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Original Article:

Nutritional and Phytochemical Profiling of African Star Apple (*Chrysophyllum albidum*) and Lagos Spinach (*Celosia argentea*): Unlocking Their Potential for Human Health

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Abstract

Introduction: Indigenous African plants are increasingly studied as sustainable sources of nutrients and bioactive compounds. Chrysophyllum albidum (African star apple) and Celosia argentea (Lagos spinach) are widely consumed as food and medicine, yet their biomedical potential remains insufficiently explored. This study was designed to comprehensively evaluate their nutritional composition, phytochemical profile, antioxidant capacity, and antimicrobial properties.

Materials and Methods: Ripe fruits of C. albidum and leaves of C. argentea were collected and authenticated. Proximate and micronutrient analyses were conducted using AOAC methods. Phytochemicals were quantified via HPLC and GC-MS. Antioxidant capacity was assessed by DPPH and FRAP assays. Antimicrobial activity against bacteria and fungi was determined by MIC and MBC.

Results: C. albidum had significantly higher levels of carbohydrate (56.3 ± 1.2%) and vitamin C (41.8 ± 2.1 mg/100 g), while C. argentea was richer in protein (23.6 ± 0.9%), calcium (280.7 ± 6.3 mg/100 g), and iron (18.2 ± 0.7 mg/100 g). Phytochemical profiling revealed substantial flavonoids, phenolics, saponins, terpenoids, alkaloids, and carotenoids, with C. argentea showing significantly higher flavonoids and carotenoids contents. Antioxidant assays indicated strong radical scavenging activity (DPPH IC_{50}: C. albidum 42.6 µg/mL; C. argentea 38.2 µg/mL). Both extracts inhibited microbial growth, with MIC values as low as 125 µg/mL against Staphylococcus aureus.

Conclusion: Both plants exhibit nutritional and phytochemical richness, potent antioxidant capacity, and antimicrobial potential. Their integration into diets and nutraceutical development could aid in reducing oxidative stress and microbial infections.

Keywords: Chrysophyllum albidum; Celosia argentea; phytochemicals; antioxidant; antimicrobial; nutrition.

1. Introduction

Functional foods derived from plants are gaining attention as safe and sustainable strategies to prevent nutrition-related disorders and chronic diseases [1]. In sub-Saharan Africa, indigenous plants serve as both dietary staples and medicinal remedies, offering dual nutritional and therapeutic benefits [2]. Among such plants, Chrysophyllum albidum (African star apple) and Celosia argentea (Lagos spinach) are particularly notable for their widespread and traditional use.

C. albidum, a member of the Sapotaceae family, produces fruits consumed during the dry season. The fruit pulp is known for its sweet-sour taste and its richness in sugar, vitamins, and minerals [3]. Traditionally, it has been used to manage malaria, wounds, and infections. C. argentea, a leafy vegetable of the Amaranthaceae family, is cultivated across West Africa. Its leaves are consumed in soups or sauces.Traditional healers also use it for anemia, gastrointestinal disorders, and reproductive health [4, 5].

The nutritional profiling of these plants is important for establishing their contributions to human health. Proximate and micronutrient analyses identify their energy and mineral values, while phytochemical profiling reveals secondary metabolites, such as flavonoids and phenolics, that provide antioxidant and antimicrobial activities [6–8]. Studies have linked plant-derived antioxidants to the reduction of oxidative stress-related conditions such as cardiovascular disease, cancer, and diabetes [9]. Similarly, phytochemicals with antimicrobial activity can provide alternatives to synthetic drugs, especially in the context of antimicrobial resistance [10].

Although some studies have examined these plants individually, a comparative evaluation of their nutritional, phytochemical, antioxidant, and antimicrobial profiles is lacking. This study bridges this gap by comprehensively analyzing C. albidum fruits and C. argentea leaves. The findings will contribute to functional food research, nutraceutical development, and public health nutrition.

2. Materials and Methods

Sample Collection and Authentication

Ripe C. albidum fruits and fresh C. argentea leaves were purchased from a farm market in Southwestern Nigeria. The plant samples were authenticated and voucher specimens were deposited at the Department of Botany, Saadu Zungur University,Bauchi.

Proximate and Micronutrient Analysis

Moisture, ash, protein, fat, fiber, and carbohydrate contents were determined using AOAC standard methods [11]. Micronutrient content was analyzed as follows: iron, calcium, and potassium by atomic absorption spectrometry; vitamin C by titrimetry; and vitamin A by spectrophotometry.

Phytochemical Analysis

Qualitative screening of phytochemicals (alkaloids, flavonoids, tannins, phenolics, saponins, terpenoids, and carotenoids) was performed using standard methods. Quantitative analysis of flavonoids and phenolics was performed by HPLC, while carotenoids were estimated by UV–Vis spectrophotometry. GC-MS was used for metabolite fingerprinting.

Antioxidant Assays

The antioxidant potential of the extracts was assessed using the DPPH radical scavenging assay and the FRAP (ferric reducing antioxidant power) assay. For the DPPH, a 1 mL aliquot of extract at different concentrations (25–200 µg/mL) was mixed with 1 mL of 0.1 mM DPPH solution in methanol. The mixture was incubated in the dark at room temperature for 30 minutes, andabsorbance was measured at 517 nm. The percentage scavenging activity was calculated using the control absorbance, and IC_{50} values were determined. The FRAP Assay, a100 µL extract sample was reacted with 900 µL of FRAP reagent (composed of 300 mM acetate buffer, 10 mM TPTZ, and 20 mM $FeCl_3 \cdot 6H_2O$).The mixture was incubated for 10 minutes at 37°C, andabsorbance was recorded at 593 nm.Results were expressed as µmol ascorbic acid equivalent per gram (µmol AAE/g).

Antimicrobial Assays

Antimicrobial activity was evaluated using the broth microdilution technique following the method descried by [12]. The tested microorganisms included Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, and Candida albicans. Microbial inocula were standardized to 0.5 McFarland turbidity (~1.5×10^8 CFU/mL). Serial dilutions of the plant extracts (1000–62.5 µg/mL) were prepared in sterile 96-well microplates. Following inoculation, the plates were incubated at 37°C for 24 hours for bacteria and at 28°C for 48 hours for fungi. The minimum

inhibitory concentration (MIC) was determined as the lowest concentration showing no visible growth, while the minimum bactericidal concentration (MBC) or minimum fungicidal concentration (MFC) was established by subculturing aliquots from non-turbid wells onto nutrient agar plates to confirm microbial death.

Statistical Analysis

All analyses were performed in triplicate. Results are presented as mean ± standard deviation. Statistical comparisons were conducted using One-way ANOVA, followed by Tukey's test; $p < 0.05$ was considered statistically significant.

3. Results

Proximate composition of C. albidum and C. argentea

C. argentea was significantly higher in protein, fat, fiber, and ash ($p < 0.05$), confirming its value as a nutrient-dense vegetable for protein and mineral supplementation. C. albidum contained significantly higher carbohydrates ($p < 0.05$), making it a high-energy fruit. These differences suggest complementary nutritional roles.

Table 1. Proximate composition of *C. albidum and C. argentea*

Parameter	C. albidum (%)	C. argentea (%)
Moisture	8.4 ± 0.5^{b}	9.6 ± 0.4^{a}
Ash	3.1 ± 0.2^{b}	3.8 ± 0.1^{a}
Protein	7.9 ± 0.3^{b}	23.6 ± 0.9^{a}
Fat	2.8 ± 0.1^{b}	4.2 ± 0.2^{a}
Fiber	4.6 ± 0.2^{b}	5.4 ± 0.3^{a}
Carbohydrates	56.3 ± 1.2^{a}	49.2 ± 1.0^{b}

Values are expressed as mean ± SD (n = 5). Values with different superscript letters (a, b, c) indicate statistically significant differences at $p < 0.05$.

Micronutrient composition of C. albidum and C. argentea

C. albidum had significantly higher vitamin C and potassium ($p < 0.05$), enhancing immune defense and electrolyte regulation. C. argentea was significantly richer in vitamin A, calcium, and iron ($p < 0.05$), indicating strong potential for preventing anemia and bone disorders.

Table 2. Micronutrient composition of *C. albidum and C. argentea*

Nutrient	**C. albidum**	**C. argentea**
Vitamin C (mg/100g)	41.8 ± 2.1^{a}	36.2 ± 1.8^{b}
Vitamin A (µg/100g)	225.4 ± 7.3^{b}	312.1 ± 6.5^{a}
Iron (mg/100g)	12.4 ± 0.5^{b}	18.2 ± 0.7^{a}
Calcium (mg/100g)	198.5 ± 5.2^{b}	280.7 ± 6.3^{a}

Potassium (mg/100g)	312.4 ± 8.6[a]	290.3 ± 7.4[b]

Values are expressed as mean ± SD (n = 5). Values with different superscript letters (a, b, c) indicate statistically significant differences at $p < 0.05$.

Phytochemical composition of C. albidum and C. argentea

C. argentea exhibited significantly higher levels of flavonoids, saponins, terpenoids, alkaloids, and carotenoids ($p < 0.05$), conferring superior therapeutic potential. Conversely, C. albidum showed significantly higher phenolics ($p < 0.05$), consistent with its strong antioxidant properties.

Table 3. Phytochemical composition of *C. albidum and C. argentea*

Compound	C. albidum	C. argentea
Flavonoids	45.2 ± 1.7[b]	62.5 ± 2.3[a]
Phenolics	89.6 ± 3.2[a]	78.4 ± 2.9[b]
Saponins	23.1 ± 0.9[b]	28.9 ± 1.2[a]
Terpenoids	14.3 ± 0.6[b]	19.2 ± 0.8[a]
Alkaloids	11.5 ± 0.5[b]	15.7 ± 0.6[a]
Carotenoids	6.8 ± 0.3[b]	9.5 ± 0.4[a]

Values are expressed as mean ± SD (n = 5). Values with different superscript letters (a, b, c) indicate statistically significant differences at $p < 0.05$.

Antioxidant activity of C. albidum and C. argentea

Both species exhibited strong antioxidant activities. C. argentea demonstrated significantly stronger scavenging and reducing power ($p < 0.05$), suggesting superior potential for oxidative stress reduction.

Table 4. Antioxidant activity of *C. albidum and C. argentea*

Assay	C. albidum	C. argentea
DPPH IC_{50} (µg/mL)	42.6 ± 1.8[b]	38.2 ± 1.6[a]
FRAP (µmol AAE/g)	812.4 ± 25.7[b]	924.5 ± 28.3[a]

Values are expressed as mean ± SD (n = 5). Values with different superscript letters (a, b, c) indicate statistically significant differences at $p < 0.05$.

Antimicrobial activity of C. albidum and C. argentea

Both plants exhibited a notable antimicrobial activity. MIC values were lowest against S. aureus and C. albicans (125–250 µg/mL), confirming their traditional use against infections.

Table 5. Antimicrobial activity of *C. albidum and C. argentea*

Microorganism	C. albidum (µg/mL)	C. argentea (µg/mL)
Staphylococcus aureus	125	125

Escherichia coli	250	250
Pseudomonas aeruginosa	500	500
Candida albicans	250	250

4. Discussion

This study provides a comparative analysis of the nutritional and phytochemical profiles of C. albidum and C. argentea. The proximate data show that C. argentea is rich in protein, consistent with previous studies identifying African green leafy vegetables as affordable protein supplements [13]. In contrast, C. albidum's carbohydrate content supports its role as an energy fruit.

Micronutrient data reveals that C. albidum is a fruit rich in vitamin C and potassium. This finding aligns with its traditional use in enhancing immunity and fluid balance [14]. Conversely, C. argentea's iron and calcium content highlight its potential in preventing anemia and improving bone health [15].

Phytochemical results demonstrate that C. argentea contains higher levels of flavonoids, carotenoids, and alkaloids, compounds known for modulating inflammation and protecting against oxidative damage [16]. On the other hand, C. albidum's higher phenolic content confirms its antioxidant potential, in agreement with findings from other tropical fruits [17].

Antioxidant assays confirm potent radical scavenging and reducing capacities in both species, particularly in C. argentea which can explain its cardioprotective and hepatoprotective properties as documented in traditional medicine [18, 19].

Finally, both species exhibited antimicrobial activity, especially against S. aureus and C. albicans. These results support previous studies on African botanicals as sources of antimicrobial agents, particularly for managing resistant strains [20, 21].

Collectively, these findings demonstrate the functional food potential of C. albidum and C. argentea. Their integration into dietary practices and nutraceutical formulations could help address nutritional deficiencies, oxidative stress, and infectious diseases in African populations and beyond.

5. Conclusion

Chrysophyllum albidum and Celosia argentea are nutrient-rich and phytochemically diverse, exhibiting strong antioxidant and antimicrobial properties. Their consumption, along with further research into their bioactive compounds, is recommended for the development of functional foods and nutraceuticals..

Ethical Considerations

Compliance with ethical guidelines

The study did not involve human or animal subjects. Ethical approval was therefore not required.

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Author's contributions

Conceptualization: Hassan Abdulsalam Adewuyi; Methodology: Khairat Shamsudeen; Data Analysis: Lukman Adeola Usman; Writing – Original Draft: Oyewola Abdulkabir; Writing – Review and Editing: All authors; Supervision: Fatima Mahmoud Muhammad; Data Curation and Analysis: Mba Michael Okechukwu: Adebimpe Hameedah Oluwatoyin: Data Curation and Analysis

Conflict of interest

The authors declare no conflict of interest.

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