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ASSESSMENT OF THE MORPHOLOGICAL CHARATERISTICS AND YIELD OF TEN GROUNDNUT (*Arachis hypogaea L.*) VARIETIES GROWN IN WUKARI, SOUTHERN GUINEA SAVANNAH AGRO-ECOLOGICAL ZONE

By

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Abstract

This study evaluated the morphological characteristics and yield potentials of ten groundnut (Arachis hypogaea L.) varieties cultivated in Wukari, Taraba State, Nigeria, with the aim of assessing their genetic variability and nutritional composition. Conducted at the Federal University Wukari Teaching and Research Farm, the experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The analyses of proximate compositions of lipid, protein, carbohydrate, fiber, ash, and moisture content, indicated significant morphological diversity among the groundnut varieties; where Door possessed the highest lipid (40.80%) and protein (22.26%) contents, while Kampala recorded the highest protein content at 25.46%. Further, agronomic analysis revealed highly significant differences ($p < 0.05$) in days to 50% flowering, days to 95% maturity, and number of branches, reflecting substantial genetic variability among the varieties assessed. Notably, Erikasa produced the longest seed size (3.70 mm), while Dama recorded the highest 100-seed weight of 36.00 g. Thus, the study recommends the exploitation of the potential of Erikasa and Dama for breeding programmes that are targeted at enhancing yield in groundnut, alongside Door and Kampala for improving nutritional quality in Wukari.

Keywords: *Groundnut, Morphological characteristics, Yield components, Nutritional composition, Genetic variability, Wukari.*

INTRODUCTION

Groundnut (Arachis hypogaea L.) is an important grain legume that grows in wet conditions in semi-arid regions of the world (Singh, 2015). As a major crop in most of the tropical and subtropical regions, groundnut ranks 12th in the world crop production. It is grown in all continents with a total area of 24.6 million hectares, and a production of 41.3 million tons in 2012 (FAO, 2018). Africa, with 11.7 million hectares of land used for groundnut production and 10.9 million tons of annual production in 2012 is second only to the American continent (FAO, 2018). Despite this second position in terms of groundnut production, Africa has the lowest average yield per hectare (1ton ha-1) compared to Asia (1.8 tons ha-1) and America (3 tons ha-1). These low yields related not only to the rain fed production systems combined with very low input but also to the use of traditional varieties that, despite their genetic diversity, are low yielding. Several studies have shown that there is a large agro-morphological diversity in groundnut. This large diversity has led to the distinction of two sub-species: A. hypogaea and A. fastigiata. These subspecies are distinguished primarily by their port, usually crawling in hypogaea and erected in fastigiata, the absence of flowers on the main axis in hypogaea and the difference in leaf color: Dark green in hypogaea and light green in fastigiata (Fonceka, 2020). Both subspecies were themselves divided into several botanical groups including several commercial types. Groundnut plays a key role in African farming systems, including savanna zone, in rotation or in combination with staple crops. Generally, groundnut provides both food for humans and feed for livestock. In addition, it is used as fuel and also contributes to environment protection through nitrogen fixation. It also provides an additional source of income as a cash crop (NARP, 1993). Globally, in 2007, groundnut production volume representing 10% of the production of oilseeds, accounted for a turnover of about $ 17 billion (Foncéka, 2010). Worldwide, groundnut was produced 45.22 million tons from 25.44 million ha with an average yield of 1.77 t ha–1 (FAO, 2018). The crop is the second most important cultivated food legume and the fourth

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largest edible oilseed crop in the world (Shilman *et al*. 2021). The seeds have palmitic, oleic and linoleic acids accounting for about 90% of total fatty acids at seed maturity (Shilman *et al*., 2011). Groundnut seeds with high oleic acid provide lower rate of oxidation and less painty flavor in storage, causing higher acceptability for marketing (Mozingo *et al*., 2004). Groundnut is also a valuable source of vitamins E, K, and B (the richest source of thiamine and niacin) and other essential minerals (Kassa *et al*., 2019). Groundnut cake, after oil extraction, is especially used for animal feeding with high protein content (Savage and Keenan, 1994). Studies indicated that consuming groundnut at least four times a week showed a 37% reduced risk of coronary heart disease (Suchoszek-Lukaniuk *et al*., 2011) and anticancer activity with 50% inhibition of the proliferation of related leukemia cells (Hwang *et al*., 2018). Evaluation of genetic resources is a key step towards efficiency in utilization of these resources through introduction of new genes as well as for their maintenance (Ibirinde *et al*., 2022). In addition, the evaluation and characterization of the collection on the basis of morphological and agronomic traits are the starting point of any breeding program (Fundora, 1998). There are several reports on breeding for varieties adapted to abiotic and biotic stresses to alleviate the major constraints in groundnut production (Ntare and Waliyar, 2019).

MATERIALS AND METHODS

Experimental Site

The experiment was conducted during the 2023/2024 cropping seasons at the Federal University Wukari, Teaching and Research Farm, located in Taraba State, Nigeria. The site has a tropical climate with a mean annual rainfall of about 1,200 mm and a mean annual temperature of about 27°C. The soil is sandy-loam with an average organic matter and nutrient content. The site is suitable for arable crop cultivation as it receives adequate rainfall during the growing season and has moderate drought stress during the post-flowering stages.

Genetic and other Experimental Materials

Ten groundnut varieties (Door, Annyian, Akpom, Shator, Goja and Banada), sourced from Ukum; (Kampara, Dama and Erikasa), from Jalingo; and (White), from Wukari respectively. Other materials used include the weighing balance, measuring tape, oven, and statistical software for data analysis. These materials aided in measuring various aspects of the maize plants' growth, physiology, and environmental conditions

Land preparation

The land was mapped out into a gross plot size 4m x 9m (178.5). The land was cleared, harrowed and ridged. The groundnut seeds was sown at inter row spacing of 75cm and intra row spacing of 50cm.

Data Collection

Different data were taken at different stages of growth and harvest, such as growth parameters and seed parameters at reproductive stage. Data was collected on the following parameters;

Growth Parameters

i. **Days to flowering (DF);** Number of days to the flowering of the planted groundnuts
ii. **Days to 50% flowering (DF50%);** Number of days to 50% flowering of the planted groundnuts seeds
iii. **Days to 95% maturity (DM95%);** Number of days to 95% maturity of the groundnuts varieties planted
iv. **Plant height measurement (PH);** Plant height was measured using meter rule
v. **Number of branches (NoB);** The number of branches was counted manually and recorded

Crop yield measurement

The following quantitative data were collected:

i. **Length of groundnut seed (LGS);** the length of the groundnut seed was measured with the used of metre rule and recorded.
ii. **100-seed weight (g);** The weight of 100-seed of groundnut was measured using a weighing balance
iii. **Seed weight (kg/ha);** The seed weight (kg/ha) of the groundnut seed was measured using a weighing balance
iv. **Weight of 100 Podded groundnut (W100-PG);** the weight of 100 podded groundnuts, using sensitive scale.
v. **Weight of 100 Pods without Seeds (W100-WS);** weight of 100 pods without seeds, using sensitive scale.

Quality assessment

The following qualitative data were observed:

Seed color: Using of hand lens and microscope in the laboratory.

Length of seed (LS): Measured in centimeter (cm) using Vanier caliper

Results and Discussion

Phenotypic Description of Groundnut Seeds and Source

This table outlines the morphological characteristics of ten groundnut varieties, showing differences in seed coat color, seed size, helium color, and source location. Most varieties, such as Akpom, Banada, Dama, Door, Goja, and Shator, had beige seed coats, while Erikasa and Annyian showed a terracotta color, and Kampala and White GNT presented white-brown and white colour, respectively. The seed size varied from medium to big, with Banada, Dama, and Erikasa having notably larger seeds. The helium colour, ranged from dark brown to magnolia and charcoal black, further reflecting varietal uniqueness. These morphological traits may influence market preference, processing characteristics, and possibly even nutritional content.

Table 1: Phenotypic Description of Groundnut Seeds and Source

Variety	Seed Coat Colour	Size	Helium Colour	Source

Akpom	Beige	Medium	Dark Brown	Ukum
Annyian	Terracotta	Medium	White	Ukum
Banada	Beige	Big	Magnolia	Ukum
Dama	Beige	Big	Brown	Jalingo
Door	Beige	Medium	Brown	Jalingo
Erikasa	Terracotta	Big	Charcoal Black	Jalingo
Goja	Beige	Medium	Magnolia	Ukum
Kampala	White Brown	Medium	Brown	Jalingo
Shator	Beige	Medium	Dark Brown	Ukum
White	White	Medium	Brown White	Wukari

ANOVA of Vegetative Growth Traits

Table .2 presents the statistical significance of variation in vegetative growth traits across the ten groundnut varieties. Highly significant differences (p<0.05) were observed in the days to 50% flowering (DF50), days to 95% maturity (DMT95), and the number of branches (NB), indicating strong genetic variability among the varieties for these traits. However, there was no significant difference (NS) in plant height after 9 weeks (PH9WK), suggesting that height may be less influenced by genetic factors or that the varieties have similar growth heights under the same conditions.

Table 2: ANOVA of Vegetative Growth Traits

SOV	DF	DF50	DMT95	PH9WK	NB
Varieties	9	2.133**	7.200**	64.23NS	1.158**
Rep	2	0.000	0.000	62.14	0.000
Error	18	0.000	0.000	45.54	0.000
Total	29	1.745	5.985	63.90	5.018

Analysis of Variance for Yield Traits

The yield parameters showed mixed results. Significant differences (p<0.05) were found in seed length (LGS), implying that varieties differed considerably in this trait (Table 3). However, no significant variation was detected in weight of 100 podded groundnut (W-100PG), 100 seed weight (100SW), and weight of 100 pods without seeds (W-100PWTS). This suggests that while seed size varies, the actual yield-related weights were statistically similar across the varieties, possibly due to environmental uniformity or similar genetic yield potential.

Table 3: Analysis of Variance for Yield Traits

SOV	DF	LGS(mm)	W-100PG (g)	100SW(g)	W-100PWTS
Varieties	9	1.158**	233.8NS	44.74 NS	62.90NS
Rep	2	0.105	274.4	164.8	174.6
Error	18	0.009	209.2	33.31	110.9
Total	29	1.737	236.2	66.56	83.22

Mean of Yield Performance

As presented in Table 4, the mean performance of the studied groundnut varieties showed significant differences in key yield traits. Erikasa had the longest seeds (3.70 mm and 3.50 mm, respectively), while White GNT and Shator recorded the shortest (1.94 mm and 2.12 mm). In terms of 100-podded groundnut weight, Erikasa ranked highest (106.67 g), indicating superior pod yield. Dama recorded the highest 100 seed weight (36.00 g), suggesting it produces larger seeds. The data indicate Erikasa and Dama as promising varieties for breeding programs targeting seed and pod yield improvement.

Table 4: Mean of Yield Performance

VARIETY	LGS(mm)	W-100PG(g)	100SW(g)	W-100PWTS
Akpom	2.27^{e}	78.67^{b}	28.33^{a}	48.66^{a}
Annyian	2.37^{e}	80.00^{b}	30.33^{a}	54.33^{a}
Banada	2.64^{b}	85.00^{a}	35.00^{a}	50.33^{a}
Dama	2.40^{d}	85.00^{a}	36.00^{a}	56.66^{a}
Door	3.50^{a}	89.67^{a}	23.33^{a}	53.33^{a}
Erikasa	3.70^{a}	106.67^{a}	33.33^{b}	57.66^{a}
Goja	2.74^{b}	82.00^{a}	33.00^{a}	52.00^{a}
Kampala	2.56^{d}	88.33^{a}	30.00^{a}	43.33^{a}
Shator	2.12^{f}	80.00^{b}	31.00^{a}	49.66^{a}
White	1.94^{g}	75.00^{b}	30.66^{a}	45.66^{a}

Trait Correlations

Correlation matrix revealed the relationships between vegetative and yield traits. Days to flowering (DTF) was strongly positively correlated with days to 50% flowering (DF50, r=0.69) and days to maturity (DMAT95, r=0.80), reflecting their interconnectedness. Seed length (LGS) showed moderate positive correlations with DTF (r=0.54), DF50 (r=0.61), and number of branches (NB, r=0.51), suggesting these traits could be used as indirect selection criteria for longer seeds. A strong correlation was noted

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between W-100PG and W-100PWTS (r=0.82), highlighting that pod weight is a major contributor to total groundnut yield.

Table 5: Trait Correlations

	DTF	DF50	DMAT95	PH9W	NB	LGS	W-100 PG(g)	100SW(g)	W-100PWTS
DTF	1.00								
DF50	0.69	1.00							
DMAT95	0.80	0.69	1.00						
PH9W	-0.30	0.29	0.05	1.00					
BT	0.69	0.60	0.49	0.31	1.00				
LGS	0.54	0.61	0.02	-0.45	0.51	1.00			
WP100s	0.41	0.37	0.44	-0.08	0.29	0.43	1.00		
WS-100s	-0.06	-0.28	-0.13	-0.04	0.04	0.13	-0.18	1.00	
WS-100s-PWS	0.07	0.00	0.01	-0.07	0.18	0.19	0.82	0.09	1.00

Proximate Nutrient Composition of Groundnut Seeds

The Table 6 shows the nutritional composition of the groundnut varieties. Door had the highest lipid (40.80%) and protein (22.26%) contents, indicating its superior nutritional value, especially for oil and protein considerations. Kampala recorded the highest protein content (25.46%), making it a suitable variety for protein-rich diets. Moisture content across varieties ranged from 2.45% to 3.85%, while carbohydrate levels were inversely related to lipid and protein contents, with Akpom showing the highest carbohydrate content (59.23%). Fibre and ash contents were fairly consistent, ranging from 6.00% to 8.00% and 1.91% to 3.25% respectively. These findings underscore the varietal differences in nutritional potential, which can guide consumer choice and industrial application.

Table 6: Proximate Nutrient Composition of Groundnut Seeds

S/N	Samples	% Moisture	% Ash	% Lipid	% Protein	% Fibre	% CHO
1	Akpom	3.85±0.23	2.34±0.56	19.80±2.23	14.78±2.12	7.95±1.23	59.23±3.67
2	Annyian	2.60±0.51	2.64±0.12	26.70±1.73	12.25±1.32	6.00±1.25	55.81±2.53
3	Banada	3.00±0.10	2.74±0.55	18.90±2.16	19.43±3.45	6.80±1.23	55.93±3.15
4	Dama	2.45±0.23	2.68±0.71	30.50±3.57	14.26±2.55	6.50±0.55	50.11±2.12
5	Door	2.60±0.05	3.25±0.56	40.80±2.89	22.26±1.15	7.59±1.23	31.09±2.56
6	Erikasa	2.95±0.47	3.15±0.72	17.70±1.29	21.53±1.54	8.00±1.24	54.67±0.56
7	Goja	3.10±0.61	2.56±0.10	24.20±1.55	17.33±2.32	7.25±1.02	52.81±4.12
8	Kampara	2.55±0.05	1.91±0.01	25.20±0.98	25.46±1.25	6.30±0.21	44.88±2.35
9	Shatar	2.75±0.28	3.01±0.21	23.00±1.32	22.40±2.23	7.15±2.53	48.84±5.12
10	Whitegnt	2.85±0.33	2.46±0.23	21.70±1.23	20.37±0.59	8.00±1.23	52.62±0.25

CONCLUSION

This study presents compelling evidence of the remarkable morphological, agronomic, and nutritional diversity found among ten distinct groundnut varieties. Key findings revealed substantial differences in seed characteristics, including variations in color, size, and helium color, which are critical for breeding progtammes. Furthermore, significant genetic variability was observed in flowering and maturity traits, positioning these varieties as promising candidates for targeted breeding programmes. Laboratory analysis highlighted notable nutritional diversity, particularly in lipid and protein content, with standout varieties like Door and Kampala demonstrating exceptional qualities. This underscores the immense potential for breeding efforts aimed at enhancing specific traits, such as yield, early maturity, or nutritional quality, paving the way for advancements in groundnut production. The strong correlations between

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various agronomic and yield traits provide invaluable criteria for selection, reinforcing the need for careful varietal selection based on end-use requirements whether for industrial processing, food fortification, or direct consumption. Further multi-locational trials are recommended to validate the stability of these traits and also optimize cultivation practices, ultimately leading to improved groundnut production and utilization. The findings here serve as a vital foundation for future research and development, aiming to capitalize on the full potential of these remarkable groundnut varieties.

RECOMMENDATIONS

i. Prioritize Erikasa and Dama for yield improvement due to their superior pod and seed traits.
ii. Door and Kampala should be further studied for high oil and protein content, respectively, to enhance their use in food fortification.
iii. Conduct multi-location trials to assess trait stability across different environments.
iv. Investigate the impact of soil and climatic factors on yield and nutritional composition.
v. Promote Door for oil extraction due to its high lipid content.
vi. Explore Kampala for protein-rich food products and Akpom for energy-dense formulations.
vii. Educate stakeholders on the nutritional benefits of different varieties to drive demand.
viii. Encourage value addition through processing to maximize economic returns.

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