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Comparative Assessment of Agronomic Traits and Biochemical Profiles of Five Cowpea (*Vigna Unguiculata* (L.) Walp.) Varieties Cultivated in Abeokuta, Nigeria

***Odutayo, Victoria Titilope**

Department of Plant Breeding and Seed Technology, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria.

*Corresponding authors' email: ajibodetitilopemi@gmail.com

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ABSTRACT
This study evaluated the agronomic performance and biochemical composition of five cowpea (*Vigna unguiculata* L. Walp) varieties: Drum, Botoro, Oloyin, Ife-Brown, and IT04K-332-1. Cultivated under field conditions using a randomized complete block design (RCBD) with three replications, all varieties received uniform management practices. Data were collected on key agronomic parameters, including seed yield, 100-seed weight, pod length, branching, and pod count per plant. Subsequent proximate analysis determined moisture, dry matter, crude fat, ash, crude fibre, and crude protein content. Significant differences ($p<0.05$) were observed across all agronomic and biochemical traits among the varieties. The improved variety IT04K-332-1 produced the highest seed yield (272.00 g/plot), whereas Botoro recorded the lowest yield (9.50 g/plot). Conversely, Botoro exhibited the highest crude protein content, while IT04K-332-1 had the lowest. A positive correlation was found among crude protein, dry matter, branching, and 100-seed weight, but crude protein was negatively correlated with overall seed yield. This inverse relationship indicates a distinct trade-off between nutritional quality and grain production. Consequently, IT04K-332-1 is recommended for commercial farmers seeking maximum grain yield, while Botoro is recommended for targeted high-protein nutritional applications.

Keywords: Cowpea (*Vigna unguiculata*), Agronomic traits, Proximate, Varietal performance

INTRODUCTION

Cowpea (*Vigna unguiculata* L. Walp.) is one of the most ancient and economically important food legumes cultivated across tropical and subtropical regions of the world. It plays a pivotal role in ensuring food security, soil fertility enhancement, and income generation for smallholder farmers, particularly in sub-Saharan Africa (Kim *et al.,* 2025). Nigeria is recognized as the world's largest producer and consumer of cowpea, accounting for nearly 39 % of global production, where it serves as a vital source of affordable dietary protein and essential micronutrients (Boukar *et al.,* 2022).

Cowpea belongs to the family Fabaceae and is well adapted to marginal soils, drought prone environments, and high temperatures, making it particularly suited to the arid and semi-arid zones of West Africa (Poudel *et al.,* 2025). The crop's ability to fix atmospheric nitrogen, improve soil structure, and reduce erosion through its ground covering canopy enhances its role in sustainable agricultural systems (Mekonnen *et al.,* 2022)

In southwestern Nigeria, cowpea is cultivated for multiple purposes including grain, tender leaves, and green pods used as vegetables. Beyond human consumption, the crop residues serve as livestock feed and organic manure, contributing significantly to integrated crop livestock systems (Omomowo and Babalola, 2021). The seeds are rich in protein (24-26 %), carbohydrates (60-65 %), and dietary fiber (5-7 %), as well as minerals such as iron, zinc, and phosphorus (Mune *et al.,* 2024). These nutritional properties make cowpea a key dietary component in regions where access to animal protein is limited.

Despite its importance, cowpea productivity remains constrained by several biotic and abiotic factors. Insect pests such as *Callosobruchus maculatus* (F.) cause severe damage during post-harvest storage, leading to weight loss, reduced germination, and deterioration of nutritional quality (Kalpna *et al.,* 2022). Similarly, environmental stresses like drought, heat, and poor soil fertility further limit yield potential (Oliveira *et al.,* 2024). Recent research efforts have focused on evaluating varietal performance to identify high-yielding, nutritionally superior, and stress-tolerant genotypes that can thrive under local production environments (Popoola *et al.,* 2022)

Given the importance of cowpea in enhancing food and nutritional security, there is a need for continuous evaluation of both agronomic and biochemical characteristics of available varieties. Such studies are essential to guide breeding programs, promote adoption of improved cultivars, and optimize production under local agro-ecological conditions. The present study aims to evaluate the agronomic performance and biochemical composition of five cowpea varieties cultivated in Abeokuta, Southwestern Nigeria.

MATERIALS AND METHODS

Experimental site- This study was carried out at the Teaching and Research Farm Directorate (TREFAD) and the Department of Biology Laboratory of the Federal University of Agriculture, Abeokuta, (FUNAAB), Ogun State.

Source of Planting Material -Seeds of five varieties of cowpea (Oloyin, Drum, IT04K-332-1, Ife-Brown and Botoro) used for the study were sourced from International Institute of Tropical Agriculture (IITA), Ibadan, Oyo State.

Land preparation and planting-The land used was ploughed and harrowed; thereafter fifteen plots measuring 2m by 4m bed were constructed for the study i.e., five varieties (treatments) and three replicates of each. Spacing for planting was 75cm by 50cm and 3 seeds were planted per hole. This was later thinned to two plants per stand after 4 weeks of planting. The planting was done manually with aid of cutlass.

Experimental Design- The experimental design used was laid out as a Randomised Complete Block Design with five (5) cowpea varieties and three replications.

Data Collection

Assessment of Agronomic Parameters

Data were collected from the two inner rows of each plot to avoid border effects and ensure that the observations reflected normal plant growth. The total number of plants that established and remained until maturity was counted and recorded as the number of stands per plot. From each plot, five plants were randomly selected to represent the population, and these plants were used for all plant-based measurements. For each selected plant, the number of branches was counted to assess vegetative growth. Pod length (cm) was measured using a digital measuring ruler by selecting fully matured pods from the sampled plants and measuring from the base to the tip. The total number of pods produced by each sampled plant was counted, and the average value per plot was calculated to represent the number of pods per plant. At harvest, pods from the sampled plants were carefully threshed, and the seeds obtained were weighed using a digital sensitive balance to determine seed yield per plant (g plant^{-1}). To determine the 100-seed weight (g), one hundred seeds were randomly taken from the cleaned seed sample of each plot and weighed. This parameter served as an indicator of seed size and density.

Determination of biochemical/proximate composition of cowpea seed

The proximate composition of the cowpea seeds was analysed to determine their moisture, dry matter, ash, crude fiber, crude fat, crude protein, and carbohydrate contents. All analyses were carried out in triplicate using standard procedures described by the AOAC (2016).

Moisture and dry matter content- Moisture content was determined using the oven-drying method. About 2 g of finely ground sample was weighed into a pre-dried porcelain dish and placed in a hot-air oven at 105 °C for four hours until a constant weight was achieved. The dish was then cooled in a desiccator and reweighed. The reduction in weight represented the moisture loss. The dry matter content of each sample was calculated as the proportion remaining after moisture loss.

Ash content- Ash content was determined by ashing the sample in a muffle furnace. A known weight of the dried sample was placed in a porcelain crucible, charred gently to remove smoke, and then incinerated at 600 °C for two hours. After cooling in a desiccator, the weight of the remaining ash was recorded. This represents the total mineral content of the sample.

Crude fiber content- Crude fiber was determined by subjecting the sample to acid and alkali digestion. One gram of the ground sample was boiled under reflux in a prepared digestion reagent for about forty minutes. The mixture was filtered and thoroughly washed with hot water and a little methylated spirit to remove soluble materials. The remaining residue was dried in an oven at 105 °C, cooled, and weighed. It was then placed in a muffle furnace at 600 °C to burn off the organic matter, cooled again, and reweighed. The difference between the two weights represented the crude fiber fraction.

Crude fat content- Crude fat was extracted using the Soxhlet extraction technique. Two grams of the sample was placed in an extraction thimble and extracted with petroleum ether (boiling range 40–60 °C) for six hours. The solvent was evaporated after extraction and the flask containing the extracted lipid was dried, cooled, and reweighed. The weight of the recovered oil corresponded to the crude fat content of the sample.

Crude protein content- Crude protein was estimated using the Kjeldahl method. The sample was digested in concentrated sulphuric acid with a catalyst mixture until a clear solution was obtained. The digest was diluted and distilled with sodium hydroxide to liberate ammonia, which was absorbed in boric acid and later titrated with standard hydrochloric acid. The amount of nitrogen obtained from the titration was converted to crude protein using a standard conversion factor.

Carbohydrate content- Carbohydrate content was obtained by difference, that is, by subtracting the sum of moisture, ash, crude fiber, crude fat, and crude protein values from 100%.

RESULTS AND DISCUSSION

The performance of the five cowpea varieties differed significantly across the traits assessed. As shown in Table 1, Botoro, Drum, Ife-Brown, and Oloyin produced more branches compared to IT04K-332-1, indicating stronger vegetative growth in these varieties. However, this did not translate into higher yield. The highest seed yield was recorded in IT04K-332-1 (272.00 g/plant), which also produced one of the highest numbers of pods. In contrast, Botoro had the lowest seed yield (9.50 g/plant) despite having the largest seed size, as indicated by its highest 100-seed weight (27.50 g). Pod length also varied significantly among the varieties, with Botoro producing noticeably shorter pods than the others. Dry matter content was highest in Botoro and lowest in IT04K-332-1.

The differences observed among the five cowpea varieties clearly show that genetic background plays a major role in determining their growth performance and nutritional qualities. This agrees with previous findings that cowpea exhibits a wide range of variation in both agronomic and biochemical traits due to genotype differences (Singh *et al.,* 2002; Timko and Singh, 2008). In this study, although Botoro, Drum, Ife-Brown and Oloyin produced more branches, this did not lead to higher yield. Instead, IT04K-332-1 produced the highest seed yield primarily because it formed more pods. The strong positive correlation between number of pods and seed yield confirms that pod production is one of the most reliable indicators of yield potential in cowpea, as highlighted in earlier work by Muchero *et al.* (2010) and Boukar *et al.* (2019).

Botoro, on the other hand, produced fewer seeds but with the highest crude protein content and the heaviest seed weight. This suggests that the variety channels more of its resources into producing nutrient-dense seeds rather than producing a large number of seeds. This pattern reflects a common yield–protein trade-off reported in legumes, where increasing yield often results in lower protein concentration and vice-versa (Igbasan and Guenter, 1996; Shegro *et al.,* 2010). The positive association observed between crude protein, dry matter and 100-seed weight supports this, and similar findings have been noted in seed quality studies in cowpea (Mamiro *et al.,* 2011).

Table 1: Mean Yield Attributes Evaluated for Five Cowpea Varieties

Variety	Number of branches	Number of pods	Pod length (cm)	100-seed weight	Dry matter	Seed yield (g/plant)
Botoro	4.83a	2.80b	6.60b	27.50a	95.67a	9.50c
Drum	4.93a	6.40ab	13.15a	26.67a	94.06c	50.50cb
Ife-Brown	4.80a	11.90a	12.05a	17.50b	93.47d	136.50b
IT04K- 332 -1	4.13b	11.93a	13.73a	16.67b	89.82e	272.00a
Oloyin	4.73a	2.80b	11.53a	18.00b	94.87b	132.33cb

Mean followed by different letters in a column are significantly different.

The results of the proximate composition are presented in Table 2. Moisture content was highest in IT04K-332-1 and lowest in Botoro, while dry matter showed the opposite trend. Fat content was highest in IT04K-332-1, although it did not differ significantly from that of Botoro, Drum, and Oloyin. Oloyin contained the highest ash content, suggesting a relatively higher mineral concentration, while IT04K-332-1 recorded the lowest value. Crude fiber varied moderately among the varieties, with Botoro having the highest value. Botoro also had the highest crude protein content (23.14%), while IT04K-332-1 had the lowest. Meanwhile, Drum and Oloyin contained the highest carbohydrate levels.

Table 2: Mean Proximate Composition for Five Cowpea Varieties

Variety	Moisture (%)	Dry matter (%)	Fat (%)	Ash (%)	Crude fiber (%)	Protein (%)	Carbohydrate (%)
Botoro	3.68e	95.67a	1.84ab	3.64ab	4.30a	23.14a	47.19b
Drum	5.57c	94.06c	1.90ab	3.42bc	4.07b	22.36bc	60.85a
Ife– Brown	5.93b	93.47d	1.78b	3.45bc	4.14b	22.27c	60.58a
IT04K- 332 -1	9.56a	89.81e	2.03a	3.35c	3.86c	21.36d	57.67ab
Oloyin	4.52d	94.87b	1.87ab	3.73a	4.14b	22.56b	62.06a

Mean followed by different letters in a column are significantly different.

At 2 weeks after planting (WAP), none of the evaluated cowpea varieties had initiated branch development, resulting in a uniform mean branch count of 0.00 across all treatments. Branching commenced by 4 WAP, with mean branch numbers ranging from 1.07 in Botoro to 3.53 in Ife Brown. By 6 WAP, branch development accelerated across all varieties, ranging between 3.73 in Ife Brown and 4.80 in Botoro. Despite these numerical variations, analysis of variance indicated no statistically significant differences ($p<0.05$) among the five varieties during these early growth stages (2, 4, and 6 WAP). However, a statistically significant difference ($p<0.05$) in branching capacity emerged by 8 WAP. The improved variety IT04K-332-1 produced significantly fewer branches (4.13) compared to the remaining four varieties. In contrast, Drum (4.93), Botoro (4.80), Ife Brown (4.80), and Oloyin (4.73) exhibited statistically similar branching levels, all belonging to the same significance grouping.

Table 3: Mean Number of Branches Evaluated for Five Varieties of Cowpea

Variety	Number of branches 2wks	Number of branches 4wks	Number of branches 6wks	Number of branches 8 wks
Botoro	0.00	1.07	4.80	4.80a
Drum	0.00	3.00	4.67	4.93a
Ife Brown	0.00	3.53	3.73	4.80a
IT04K-332-1	0.00	3.47	4.13	4.13b
Oloyin	0.00	3.47	4.73	4.73a

Mean followed by different letters in a column are significantly different.

The relationships among the agronomic and nutritional traits are summarized in Table 4. The number of pods showed a strong positive correlation with seed yield. In contrast, the number of branches showed a negative relationship with seed yield, indicating that producing more branches did not contribute to higher yield. Moisture content showed negative correlations with crude fiber, crude protein, and dry matter, suggesting that seeds with high moisture content tended to have lower nutrient density. Crude protein was positively associated with both dry matter and 100-seed weight, but negatively associated with seed yield.

The variation in carbohydrate content among the varieties indicates different nutritional strengths. Drum and Oloyin, which had the highest carbohydrate values, may be more suitable in diets where cowpea serves primarily as an energy source. Conversely, Botoro, with its high crude protein and fiber levels, may be more beneficial in communities where protein intake is limited or where cowpea is used in complementary foods. Previous research has shown that such nutritional variability among cowpea varieties can be influenced by genotype, soil fertility conditions and nitrogen fixation efficiency (Reddy *et al.,* 2017; Owade *et al.,* 2020).

The differences in moisture and dry matter content also have practical implications for storage. The lower moisture and higher dry matter values recorded in Botoro and Oloyin suggest that these varieties may store better and be less prone to spoilage. In contrast, IT04K-332-1 may need more careful drying and handling after harvest to maintain quality. This agrees with earlier findings that cowpea storage quality improves as seed moisture decreases (Omoikhoje, 2008).

Generally, the results show that no single variety excelled in all traits. IT04K-332-1 is best suited for farmers aiming for high yield. Botoro is the strongest candidate for improving dietary protein intake. Drum and Oloyin are better suited for providing energy in daily diets. This means that the choice of variety should depend on specific production target, nutritional need or market demand. Importantly, the contrasting strengths of IT04K-332-1 (high yield) and Botoro (high protein and nutrient density) suggest that using them together in breeding programs may help balance yield and nutritional quality.

Table 4: Correlation Coefficients among Characters Evaluated For Five Cowpea Varieties

	Number of pods	Pod length (cm)	Moisture (%)	Fat (%)	Ash (%)	Crude fiber (%)	Carbohydrate (%)	Crude protein (%)	Dry matter (%)	100-seed weight (%)	Seed yield (g/plant)
Number of branches	-0.31	-0.13	-0.68**	-0.05	0.19	0.57*	-0.15	0.57*	0.70**	0.51	-0.55*
Number of pods		0.41	0.57*	-0.01	-0.33	-0.52*	0.3	-0.59*	-0.59*	-.056*	0.74**
Pod length			0.623*	0.49	-0.08	-0.65**	0.12	-0.57*	-0.53*	-0.31	0.50
Moisture				0.38	-0.28	-0.87**	0.17	-0.85**	-0.97**	-0.51	0.74**
Fat					0.53*	-0.13	-0.3	0.06	-0.18	0.20	0.31
Ash						0.56*	-0.19	0.65**	0.45	0.29	-0.07
Crude fiber							-0.32	0.96**	0.91**	0.57*	-0.64*
Carbohydrate								-0.34	-0.23	-0.49	0.26
Crude protein									0.93**	0.67**	-0.62*
Dry matter										0.59*	-0.72**
100-seed weight											-0.58*

CONCLUSION

The study showed significant variation among the cowpea varieties, with IT04K-332-1 producing the highest seed yield while Botoro had superior protein and dry matter content. Therefore, IT04K-332-1 is recommended for high-yield production, whereas Botoro is recommended for nutritional improvement and can be used as a parent in breeding programmes aimed at combining yield and protein quality.

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