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Full Length Research Article

COMPARATIVE ASSESSMENT OF CHLOROPHYLL CONTENT, YIELD PARAMETERS AND NUTRIENTS OF THREE VARIETIES OF COWPEA (*VIGNA UNGUICULATA (*L.) WALP)

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ABSTRACT
Cowpea (*Vigna unguiculata* L.), is a vital crop in sub-Saharan Africa, that contributes significantly to nutrition, food security, and income generation. The varieties abound vary in the bio-productivity and nutritional status, hence the need to evaluate the agronomic performance and nutritional value of the three newly improved cowpea varieties (Sampea 11, Sampea 12, and Sampea 15) that are cultivated in the Northern Savanna zone of Nigeria. In this study, growth parameters chlorophyll content, and yield components were assessed. Additionally, proximate and mineral analyses which provided insights into the nutritional profiles of these varieties were also investigated. Results identified Sampea 15 as the superior variety, in terms of chlorophyll content, seed weight, protein, fat, energy value, sodium, phosphorus, zinc and manganese. These findings underline the potential of Sampea 15 to enhance food security and nutritional outcomes in West Africa, where malnutrition remains a significant challenge. Considering the superiority of Sampea 15 over all other varieties, there is a need for an agricultural extension officer to make this variety known to the farmers for cultivation in the Southern Guinea savanna ecological zone where the study was carried out.

Keywords: Cowpea, Growth Performance, Yield Analysis, Nutritional Composition, Food Security, Sub-Saharan Africa.

INTRODUCTION
Cowpea (*Vigna unguiculata* L.), commonly known as black-eyed pea or southern pea, is a highly versatile legume of the Fabaceae family. It is cultivated for its edible seeds, green pods, and leaves, which provide a rich source of protein, vitamins, and minerals (Dugje *et al.,* 2009). Originating in West Africa, the plant exhibits high adaptability to poor soils, drought conditions, and diverse agro-ecological zones, making it an essential crop in semi-arid regions (Ayangbenro & Babalola, 2021).

Cowpea plants are typically herbaceous annuals that can be erect, semi-erect, trailing, or climbing. Their compound leaves consist of three leaflets, and the plants produce flowers in hues of white, purple, or pale yellow. Pods vary in length, typically ranging from 10 to 110 cm, and contain six to thirteen seeds (Sheahan, 2012). Seeds exhibit considerable morphological diversity in size, shape, and color, which include white, cream, red, brown, or black, often with a characteristic eye spot at the hilum.

The plant has a robust taproot system that enables it to thrive in sandy, nutrient-poor soils and tolerate dry spells. Its nitrogen-fixing ability enriches soil fertility, benefiting intercropping systems with cereals like millet and maize (Kamara *et al.,* 2018). The entire plant is utilized: leaves as vegetables, seeds for human consumption, and haulms as animal fodder.
Cowpea's significance extends beyond agriculture, providing a low-fat, low-cholesterol dietary staple that supports metabolic and health functions. The crop also contributes to sustainable farming by preventing erosion and restoring soil fertility (FAO, 2017).
Cowpea is a versatile and essential legume crop widely cultivated across West Africa. It is a significant source of protein, vitamins, and minerals, playing a crucial role in addressing malnutrition and serving as a staple dietary component in the region (Dugje *et al.,* 2009). Its adaptability to poor soils, drought tolerance, and low input requirements make it a vital crop for resource-limited farmers in semi-arid regions (Ayangbenro & Babalola, 2021). Moreover, its ability to fix atmospheric nitrogen enriches soil fertility, enhancing the productivity of subsequent crops when included in rotation systems (Kamara *et al.,* 2018).

In addition to its agronomic benefits, cowpea offers diverse uses. The seeds, leaves, and pods are consumed directly, while the haulms serve as nutritious fodder for livestock, especially during the dry season (FAO, 2017). Despite its importance, cowpea cultivation faces challenges such as pest infestations, diseases, and declining soil fertility. These constraints can lead to significant yield losses, necessitating research into improved varieties and sustainable farming practices (Ayangbenro & Babalola, 2021).
This study focuses on three improved cowpea varieties, Sampea 11, Sampea 12, and Sampea 15, developed to overcome common production constraints. By assessing their growth, yield, and nutritional composition, the research aims to identify the most promising variety for enhancing food security and supporting sustainable agricultural practices in the Guinea Savanna region of Nigeria. Such an evaluation is crucial for guiding farmers, policymakers, and researchers toward practices and policies that maximize cowpea's potential in addressing food and nutritional security.

MATERIALS AND METHODS

Seed collection and description: Three improved varieties of Cowpea seeds (Sampea 11, Sampea 12, and Sampea 15) were collected from the Institute of Agricultural Research (IAR), Zaria, Nigeria, in a sealed jute bag for this study. The seeds of Sampea 12 were of medium size, brown in colour with black helium and rough seed coats, while those of Sampea 11 and Sampea 15 were of medium size, white in colour with black helium and rough seed coats.

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Study Area: The research was conducted in Ilorin, Kwara State, located within Nigeria's Guinea Savanna zone. The area features an annual rainfall of 600-1200 mm and sandy-loam soil with moderate organic matter content, ideal for cowpea cultivation.

Experimental Design: A randomized complete block design (RCBD) with three replicates was employed. Three cowpea varieties (Sampea 11, Sampea 12, and Sampea 15) were planted and monitored. Morphological parameters, including plant height, number of leaves, and stem girth, were measured biweekly. Reproductive traits, such as days to 50% flowering and pod development, were recorded.

Leaf Chlorophyll Content Analysis: Chlorophyll content was determined using the methods of Coombs *et al.* (1985), with the evaluation done at different stages of growth on the plant flag leaves. One gram of the harvested fresh leaf tissue was weighed, cut into pieces, and placed into a bottle containing 10 ml of absolute ethanol. This was then stored in the dark for two weeks. 1 ml of the filtered extract was then diluted with 6 ml of absolute ethanol, and the absorbance of the chlorophyll solution was measured using a spectrophotometer (Ultrospec 11) at 645 and 663 nm. Chlorophyll a and b content in milligrams of chlorophyll per gram of leaf tissue were estimated using the formula of Arnon (1949).

Yield parameters: Yield components such as number of pods and seeds per plant, pod weight and seed weight per plant, number of seeds per pod, seed weight per pod and pod filling were determined by counting and using Mettler Toledo XP205 weighing balance with precision measurement from 0.01 mg to 200 g.

Proximate composition: Seed quality in terms of proximate and mineral composition were determined from harvested seeds. The moisture, ash, fibre, crude protein, crude fat, and carbohydrate as a measure of proximate composition were estimated according to the method of the Association of official Analytical Chemists (AOAC, 2005). It should be noted that carbohydrate was calculated by subtracting the sum of moisture, ash, protein, crude fat, and crude fibre percentage from hundred. The calorific value in each sample was calculated by multiplying the percentage of protein and carbohydrate by 4 and the percentage of fat by 9.

Mineral quantification: The dried sample (0.5 g) was transferred into the digestion glass tube. Ten milliliters (10 ml) of HNO_3 was added to the sample. The resulting mixture was kept overnight at room temperature. Thereafter, 4.0 ml perchloric acid ($HClO_3$) was added to the mixture and kept in fume cupboard. The temperature was increased gradually stating from 50°C and increasing up to 300°C in the digestion unit. The digestion was achieved in about 70-80 minutes as indicated by the appearance of the white fumes. The mixture was allowed to cooled and transferred into 100 ml volumetric flasks and the volume of the contents were made up to 100 ml with distilled water. The resulting solution was filtered. The filtrate was then used for the mineral determination. Nitrogen (N) was determined using micro Kjeldhal method. Sodium (Na), iron (Fe), magnesium (Mg), zinc (Zn) and copper (Cu) were determined with the use of Atomic Absorption Spectrophotometer (AAS) (Shimazzu, Japan AA- 6200). Other mineral elements such as potassium (K) and phosphorus (P) were determined by Flame Photometer (Bibby Scientific Limited, UK: Model No PFP7) following the method of Allen (1989).

Data analysis: All the data were presented in triplicates (3*n*); Data collected were subjected to One-Way Analysis of Variance followed by a post-hoc LSD (Least Significant Difference) at $p \leq 0.05$.

RESULTS

Soil Characteristics: The experimental soil was sandy-loam with a pH of 7.2 (neutral). Organic matter content was 0.52 %, while essential nutrients, such as nitrogen (0.16 %) and phosphorus (2.67 mg/L), were moderately available (Table 1). However, the soil's cation exchange capacity was low (5.55 cmol/kg), emphasizing the need for organic amendments to optimize crop performance.

Chlorophyll Content

The results of the chlorophyll analysis of the three cowpea varieties revealed some variations with a specific trends (Fig. 1) at different sampling period. At 30 days after planting (DAP) significant differences were no recorded in chlorophylls a and b and total chlorophyll among the varieties. However, Sampea 15 showed higher chlorophyll content when compared to other varieties. At 60 DAP, the same pattern of results were recorded expect that chlorophyll contents was its peak when compared to other times of sampling. Chlorophyll contents at 90 DAP sampling period differed significantly for chlorophyll b and total chlorophyll and during this period Sampea 15 recorded chlorophyll contents when compared to other varieties (Fig. 1). This indicates a superior photosynthetic potential in Sampea 15.

Yield parameters

Table 2 shows the comparison of yield parameters among the three cowpea varieties. Significant differences were observed in all the yield parameters except for pod filling percentage. Among the varieties Sampea 15 exhibited superior bio-productivity in yield components such in terms of number of pods and seeds per plant, pod weight and seed weight per plant, number of seeds per pod, seed weight per pod and this was closely followed by Sampea 15. Lowest values of all the aforementioned parameters were recorded for Sampea 11 (Table 2).

The heatmap as shown in Fig. 2 further gave credence to Sampea 15 as the variety that showed better performance in all the yield attributes that were assessed. The performance was tremendous in parameters such as number of pods per plant (12.00), number of seeds per plant (120.33), pod weight per plant (46.59), and seed weight per plant (39.47) among other varieties. (Fig. 2) as earlier reiterated.

Table 1: Soil physico-chemical properties

Soil profile	Particle Size	Percent Distribution (%)
Physical Properties	Sand	83.52
	Silt	6.18
	Clay	10.3
	Bulk density g/cm^3	1.09
	Total Porosity g/cm^3	0.09
	Textural Class	Sandy-loam
Chemical Properties		
	pH (water, 1:1)	7.2
	pH (KCl, 1:1)	6.8
	Org. M	0.52
	Org. C	0.3
	Ca ($cmol/kg^{-1}$)	0.9
	Mg ($cmol/kg^{-1}$)	1.43
	Na ($cmol/kg^{-1}$)	0.68
	K ($cmol/kg^{-1}$)	0.91
	N	0.16
	Av.P (mg/L)	2.67
	Mn (mg/L)	0.334
	Fe (mg/L)	0.763
	Cu (mg/L)	0.04
	Zn (mg/L)	0.91
	Cd (mg/L)	ND
	Pb (mg/L)	ND
	Ni (mg/L)	0.031
	ECEC (cmol/kg)	5.55

Org. C = Organic Carbon; Org. M = Organic Matter; AV. P = Available Phosphorus; Ca = Calcium; Mg = Magnesium; K = Potassium; Na = Sodium; N = Nitrogen; Mn = Manganese; Fe = Iron; Cu = Copper; Zn = Zinc; Cd = Cadmium; Pb = Lead; Ni = Nickel A1 + H = Exchange Acidity, and ECEC = Effective Cation Exchange Capacity.

Table 2: Comparison of the yield parameters of three varieties of cowpea

Yield parameters	Sampea 11	Sampea 12	Sampea 15	LSD 5%
Number of pods per plant	5.00 ± 0.00^b	5.00 ± 0.58^b	12.00 ± 0.58^a	1.62
Number of seeds per plant	36.67 ± 1.67^b	47.00 ± 7.00^b	120.33 ± 11.35^a	26.83
Pod weight per plant (g)	13.81 ± 0.55^b	17.60 ± 3.12^b	46.59 ± 4.40^a	10.83
Seed weight per plant (g)	11.50 ± 0.53^b	15.18 ± 2.73^b	39.47 ± 4.35^a	10.31
Number of seeds per pod	7.33 ± 0.33^b	9.33 ± 0.33^a	10.00 ± 0.58^a	1.49
Seed weight per pod (g)	2.30 ± 0.11^b	3.00 ± 0.22^a	3.27 ± 0.22^a	0.65
Pod length (cm)	3.88 ± 0.10^c	4.57 ± 0.01^b	4.87 ± 0.01^a	0.20
Pod filling percentage	83.19 ± 0.56^a	86.28 ± 1.40^a	84.36 ± 1.52^a	4.28

Means followed by the same letter within the same row are statistically similar as determined by LSD at $p<0.05$

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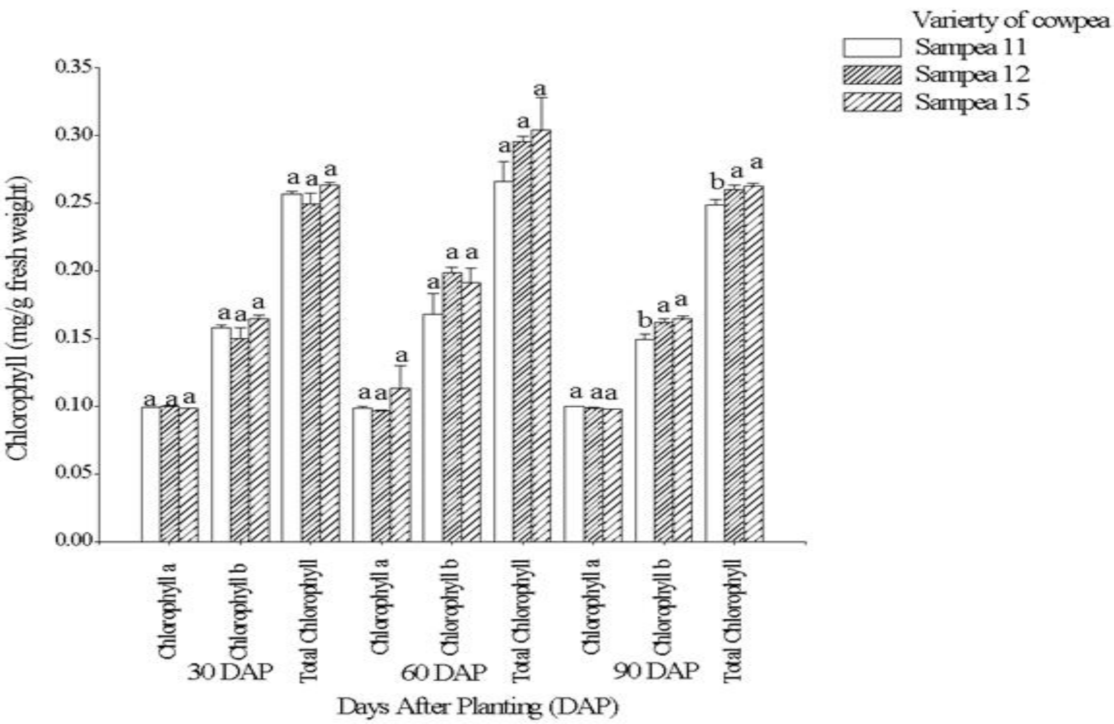

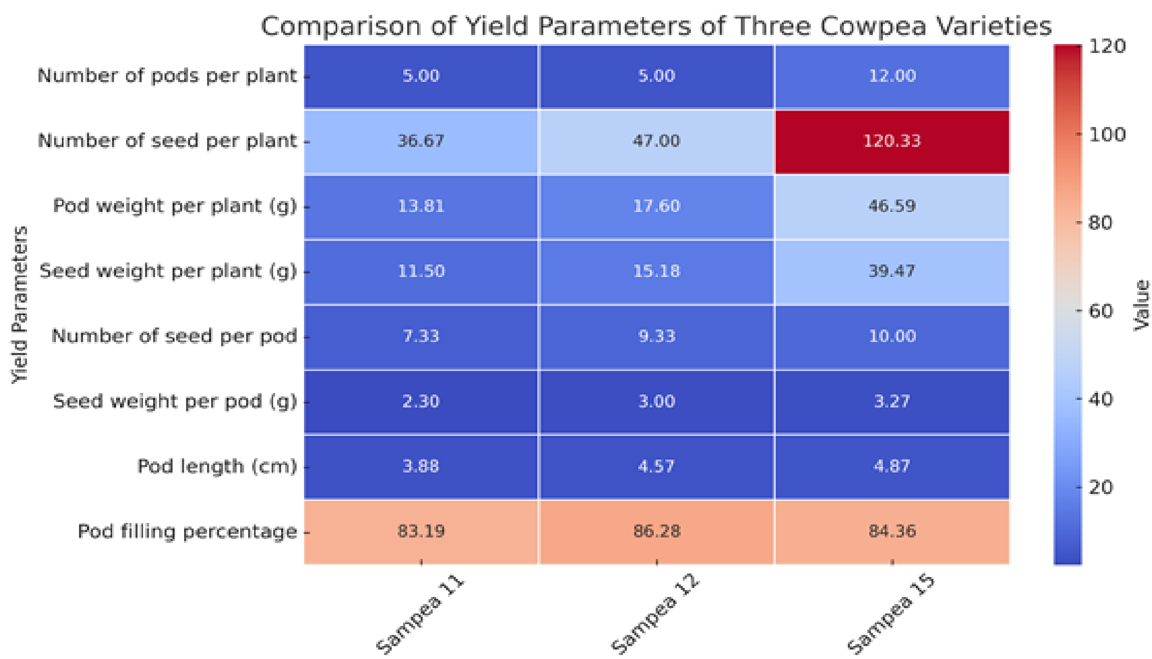

Fig. 2: Heatmap showing the comparison of yield parameters

Nutritional profile: Proximate composition regardless of the varieties differences had a moisture value that ranged from 4.62% to 5.10%, The ranged values for protein, ash, fibre, fat and carbohydrate were 13.70 – 17.25%, 2.87- 3.25%, 5.41-5.83%, 11.59-13.64% and 55.46-60.05% respectively. Among the proximate composition, carbohydrate was highest and followed in decreasing order of magnitude by protein, fat, fibre and ash (Table 3). With respect to varietal differences, Sampea 15 had the highest protein content (17.25 %) and crude fat (13.64 %), making it the most nutritionally dense variety. Sampea 12 had the highest crude fiber and ash contents, while Sampea 11 excelled in carbohydrate content (60.05 %)(Table 3). The energy value of 413.56 kcal recorded in Sampea 15 surpassed the other two varieties.

Macro-element profile: Sampea 15 was richest in sodium (40.85 mg/100g) and calcium (26.60 mg/100g), essential for maintaining electrolyte balance and bone health. Sampea 12 showed the highest levels of potassium (106.99 mg/100g) and zinc (2.20 mg/100g), while Sampea 11 contained more magnesium (29.22 mg/100g) and manganese (1.41 mg/100g). (Table 4).

Micro-element profile: Sampea 15 was richest in sodium (40.85 mg/100g) and calcium (26.60 mg/100g), essential for maintaining electrolyte balance and bone health. Sampea 12 showed the highest levels of potassium (106.99 mg/100g) and zinc (2.20 mg/100g), while Sampea 11 contained more magnesium (29.22 mg/100g) and manganese (1.41 mg/100g). (Table 5).

DISCUSSION

The findings highlight Sampea 15's genetic advantage in optimizing growth and yield parameters. Its rapid growth and early flowering (49 days to 50% flowering) make it suitable for regions with short growing seasons. This will offer an advantage in resource use and timely harvest, as emphasized by previous studies where the significance of early maturing cowpea varieties in improving agricultural productivity was discussed (Owusu *et al.* 2018; Iduh *et al*., 2023).
The significantly higher total chlorophyll content (2.35 mg/g) observed in Sampea 15 as compared to Sampea 11 (2.12 mg/g) and Sampea 12 (2.20 mg/g) indicates a superior photosynthetic efficiency. This photosynthetic efficiency could be said to have contributed to its increased pod and seed production. Previous studies have also reinforced the role of chlorophyll concentration in determining biomass and plant vigour (Karale *et al.* 2024; Ullah *et al.,* 2024).

Nutritionally, Sampea 15 demonstrated the highest protein (17.25%) and crude fat (13.64%) content among the three varieties. This makes it a very valuable food crop in addressing protein-energy malnutrition, especially in regions of high environmental stress such as drought. With a high energy value (413.56 kcal), it is an essential dietary staple, but the low carbohydrate content (55.46%) compared to Sampea 11 (60.05%) suggests that supplementary carbohydrate-rich sources may be required in diets where energy needs are a primary concern to align with nutritional recommendations for balanced dietary formulations in food-insecure regions (Visser *et al.,* 2018).
The mineral profile of Sampea 15 also enhances its dietary significance, with the highest sodium (40.85 mg/100g) and calcium (26.60 mg/100g) concentrations compared to the other varieties. These minerals play crucial roles in electrolyte balance and bone health (Vannucci *et al.,* 2018; Metheny, 2012).

Table 3: Comparison of the proximate compositions of three varieties of cowpea

Proximate composition (mg/100g)	Sampea 11	Sampea 12	Sampea 15	LSD 5%
Moisture content	4.72 ± 0.09[b]	4.62 ± 0.16[b]	5.10 ± 0.01[a]	0.36
Protein	15.70 ± 0.26[b]	16.93 ± 0.06[a]	17.25 ± 0.09[a]	0.56
Total ash content	2.87 ± 0.06[b]	3.25 ± 0.05[a]	3.15 ± 0.05[a]	0.18
Crude fibre	5.09 ± 0.02[c]	5.83 ± 0.05[a]	5.41 ± 0.03[b]	0.14
Crude fat	11.59 ± 0.20[b]	11.75 ± 0.18[b]	13.64 ± 0.11[a]	0.58
Carbohydrates	60.05 ± 0.07[a]	57.65 ± 0.19[b]	55.46 ± 0.23[c]	0.60
Energy value	407.27 ± 0.47[b]	403.99 ± 1.13[c]	413.56 ± 0.43[a]	2.59

Means followed by the same letter within the same row are statistically similar as determined by LSD at $p<0.05$

Table 4: Comparison of the macronutrients of three varieties of cowpea

Mineral element (mg/100g)	Sampea 11	Sampea 12	Sampea 15	LSD 5%
Sodium	33.51 ± 0.08[c]	38.35 ± 0.12[b]	40.85 ± 0.12[a]	0.38
Calcium	21.03 ± 0.13[b]	26.60 ± 0.16[a]	21.10 ± 0.03[b]	0.42
Potassium	104.34 ± 0.71[b]	106.99 ± 0.08[a]	105.42 ± 0.17[b]	1.46
Magnesium	29.22 ± 0.15[a]	28.72 ± 0.27[a]	26.96 ± 0.08[b]	0.63
Nitrogen	2.73 ± 0.01[a]	2.37 ± 0.04[c]	2.51 ± 0.06[b]	0.14
Phosphorus	1.50 ± 0.02[b]	1.71 ± 0.03[a]	1.85 ± 0.06[a]	0.15

Means followed by the same letter within the same row, are statistically similar as determined by LSD at $p<0.05$

Table 5: Comparison of the micro-nutrients of three varieties of cowpea

Mineral element (mg/100g)	Sampea 11	Sampea 12	Sampea 15	LSD 5%
Iron	1.56 ± 0.09[b]	2.20 ± 0.16[a]	1.54 ± 0.01[b]	0.37
Manganese	1.41 ± 0.15[a]	1.49 ± 0.06[a]	1.51 ± 0.02[a]	0.33
Copper	0.30 ± 0.03[b]	0.43 ± 0.03[a]	0.27 ± 0.01[b]	0.09
Zinc	0.87 ± 0.02[b]	0.84 ± 0.03[b]	1.00 ± 0.01[a]	0.06

Means followed by the same letter within the same row are statistically similar as determined by LSD at $p<0.05$

However, the lower magnesium (15.35 mg/100g) and potassium (268.5 mg/100g) levels compared to Sampea 12 (16.12 mg/100g and 275.6 mg/100g, respectively) underscore the need for dietary diversification to ensure optimal micronutrient intake.
Despite its advantages, Sampea 15's lower pod filling percentage (84.36%) suggests potential inefficiencies in resource allocation, warranting further investigation into agronomic practices and environmental conditions that could enhance its yield potential.

Conclusion

Sampea 15 demonstrates superior agronomic performance and nutritional value among the tested cowpea varieties, making it a promising candidate for large-scale cultivation in Nigeria and similar agro-ecological zones. Its adoption could significantly enhance food security and dietary quality, particularly in regions where protein and mineral deficiencies are prevalent. Future research should focus on optimizing cultivation techniques and addressing biotic and abiotic stress factors to maximize its productivity.

REFERENCES

Arnon, D. I. (1949). Copper enzymes in isolated chloroplasts. Polyphenolexidase in Beta vulgaris. *Plant physiology*, 24(1):1.

AOAC. (1990). *Official methods of analysis of the Association of Official Analytical Chemists* (15th ed.). Association of Official Analytical Chemists.

Ayangbenro, A. S., & Babalola, O. O. (2021). Reclamation of arid and semi-arid soils: The role of plant growth-promoting archaea and bacteria. *Current Plant Biology*, *25*, 100173. https://doi.org/10.1016/j.cpb.2020.100173

Coombs, J., Hind, G., Leegood, R.C., Tieszen, L. L. and Vonshak, A. (1985), Analytical Techniques, In: Techniques in Bioproductivity and photosynthesis 2nd ed. (Eds). J. Coombs, D.O. Hall, S.P. Long and J.M.O. Scurlock, pp 219-220.

Dugje, I. Y., Omoigui, L. O., Ekeleme, F., Kamara, A. Y., & Ajeigbe, H. (2009). *Cowpea production handbook*. International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria.

FAO. (2017). *State of food security and nutrition in the world 2017: Building resilience for peace and food security*. Food and Agriculture Organization of the United Nations.

Iduh, M. O., Ekeruo, G. C., Ayeni, O., Koletowo, F. O., & Omoigui, L. (2023). Characterization of Early-Maturing Cowpea (Vigna unguiculata (L.) Walp.) Germplasms Through Association Analysis. https://doi.org/10.1101/2023.12.05.570049

Kamara, A. Y., Ewansiha, S. U., Ajeigbe, H. A., Tofa, A. I., & Omoigui, L. O. (2018). Genetic and agronomic approaches to improving cowpea productivity in semi-arid West Africa: A review. *Experimental Agriculture, 54*(4), 629-650. https://doi.org/10.1017/S0014479717000381

Metheny, N. (2012). *Fluid and electrolyte balance*. Jones & Bartlett Publishers.

Owusu, E. Y., Akromah, R., Denwar, N. N., Adjebeng-Danquah, J., Kusi, F., & Haruna, M. (2018). Inheritance of early maturity in some cowpea (Vigna unguiculata (L.) Walp.) genotypes under rain fed conditions in Northern Ghana. *Advances in agriculture*, *2018*(1), 8930259.

Sheahan, C. M. (2012). *Plant guide for Vigna unguiculata (cowpea)*. USDA-Natural Resources Conservation Service, Cape May Plant Materials Center. Retrieved from https://plants.usda.gov

Ullah, Q., Ishaq, A., Ahmed, F., Nisar, I., Memon, S. U. R., Abubakar, M. & Qasim, M. (2024). Impact of Copper on Spectral Reflectance and Biomass Accumulation in Spinach Samples. *Global Journal of Arts Humanity and Social Sciences*, 4(8): 516-524. DOI: 10.5281/zenodo.13169780

Vannucci, L., Fossi, C., Quattrini, S., Guasti, L., Pampaloni, B., Gronchi, G. & Brandi, M. L. (2018). Calcium intake in bone health: a focus on calcium-rich mineral waters. *Nutrients*, *10*(12), 1930.

Visser, J., McLachlan, M. H., Maayan, N., & Garner, P. (2018). Community-based supplementary feeding for food insecure, vulnerable and malnourished populations–an overview of systematic reviews. *Cochrane Database of Systematic Reviews*, 11.