2021) and House *et al*. (2020) noted that the bioactive phytochemicals in Amaranthus species confer antiallergic, antihypertensive, anticancer, and antioxidant properties. These benefits are especially important in the context of increasing demand for natural, plant-based interventions in health care and functional food production. Overall, the differences in phytochemical composition between *A. hybridus* and *A. spinosus* not only offer insights into their nutritional and medicinal value but also highlight their potential applications in nutraceutical development, dietary supplementation, and herbal formulations (Mathur *et al.*, 2010). The varied distribution of phytochemicals suggests that both species could serve complementary roles in promoting health and preventing disease.

Table 4: Phytochemicals in Leaves of *Amaranthus hybridus and Amaranthus spinosus*

Phtochemicals (g/100g)	*Amaranthus hybridus*	*Amaranthus spinosus*
Alkaloid	47.20±0.60	48.92±0.13
Tannin	9.30±0.12	8.18±0.10
Saponin	4.92±0.34	4.70±0.21
Oxalate	2.40±0.20	3.03±0.91
Glycoside	7.51±0.23	8.60±0.53
Phenolics	10.40±0.20	14.25±0.42
Flavonoid	53.31±0.40	48.92±0.31

Mean ± standard error from 3 replicates

Conclusion

This study evaluated the morphological, nutritional, and phytochemical characteristics of *Amaranthus hybridus* and *Amaranthus spinosus* cultivated in Delta State, Nigeria. As widely consumed leafy vegetables, both species are recognized for their dual role in human and animal nutrition. The findings revealed notable differences between the two species across all examined parameters. Morphologically, they exhibited variations in leaf structure and surface features, which are useful for taxonomic differentiation. Nutritional analysis showed that both species are rich in essential minerals; however, *A. hybridus* contained significantly higher concentrations of calcium, magnesium, sodium, potassium, phosphorus, iron, manganese, zinc, and copper compared to *A. spinosus*. Proximate composition analysis further indicated that *A. hybridus* possessed greater amounts of moisture, crude fibre, ash, fat, and protein, while *A. spinosus* had a relatively higher carbohydrate content. In terms of phytochemical constituents, *A. hybridus* was richer in tannins, saponins, and flavonoids, compounds known for their antioxidant and therapeutic properties. Conversely, *A. spinosus* exhibited higher levels of alkaloids, oxalates, glycosides, and phenolics, which also contribute to its pharmacological potential. These findings demonstrate that both species hold considerable nutritional and medicinal value, with each offering unique compositional advantages suitable for dietary and health-related applications.

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