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Variations in Phenotypic Characteristics of Vigna Unguiculata (L) Walp. Seeds Sourced From Open Markets in Benin City, Nigeria

Zipporah Emilomo Omage* and Beckley Ikhajiagbe

Department of Plant Biology and Biotechnology, University of Benin, Benin City, Nigeria

*Corresponding Author
Zipporah Emilomo OMAGE, Department of Plant Biology and Biotechnology, University of Benin, Benin City, Nigeria.

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Abstract

Vigna unguiculata, 'cowpea,' is a crop of numerous varieties. In Benin City, Nigeria, the three common varieties are "Ife Brown", "Ekpoma Local", and "Sokoto White". Being a very common delicacy and perhaps a cheap source of protein for the population, it is sold in nearly all available open markets. The crop is mainly consigned from numerous farms in the north and thus, is very amenable to genetic diversity. This study was undertaken to investigate the differences within and between these varieties. The seeds obtained from major open markets in Benin City were morphologically characterised quantitatively and qualitatively using standard descriptors. Seed length, width, thickness, weight, and volume were the quantitative parameters, while the qualitative parameters included seed brilliance, shape, eye colour, eye pattern, splitting of testa, testa texture, basal colour, pattern of variegation, colour of variegation, and basal colour of variegated seeds. Only "Ife Brown" varied in qualitative parameters, particularly the seed colour. Among the seed quantitative parameters measured, seed volume was the most diverse, with "Sokoto White" being significantly diverse compared to the others. "Ife Brown" was the most varied species among the three in the markets of Benin City, with a group mean sum of squares of 146.95.

Keywords: Phenotypic, Characterization, Cowpea, Diversity, Seeds, Variation, *Vigna Unguiculata.*

1. Introduction

Vigna unguiculata (L) Walp (cowpea) is a major crop cultivated worldwide. It is a good source of protein as well as a consistent source of income for both local and commercial farmers. Given the popularity of cowpea, it is not surprising that numerous variants of cowpea exist in local markets. In the City of Benin, "Ife Brown", "Ekpoma Local", and "Sokoto White" are the three most common varieties. As a consequence of the nature of these varieties, there is a need to understand how they vary from one another and if the varieties sold in Benin City are all obtained from the same source.

Cowpea is the most important arable food legume in Sub-Saharan Africa with numerous varieties of cowpea both in and outside of Nigeria. Cowpea is a staple food in Nigeria and in Africa due to its hardiness, versatility, and popularity. The seed shapes, sizes, colours, texture, pigmentation, and growth patterns of cowpea varieties in Nigeria differ greatly [1-10]. Unfortunately, the ever-changing environment, volatile global economy, and intensification of low-input agricultural production have resulted in a dramatic increase in soil depletion and nutrient depletion in many Sub-Saharan African regions [11]. This challenges food production and food stability, and while cowpea serves as a crop that meets global nutrient needs, this will only last so long before variation is lost due to cowpea succumbing to the consequences of climate change. Fortunately, genetic variation and abundance in cowpea may be used to create varieties that are more resistant to production constraints. As a result, in order to extend the collection, adequate awareness of genetic variation within current germplasm is needed. This allows breeding programs to pick and evolve more improved varieties quicker, not only in terms of yield but also of nutritional benefit [12]. Overall, germplasm with a greater genetic base acts as a buffer, providing resistance to climatic and other environmental changes and maintai6ning long-term food stability.

Hybridization is a novel practice of supplying genetic variability within a species; the resultant offspring contributes to the genetic diversity of the germplasm. When higher-precision diversity analysis approaches are no longer accessible to scientists, phenotypic assessment of genotypes for morphological classification remains the only mechanism for identifying genetic heterogeneity within a population.

Variation is quite likely to exist within species and variations. Some instances of this include the study of genetic diversity of the common bean, *Phaseolus vulgaris* from over 27 counties in China. Over 115 common bean germplasm resources were utilized and it

was discovered that the population was highly diverse.A study of the phenotypic diversity of two chickpea (*Cicer arietinum*) collections was also conducted in Ethiopia. The data was obtained from three independent places in one region, and the results indicated significant differences in phenotypic and agronomic performance variability between the two collections. Another research looked at the variance in seed morphologies of 160 *Cucurbita maxima* populations obtained from different parts of Turkey. Sizeable differences in seed shape, colour, size, and weight were ascertained. In the study of 56 Japanese native cultivars of common buckwheat, a considerable number of variances in seed shape characteristics and husk colours were also detected. This all supports the possibility of variations existing within seeds acquired from the same locale. With this in mind, the three varieties, "Ife Brown", "Ekpoma Local", and "Sokoto White", lacking sufficient data on their diversity assessment, have been selected due to Benin City being a common place in the country where all three varieties can be easily perused. This is because Benin City is a central hub where people travelling from the East, West, North and South pass through. It is imperative to know that *Vigna unguiculata* var. "Ife Brown" is indigenous to Western Nigerian, var. "Ekpoma Local" to Southern Nigeria and var. "Sokoto White" to Northern Nigeria. In regards to the lack of data, a full array of current criteria is needed to resolve this. Through this, the source can be traced and the environmental variations can be correlated with variations within a variety (Iseghohi et al., 2019). With the focus on morphological parameters, it is also important to note that identifying these morphological parameters allows one to compare them with variables such as high-yield types, industrial machinery to use, and market choice [13].

Nigeria, is both the world's largest cowpea manufacturer and consumer. Cowpea is primarily grown in northern Nigerian states such as Borno, Gombe, Kaduna, Sokoto, Yobe, and Zamfara, among others [14,15]. This is due to environmental conditions such as rainfall affecting yield in the south, rendering production seasonal and intermittent. If the majority, if not all, of the cowpeas in the market are produced in the north, it is unclear if they come from the same source. As a result, in the case of Benin City markets, where notable varieties sold include "Ife Brown", "Ekpoma Local", and "Sokoto White", it is particularly important to examine the genetic diversity of these varieties in order to ascertain if they are from the same source or not, discern them from one another, and determine the possible implications. Cowpea varieties will need to be characterized to do this. The method of assessing the distribution of highly heritable traits in order to characterize plant germplasm is known as characterization. Characterization may be achieved using morphological, molecular, or both criteria. Characterization is needed in order to provide details on the different varieties that exist [16,17]. This ensures that the germplasm sample receives all of the necessary information for further study while still assisting breeding programs. Only morphological criteria, both quantitative and qualitative, will be used in this analysis. Seed length, seed width, seed thickness, 10-seed weight, and 20-seed volume are quantitative morphological parameters, while qualitative morphological parameters include eye pattern, eye colour, seed shape, brilliance of seeds, splitting of testa, testa texture, colour variegation, basal colour, pattern of variegation, and basal colour of variegated seeds.

Scientific Classification

Kingdom: Plantae
Phylum: Angiosperms
Division: Magnoliophyta
Class: Magnoliopsida
Order: Fabales
Family: Fabaceae
Sub-family: Faboideae
Tribe: Phaseoleae
Sub-tribe: Phaseolinae
Genus: Vigna
Species: *Vigna unguiculata*
Botanical varieties: *Vigna unguiculata* var. "Ife Brown"
Vigna unguiculata var. "Ekpoma Local"
Vigna unguiculata var. "Sokoto White"

This study is focused on the three varieties described above. *Vigna unguiculata* var. "Ife Brown" is characterized by its large size and brownish testa colour. Variegated testa colour and moderate size describes *Vigna unguiculata* var. "Ekpoma Local", while *Vigna unguiculata* var. "Sokoto White" is distinguished by its pale grey testa colour and medium size.

The hypothesis for this study is that all *Vigna unguiculata* seeds sold in Benin City are acquired from the same source whereas, the aim of the study was to determine level of variability in seed phenotypic characteristics among three prominent Cowpea (*Vigna unguiculata*) varieties sold in Benin City, Edo State.
The specific objectives of the study were to;
• Identify differences in seed qualitative characteristics within and among the three cowpea varieties;
• Identify differences in seed quantitative characteristics within and among the three cowpea varieties
• Determine level statistical variability among the cowpea varieties.

2. Materials and Methods

Benin City was selected as the study area. It is the State capital of Edo, which is situated in southern Nigeria. Benin City has a total area of 1,204km2 and is located approximately 40 kilometres (25 miles) north of the Benin River and 320 kilometres (200 miles) by road east of Lagos (465 square miles).Benin City, the capital of Edo state, is the seat of activity in the state, with a population of 1,782,000 as of 2021. It is also the epicentre of Nigerian rubber industry.

Three cowpea (*Vigna unguiculata*) varieties were purchased per cup from three random locations within ten local markets from four local government areas in Benin City, Edo State (Table 1a &

b). The samples were ninety in total, thirty samples for each variety. The four local government areas and their respective markets include; Ikpoba Okha (Santana, Ekiosa and Oregbeni Markets), Oredo (Ugbighoko, Oba Market, and New Benin Markets), Egor (Egor and Uselu Markets) and Ovia North-East (Ekosodin and Oluku Markets). The total distance covered was 48.11 km (29.89 miles).

The materials used for the study consist of measuring cylinder (50ml and 100 ml), conical flask (250ml), Ethanol, vernier caliper, sensitive weighing balance, nylon bags, ruler and paper tape.

The morphological assessments of the seeds were examined based on two categories, quantitative characteristics and qualitative characteristics. In regards to the quantitative characteristics, determination of linear dimensions was done by measuring ten common-sized seeds with the aid of a vernier caliper. The linear dimensions measured were in centimetres and their average values calculated and recorded. 10-seed weight was determined by weighing ten seeds of common sizes with a high precision weighing scale. The 20-seed volume was achieved by water displacement method. Twenty seeds were dropped into a cylinder containing 95% ethanol and 5% water. The volume displaced was recorded as the volume of the seed.

The qualitative characteristics consists of the seed shape, brilliance of seeds, eye colour, eye pattern, testa texture,, colour of variegation, basal colour, pattern of variegation, basal colour of variegated seeds and splitting. The testa basal colour was determined by the application, Color Namer which was created by Katie Dektar in 2013. The qualitative characters which were determined visually were scored by nominal codes from a descriptor for cowpea by The International Board for Plant Genetic Resources (1983). The descriptor for African yam bean, Sphenostylis stenocarpa (Hochst ex. A. Rich.)Harms by Adewale and Dumet (2011) was used as a guide to develop the descriptor list for the present morphological characterization of *Vigna unguiculata* var. "Ekpoma Local". Fifteen morphological (quantitative and qualitative) characters were scored on each of the cowpea varieties. Ten seeds of each variety from each local market were measured.

The results were presented as mean of 10 random determinations where necessary. Assessment of sum of squares as a measure of source of variability among seed parameters measured was determined using two-way ANOVA. The SPSS® version 21 Statistical package was used for statistical analyses.

Seed Code	Variety	Place of purchase	Local Government Area	GPS location
IKCbMsL1	"Ife Brown"	Santana market	Ikpoba Okha	6°17'28.6"N 5°37'56.7"E
IKCbMsL2	"Ife Brown"	Santana market	Ikpoba Okha	6°17'29.1"N 5°37'57.4"E
IKCbMsL3	"Ife Brown"	Santana market	Ikpoba Okha	6°17'30.9"N 5°37'58.1"E
IKCbMeL1	"Ife Brown"	Ekiosa market	Ikpoba Okha	6°19'20.0"N 5°38'13.0"E
IKCbMeL2	"Ife Brown"	Ekiosa market	Ikpoba Okha	6°19'27.1"N 5°38'12.2"E
IKCbMeL3	"Ife Brown"	Ekiosa market	Ikpoba Okha	6°19'27.3"N 5°38'11.5"E
IKCbMoL1	"Ife Brown"	Oregbeni market	Ikpoba Okha	6°20'58.7"N 5°39'37.0"E
IKCbMoL2	"Ife Brown"	Oregbeni market	Ikpoba Okha	6°20'59.1"N 5°39'35.5"E
IKCbMoL3	"Ife Brown"	Oregbeni market	Ikpoba Okha	6°20'59.5"N 5°39'33.8"E
ORCbMuL1	"Ife Brown"	Ugbighoko market	Oredo	6°18'58.8"N 5°34'03.0"E
ORCbMuL2	"Ife Brown"	Ugbighoko market	Oredo	6°18'58.6"N 5°34'01.7"E
ORCbMuL3	"Ife Brown"	Ugbighoko market	Oredo	6°18'58.5"N 5°34'01.4"E

ORCbMoL1	“Ife Brown”	Oba market	Oredo	6°20’03.9”N 5°37’10.8”E
ORCbMoL2	“Ife Brown”	Oba market	Oredo	6°20’05.0”N 5°37’10.2”E
ORCbMoL3	“Ife Brown”	Oba market	Oredo	6°20’05.3”N 5°37’10.2”E
ORCbMnL1	“Ife Brown”	New Benin market	Oredo	6°21’03.0”N 5°37’51.7”E
ORCbMnL2	“Ife Brown”	New Benin market	Oredo	6°21’03.5”N 5°37’51.5”E
ORCbMnL3	“Ife Brown”	New Benin market	Oredo	6°21’04.3”N 5°37’52.5”E
OVCbMeL1	“Ife Brown”	Ekosodin market	Ovia North-East	6°24’45.6”N 5°37’40.8”E
OVCbMeL2	“Ife Brown”	Ekosodin market	Ovia North-East	6°24’45.6”N 5°37’41.2”E
OVCbMeL3	“Ife Brown”	Ekosodin market	Ovia North-East	6°24’45.5”N 5°37’40.8”E
OVCbMoL1	“Ife Brown”	Oluku market	Ovia North-East	6°27’21.1”N 5°35’40.9”E
OVCbMoL2	“Ife Brown”	Oluku market	Ovia North-East	6°27’20.1”N 5°35’38.7”E
OVCbMoL3	“Ife Brown”	Oluku market	Ovia North-East	6°27’20.0”N 5°35’38.3”E
EGCbMuL1	“Ife Brown”	Uselu market	Egor	6°22’28.9”N 5°36’50.4”E
EGCbMuL2	“Ife Brown”	Uselu market	Egor	6°22’27.9”N 5°36’48.9”E
EGCbMuL3	“Ife Brown”	Uselu market	Egor	6°22’27.6”N 5°36’47.6”E
EGCbMeL1	“Ife Brown”	Egor market	Egor	6°22’44.3”N 5°34’28.7”E
EGCbMeL2	“Ife Brown”	Egor market	Egor	6°22’47.3”N 5°34’27.0”E
EGCbMeL3	“Ife Brown”	Egor market	Egor	6°22’45.2”N 5°34’27.1”E
IKCeMsL1	“Ekpoma Local”	Santana market	Ikpoba Okha	6°17’28.6”N 5°37’56.7”E
IKCeMsL2	“Ekpoma Local”	Santana market	Ikpoba Okha	6°17’29.1”N 5°37’57.4”E
IKCeMsL3	“Ekpoma Local”	Santana market	Ikpoba Okha	6°17’30.9”N 5°37’58.1”E
IKCeMeL1	“Ekpoma Local”	Ekiosa market	Ikpoba Okha	6°19’20.0”N 5°38’13.0”E
IKCeMeL2	“Ekpoma Local”	Ekiosa market	Ikpoba Okha	6°19’27.1”N 5°38’12.2”E
IKCeMeL3	“Ekpoma Local”	Ekiosa market	Ikpoba Okha	6°19’27.3”N 5°38’11.5”E

IKCeMoL1	“Ekpoma Local”	Oregbeni market	Ikpoba Okha	6°20’58.7”N 5°39’37.0”E
IKCeMoL2	“Ekpoma Local”	Oregbeni market	Ikpoba Okha	6°20’59.1”N 5°39’35.5”E
IKCeMoL3	“Ekpoma Local”	Oregbeni market	Ikpoba Okha	6°20’59.5”N 5°39’33.8”E
ORCeMuL1	“Ekpoma Local”	Ugbighoko market	Oredo	6°18’58.8”N 5°34’03.0”E
ORCeMuL2	“Ekpoma Local”	Ugbighoko market	Oredo	6°18’58.6”N 5°34’01.7”E
ORCeMuL3	“Ekpoma Local”	Ugbighoko market	Oredo	6°18’58.5”N 5°34’01.4”E
ORCeMoL1	“Ekpoma Local”	Oba market	Oredo	6°20’03.9”N 5°37’10.8”E
ORCeMoL2	“Ekpoma Local”	Oba market	Oredo	6°20’05.0”N 5°37’10.2”E
ORCeMoL3	“Ekpoma Local”	Oba market	Oredo	6°20’05.3”N 5°37’10.2”E
ORCeMnL1	“Ekpoma Local”	New Benin market	Oredo	6°21’03.0”N 5°37’51.7”E
ORCeMnL2	“Ekpoma Local”	New Benin market	Oredo	6°21’03.5”N 5°37’51.5”E
ORCeMnL3	“Ekpoma Local”	New Benin market	Oredo	6°21’04.3”N 5°37’52.5”E
OVCeMeL1	“Ekpoma Local”	Ekosodin market	Ovia North-East	6°24’45.6”N 5°37’40.8”E
OVCeMeL2	“Ekpoma Local”	Ekosodin market	Ovia North-East	6°24’45.6”N 5°37’41.2”E
OVCeMeL3	“Ekpoma Local”	Ekosodin market	Ovia North-East	6°24’45.5”N 5°37’40.8”E

Table 1a: Description of seeds and location of purchase

Seed Code	Seed name	Place of purchase	Local Government Area	GPS location
OVCeMoL1	“Ekpoma Local”	Oluku market	Ovia North-East	6°27’21.1”N 5°35’40.9”E
OVCeMoL2	“Ekpoma Local”	Oluku market	Ovia North-East	6°27’20.1”N 5°35’38.7”E
OVCeMoL3	“Ekpoma Local”	Oluku market	Ovia North-East	6°27’19.8”N 5°35’38.0”E
EGCeMuL1	“Ekpoma Local”	Uselu market	Egor	6°22’28.9”N 5°36’50.4”E
EGCeMuL2	“Ekpoma Local”	Uselu market	Egor	6°22’27.9”N 5°36’48.9”E
EGCeMuL3	“Ekpoma Local”	Uselu market	Egor	6°22’27.6”N 5°36’47.6”E
EGCeMeL1	“Ekpoma Local”	Egor market	Egor	6°22’44.3”N 5°34’28.7”E

EGCeMeL2	“Ekpoma Local”	Egor market	Egor	6°22’47.3”N 5°34’27.0”E
EGCeMeL3	“Ekpoma Local”	Egor market	Egor	6°22’45.2”N 5°34’27.1”E
IKCsMsL1	“Sokoto white”	Santana market	Ikpoba Okha	6°17’28.6”N 5°37’56.7”E
IKCsMsL2	“Sokoto white”	Santana market	Ikpoba Okha	6°17’29.1”N 5°37’57.4”E
IKCsMsL3	“Sokoto white”	Santana market	Ikpoba Okha	6°17’30.9”N 5°37’58.1”E
IKCsMeL1	“Sokoto white”	Ekiosa market	Ikpoba Okha	6°19’20.0”N 5°38’13.0”E
IKCsMeL2	“Sokoto white”	Ekiosa market	Ikpoba Okha	6°19’27.1”N 5°38’12.2”E
IKCkMeL3	“Sokoto white”	Ekiosa market	Ikpoba Okha	6°19’27.3”N 5°38’11.5”E
IKCsMoL1	“Sokoto white”	Oregbeni market	Ikpoba Okha	6°20’58.7”N 5°39’37.0”E
IKCsMoL2	“Sokoto white”	Oregbeni market	Ikpoba Okha	6°20’59.1”N 5°39’35.5”E
IKCsMoL3	“Sokoto white”	Oregbeni market	Ikpoba Okha	6°20’59.5”N 5°39’33.8”E
ORCsMuL1	“Sokoto white”	Ugbighoko market	Oredo	6°18’58.8”N 5°34’03.0”E
ORCsMuL2	“Sokoto white”	Ugbighoko market	Oredo	6°18’58.6”N 5°34’01.7”E
ORCsMuL3	“Sokoto white”	Ugbighoko market	Oredo	6°18’58.5”N 5°34’01.4”E
ORCsMoL1	“Sokoto white”	Oba market	Oredo	6°20’03.9”N 5°37’10.8”E
ORCsMoL2	“Sokoto white”	Oba market	Oredo	6°20’05.0”N 5°37’10.2”E
ORCsMoL3	“Sokoto white”	Oba market	Oredo	6°20’05.3”N 5°37’10.2”E
ORCsMnL1	“Sokoto white”	New Benin market	Oredo	6°21’03.0”N 5°37’51.7”E
ORCsMnL2	“Sokoto white”	New Benin market	Oredo	6°21’03.5”N 5°37’51.5”E
ORCsMnL3	“Sokoto white”	New Benin market	Oredo	6°21’04.3”N 5°37’52.5”E
OVCsMeL1	“Sokoto white”	Ekosodin market	Ovia North-East	6°24’45.6”N 5°37’40.8”E
OVCsMeL2	“Sokoto white”	Ekosodin market	Ovia North-East	6°24’45.6”N 5°37’41.2”E
OVCsMeL3	“Sokoto white”	Ekosodin market	Ovia North-East	6°24’45.5”N 5°37’40.8”E
OVCsMoL1	“Sokoto white”	Oluku market	Ovia North-East	6°27’21.1”N 5°35’40.9”E

OVCsMoL2	"Sokoto white"	Oluku market	Ovia North-East	6°27'20.1"N 5°35'38.7"E
OVCsMoL3	"Sokoto white"	Oluku market	Ovia North-East	6°27'19.8"N 5°35'38.0"E
EGCsMuL1	"Sokoto white"	Uselu market	Egor	6°22'28.9"N 5°36'50.4"E
EGCsMuL2	"Sokoto white"	Uselu market	Egor	6°22'27.9"N 5°36'48.9"E
EGCsMuL3	"Sokoto white"	Uselu market	Egor	6°22'27.6"N 5°36'47.6"E
EGCsMeL1	"Sokoto white"	Egor market	Egor	6°22'44.3"N 5°34'28.7"E
EGCsMeL2	"Sokoto white"	Egor market	Egor	6°22'47.3"N 5°34'27.0"E
EGCsMeL3	"Sokoto white"	Egor market	Egor	6°22'45.2"N 5°34'27.1"E

Table 1b: Description of seeds and location of purchase (Cont'd)

3. Results

Presented below are results of the experiment. The quantitative characteristics of "Ife Brown" variety of cowpea has been presented on Table 2. Results show that no significant differences in seed length, seed width, seed thickness were observed. Seed length ranged therefore from 1.10 - 1.39cm respectively. The seed width, on the other hand, varied from 0.79 - 0.97cm, while seed thickness from 0.52 to 0.64cm respectively. However, significant differences in the 20-seed volume as well as the dry seed weight were shown in this study. Whereas, the seed sample with lowest 20-seed volume (OVCbMeL1) were sourced at Ovia North-East local government area from Ekosodin market with a volume of 4.10ml; compared with 20-seed volume of 8.00ml obtained from (EGCbMuL2) Uselu market at Egor local government area. Similarly, the lowest seed weight obtained for *Vigna unguiculata* var. "Ife Brown" was 2.72g from Santana market at Ikpoba Okha local government area (IKCbMsL1), and highest 4.17g from Uselu market at Egor local government area (EGCbMuL2).

Seed codes	Seed length (cm)	Seed width (cm)	20-Seed volume (ml)	Seed thickness (cm)	10-Seed weight (g)
IKCbMsL1	1.25	0.82	6.00	0.52	2.72
IKCbMsL2	1.24	0.81	6.00	0.53	4.10
IKCbMsL3	1.30	0.84	6.80	0.58	3.39
IKCbMeL1	1.23	0.93	6.00	0.57	3.71
IKCbMeL2	1.24	0.84	5.80	0.57	3.12
IKCbMeL3	1.22	0.87	6.00	0.55	3.41
IKCbMoL1	1.29	0.82	6.10	0.61	3.21
IKCbMoL2	1.10	0.80	5.70	0.58	3.13
IKCbMoL3	1.31	0.79	4.90	0.62	2.90
ORCbMuL1	1.28	0.82	5.00	0.61	3.17
ORCbMuL2	1.23	0.88	5.00	0.58	3.57
ORCbMuL3	1.29	0.84	5.20	0.58	3.46
ORCbMoL1	1.21	0.86	6.00	0.61	3.25
ORCbMoL2	1.26	0.87	6.00	0.60	3.38
ORCbMoL3	1.15	0.86	5.60	0.61	3.36
ORCbMnL1	1.21	0.82	6.00	0.56	3.78
ORCbMnL2	1.16	0.84	6.00	0.58	3.75

ORCbMnL3	1.34	0.86	6.30	0.57	3.52
OVCbMeL1	1.33	0.86	4.10	0.61	3.36
OVCbMeL2	1.25	0.87	6.80	0.62	3.62
OVCbMeL3	1.37	0.97	7.00	0.61	3.49
OVCbMoL1	1.31	0.84	5.70	0.55	3.85
OVCbMoL2	1.30	0.86	5.20	0.57	3.21
OVCbMoL3	1.32	0.84	5.30	0.60	3.65
EGCbMuL1	1.29	0.83	5.00	0.54	3.83
EGCbMuL2	1.39	0.84	8.00	0.59	4.17
EGCbMuL3	1.27	0.85	5.40	0.58	3.91
EGCbMeL1	1.30	0.90	5.40	0.64	3.69
EGCbMeL2	1.31	0.91	6.30	0.54	3.44
EGCbMeL3	1.26	0.88	5.00	0.55	2.91
LSD (0.05)	0.69	0.31	1.04	0.16	1.26
P-value	0.172	0.581	0.043	0.077	0.016

LSD-Least significant difference

Table 2: Quantitative parameters of V. unguiculata var. "Ife

The quantitative characteristics of *Vigna unguiculata* var."Ekpoma Local" variety of cowpea as presented on Table 3 shows no significant differences in all the morphological parameters measured ($p>0.05$). The seed length ranged from 0.78 to 0.87cm and 0.60 to 0.71cm for the seed width. Seed thickness varied from 0.44 to 0.47cm, while the 20-seed volume ranged from 2.10 to 3.20ml. No significant changes in seed weight occurred as seed weight ranged from 1.48 to 1.74g respectively.

The seed length of *Vigna unguiculata* var. "Sokoto White" ranged from 0.74 to 0.92cm ($p>0.05$) (Table 4). No significant changes in the seeds collected from the various sampling sites were recorded. 20-seed volume was the least (2.12ml) at the location ORCsMoL3 compared to 3.89ml of 10-seed volume collected at EGCsMeL3 (Table 4).

Seed codes	Seed length (cm)	Seed width (cm)	20-Seed volume (ml)	Seed thickness (cm)	10-Seed weight (g)
IKCeMsL1	0.85	0.63	2.90	0.46	1.59
IKCeMsL2	0.87	0.64	2.40	0.46	1.59
IKCeMsL3	0.84	0.59	3.00	0.47	1.49
IKCeMeL1	0.83	0.60	3.00	0.45	1.58
IKCeMeL2	0.82	0.71	2.00	0.46	1.61
IKCeMeL3	0.85	0.61	3.00	0.46	1.51
IKCeMoL1	0.86	0.65	2.70	0.45	1.55
IKCeMoL2	0.83	0.63	2.80	0.44	1.59
IKCeMoL3	0.81	0.65	3.00	0.45	1.63
ORCeMuL1	0.79	0.62	3.15	0.45	1.69
ORCeMuL2	0.79	0.62	3.00	0.45	1.67
ORCeMuL3	0.83	0.66	3.00	0.49	1.65
ORCeMoL1	0.78	0.62	3.20	0.46	1.65
ORCeMoL2	0.78	0.70	2.50	0.44	1.62
ORCeMoL3	0.79	0.61	2.80	0.44	1.71
ORCeMnL1	0.78	0.63	3.07	0.47	1.61

ORCeMnL2	0.81	0.61	2.90	0.45	1.63
ORCeMnL3	0.78	0.58	2.50	0.44	1.74
OVCeMeL1	0.79	0.63	2.00	0.45	1.63
OVCeMeL2	0.79	0.68	2.60	0.45	1.56
OVCeMeL3	0.78	0.61	2.10	0.44	1.65
OVCeMoL1	0.80	0.61	2.80	0.44	1.60
OVCeMoL2	0.81	0.63	2.20	0.43	1.48
OVCeMoL3	0.85	0.66	3.10	0.45	1.53
EGCeMuL1	0.81	0.62	2.50	0.44	1.65
EGCeMuL2	0.84	0.64	3.00	0.46	1.74
EGCeMuL3	0.81	0.57	3.11	0.45	1.68
EGCeMeL1	0.80	0.62	2.20	0.45	1.52
EGCeMeL2	0.82	0.63	2.20	0.45	1.65
EGCeMeL3	0.83	0.63	3.00	0.46	1.59
LSD (0.05)	0.21	0.21	1.09	0.11	0.61
P-value	0.305	0.749	0.665	0.532	0.129

LSD-Least significant difference

Table 3: Quantitative parameters of V. unguiculata var. "Ekpoma Local" seeds collected at sampling sites

Seed codes	Seed length (cm)	Seed width (cm)	20-Seed volume (ml)	Seed thickness (cm)	10-Seed weight (g)
IKCsMsL1	0.80	0.61	3.40	0.48	1.64
IKCsMsL2	0.81	0.65	2.40	0.49	1.58
IKCsMsL3	0.89	0.70	2.43	0.46	1.42
IKCsMeL1	0.89	0.63	3.00	0.48	1.67
IKCsMeL2	0.81	0.60	2.80	0.44	1.65
IKCkMeL3	0.92	0.63	3.80	0.50	1.74
IKCsMoL1	0.79	0.63	3.10	0.47	1.57
IKCsMoL2	0.77	0.61	3.00	0.44	1.66
IKCsMoL3	0.76	0.64	2.50	0.52	1.60
ORCsMuL1	0.81	0.63	3.00	0.46	1.49
ORCsMuL2	0.85	0.62	3.00	0.46	1.57
ORCsMuL3	0.78	0.62	2.50	0.45	1.66
ORCsMoL1	0.77	0.61	2.50	0.48	1.76
ORCsMoL2	0.73	0.61	3.00	0.50	1.67
ORCsMoL3	0.78	0.55	2.12	0.40	1.59
ORCsMnL1	0.74	0.61	2.90	0.48	1.64
ORCsMnL2	0.75	0.63	3.11	0.50	1.66
ORCsMnL3	0.77	0.60	3.00	0.44	1.55
OVCsMeL1	0.86	0.65	3.00	0.48	1.63
OVCsMeL2	0.87	0.66	3.60	0.49	1.60
OVCsMeL3	0.82	0.68	3.30	0.50	1.76
OVCsMoL1	0.79	0.63	2.80	0.49	1.65
OVCsMoL2	0.91	0.61	3.00	0.43	1.62

OVCsMoL3	0.76	0.61	2.60	0.46	1.47
EGCsMuL1	0.79	0.63	3.16	0.47	1.91
EGCsMuL2	0.81	0.61	3.00	0.43	1.96
EGCsMuL3	0.77	0.65	3.20	0.48	1.84
EGCsMeL1	0.87	0.70	3.50	0.52	1.48
EGCsMeL2	0.84	0.65	3.30	0.49	1.52
EGCsMeL3	0.80	0.64	3.89	0.49	1.70
LSD (0.05)	0.21	0.11	1.23	0.11	0.14
P-value	0.309	0.160	0.746	0.587	0.064

LSD – least significant difference

Table 4: Quantitative parameters of V. unguiculata var. "Sokoto White" seeds collected at sampling sites

The modal phenotypic and qualitative parameters of *Vigna unguiculata* var. "Ife Brown" has been presented in Table 5. In terms of seed shape, all seed samples selected throughout the sampling sites were 5 (rhomboid). In terms of splitting of testa, all seeds were predominantly 1 (presence of testa splitting). In terms of testa texture, all the seeds were 7 (rough to wrinkled). With the exception of testa basal colour, which had considerable variation in colouration in the testa of sample seeds, the values for pattern of testa variegation, eye colour, and brilliance of seeds amongst others were largely uniform.

Table 6 presents the modal phenotypic and qualitative characteristics of *Vigna unguiculata* var. "Ekpoma Local". No changes in seed shape were observed, as the seeds were generally 5 (rhomboid). In terms of testa colour variegation, all seeds obtained were generally and unanimously 1 (presence of testa colour variegation). The prominent testa basal colour for *Vigna unguiculata* var. "Ekpoma Local" was dark brown. All the seeds obtained from the various markets for "Ekpoma Local" variety, have the same brilliance of seeds, 2 (medium). The values for pattern of testa variegation, eye colour, testa texture and eye pattern amongst others were also largely uniform.

Seed codes	Seed shape	Splitting of testa	Testa texture	Testa colour variegation	Testa basal colour	Pattern of testa variegation	Basal colour of variegated seed	Eye colour	Eye pattern	Brilliance of seeds
IKCbMsL1	5	1	7	0	light peach	0	0	3	3	2
IKCbMsL2	5	1	7	0	Sand	0	0	3	3	2
IKCbMsL3	5	1	7	0	light brown	0	0	3	3	2
IKCbMeL1	5	1	7	0	Tan	0	0	2	3	2
IKCbMeL2	5	1	7	0	light brown	0	0	2	3	2
IKCbMeL3	5	1	7	0	light peach	0	0	2	3	2
IKCbMoL1	5	1	7	0	pale peach	0	0	2	3	2
IKCbMoL2	5	1	7	0	Beige	0	0	2	3	2
IKCbMoL3	5	1	7	0	light peach	0	0	2	3	2
ORCbMuL1	5	1	7	0	Tan	0	0	2	3	2
ORCbMuL2	5	1	7	0	Peach	0	0	2	3	2
ORCbMuL3	5	1	7	0	light peach	0	0	2	3	2
ORCbMoL1	5	1	7	0	Camel	0	0	2	3	2

ORCbMoL2	5	1	7	0	light brown	0	0	2	3	2
ORCbMoL3	5	1	7	0	pale brown	0	0	2	3	2
ORCbMnL1	5	1	7	0	cocoa	0	0	2	3	2
ORCbMnL2	5	1	7	0	pale brown	0	0	2	3	2
ORCbMnL3	5	1	7	0	light peach	0	0	2	3	2
OVCbMeL1	5	1	7	0	dull orange	0	0	3	3	2
OVCbMeL2	5	1	7	0	butterscotch	0	0	3	3	2
OVCbMeL3	5	1	7	0	light peach	0	0	3	3	2
OVCbMoL1	5	1	7	0	sand brown	0	0	3	3	2
OVCbMoL2	5	1	7	0	sand brown	0	0	3	3	2
OVCbMoL3	5	1	7	0	Tan	0	0	3	3	2
EGCbMuL1	5	1	7	0	pinkish tan	0	0	1	3	2
EGCbMuL2	5	1	7	0	pinkish grey	0	0	1	3	2
EGCbMuL3	5	1	5	0	light brown	0	0	1	3	2
EGCbMeL1	5	1	7	0	apricot	0	0	2	3	2
EGCbMeL2	5	1	7	0	light peach	0	0	2	3	2
EGCbMeL3	5	1	7	0	light peach	0	0	2	3	2

Seed shape - 1 kidney, 2 ovoid, 3 crowder, 4 globose, 5 rhomboid; splitting of testa - 0 absent, 1 present; testa texture – 1 smooth, 3 smooth to rough, 5 rough (fine reticulation); 7 rough to wrinkled; testa colour variegation – 0 absent, 1 present; pattern of testa variegation - 1 dense black uneven spot/dot on brown background basal colour with clean eye, 2 sparse black dots on creamy brown background with a concentration around the hilum, 3 patchy light brown dots on dark brown background; basal colour of variegated seeds – 0 non variegated seeds, 1 cream, 2 brown, 3 black; eye colour–0 eye absent (white, cream), 1 brown splash or grey, 2 tan brown, 3 red; eye pattern – 0 absent, 1 very small, 2 kabba group (the eye fills the narrow groove all around the hilum and the body has some form of speckling and a blue hallow is found around the hilum), 3 narrow eye (hilum ring. Eye fills the narrow groove around the hilum and spills out of this grove in front of the hilum but for a short distance but has an indistinct front margin), 4 small eye, 5 Holsten group (the eye circles the back of the hilum in a narrow ring, widens at the sides and then extends. The margin of the eye is very distinct), 6 Watson group (eye encircles the back of the hilum as a narrow ring, widens at the sides and spills over the non micropylar end of the seed with an indistinct margin. The extra width at the sides of the hilum distinguishes this group from 3, narrow eye). Brilliance of the seed – 1 shiny, 2 medium, 3 matt.

Seed codes	Seed shape	Splitting of testa	Testa texture	Testa colour variegation	Testa basal colour	Pattern of testa variegation	Basal colour of variegated seed	Eye colour	Eye pattern	Brilliance of seeds
IKCeMsL1	5	0	3	1	dark brown	2	1	2	6	2
IKCeMsL2	5	0	3	1	dark brown	2	1	2	6	2
IKCeMsL3	5	0	3	1	dark brown	2	1	2	6	2
IKCeMeL1	5	0	3	1	dark brown	2	1	2	6	2
IKCeMeL2	5	0	3	1	light brown	2	1	2	6	2
IKCeMeL3	5	0	3	1	dark brown	2	1	2	6	2
IKCeMoL1	5	0	3	1	dark brown	2	1	2	6	2
IKCeMoL2	5	0	3	1	dark brown	2	1	2	6	2
IKCeMoL3	5	0	3	1	dark brown	2	1	2	6	2
ORCeMuL1	5	0	3	1	dark brown	2	1	2	6	2
ORCeMuL2	5	0	3	1	light brown	2	1	2	6	2
ORCeMuL3	5	0	3	1	light brown	2	1	2	6	2
ORCeMoL1	5	0	3	1	dark brown	2	1	2	6	2
ORCeMoL2	5	0	3	1	dark brown	2	1	2	6	2
ORCeMoL3	5	0	3	1	dark brown	2	1	2	6	2
ORCeMnL1	5	0	3	1	dark brown	2	1	2	6	2
ORCeMnL2	5	0	3	1	dark brown	2	1	2	6	2
ORCeMnL3	5	0	3	1	light brown	2	1	2	6	2
OVCeMeL1	5	0	3	1	dark brown	2	1	2	6	2
OVCeMeL2	5	0	3	1	dark brown	2	1	2	6	2
OVCeMeL3	5	0	3	1	dark brown	2	1	2	6	2
OVCeMoL1	5	0	3	1	dark brown	2	1	2	6	2

OVCeMoL2	5	0	3	1	dark brown	2	1	2	6	2
OVCeMoL3	5	0	3	1	dark brown	2	1	2	6	2
EGCeMuL1	5	0	3	1	light brown	2	1	2	6	2
EGCeMuL2	5	0	3	1	dark brown	2	1	2	6	2
EGCeMuL3	5	0	3	1	dark brown	2	1	2	6	2
EGCeMeL1	5	0	3	1	dark brown	2	1	2	6	2
EGCeMeL2	5	0	3	1	dark brown	2	1	2	6	2
EGCeMeL3	5	0	3	1	dark brown	2	1	2	6	2

Table 6: Modal phenotypic and qualitative parameters of V. unguiculata var. "Ekpoma Local" seeds collected at sampling sites

Seed shape - 1 kidney, 2 ovoid, 3 crowder, 4 globose, 5 rhomboid; Splitting of testa - 0 absent, 1 present; testa texture – 1 smooth, 3 smooth to rough, 5 rough (fine reticulation); 7 rough to wrinkled; testa colour variegation – 0 absent, 1 present; pattern of testa variegation 1 dense black uneven spot/dot on brown background basal colour with clean eye, 2 sparse black dots on creamy brown background with a concentration around the hilum, 3 patchy light brown dots on dark brown background; basal colour of variegated seeds – 0 non variegated seeds, 1 cream, 2 brown, 3 black; eye colour – 0 eye absent (white, cream), 1 brown splash or grey, 2 tan brown, 3 red; eye pattern – 0 absent, 1 very small, 2 kabba group (the eye fills the narrow groove all around the hilum and the body has some form of speckling and a blue hallow is found around the hilum), 3 narrow eye (hilum ring. Eye fills the narrow groove around the hilum and spills out of this grove in front of the hilum but for a short distance but has an indistinct front margin), 4 small eye, 5 Holsten group (the eye circles the back of the hilum in a narrow ring, widens at the sides and then extends. The margin of the eye is very distinct), 6 Watson group (eye encircles the back of the hilum as a narrow ring, widens at the sides and spills over the non micropylar end of the seed with an indistinct margin. The extra width at the sides of the hilum distinguishes this group from 3, narrow eye). Brilliance of the seed – 1 shiny, 2 medium, 3 matt.

The modal phenotypic and qualitative characteristics of *Vigna unguiculata* var. "Sokoto White" has been presented on Table 7. The findings revealed that the shape of the seeds, the splitting of the testa, the texture of the testa, and the colour variegation of the testa all followed the same pattern throughout the experiment. The seeds of *Vigna unguiculata* var. "Sokoto White" were generally pale grey in terms of testa basal colour. There were no variegations in the appearance of testa variegation pattern, basal colour of variegated seeds, eye colour, eye pattern, and seed brilliance. That is, there were no changes in the above five parameters regardless of the market areas from which they were purchased.

Seed codes	Seed shape	Splitting of testa	Testa texture	Testa colour variegation	Testa basal colour	Pattern of testa variegation	Basal colour of variegated seed	Eye colour	Eye pattern	Brilliance of seeds
IKCsMsL1	5	0	5	0	pale grey	0	0	1	2	2
IKCsMsL2	5	0	5	0	pale grey	0	0	1	2	2
IKCsMsL3	5	0	5	0	pale grey	0	0	1	2	2
IKCsMeL1	5	0	5	0	pale grey	0	0	1	2	2
IKCsMeL2	5	0	5	0	pale grey	0	0	1	2	2
IKCkMeL3	5	0	5	0	pale grey	0	0	1	2	2
IKCsMoL1	5	0	5	0	pale grey	0	0	1	2	2

IKCsMoL2	5	0	5	0	pale grey	0	0	1	2	2
IKCsMoL3	5	0	5	0	pale grey	0	0	1	2	2
ORCsMuL1	5	0	5	0	pale grey	0	0	1	2	2
ORCsMuL2	5	0	5	0	pale grey	0	0	1	2	2
ORCsMuL3	5	0	5	0	pale grey	0	0	1	2	2
ORCsMoL1	5	0	5	0	pale grey	0	0	1	2	2
ORCsMoL2	5	0	5	0	pale grey	0	0	1	2	2
ORCsMoL3	5	0	5	0	pale grey	0	0	1	2	2
ORCsMnL1	5	0	5	0	pale grey	0	0	1	2	2
ORCsMnL2	5	0	5	0	pale grey	0	0	1	2	2
ORCsMnL3	5	0	5	0	pale grey	0	0	1	2	2
OVCsMeL1	5	0	5	0	pale grey	0	0	1	2	2
OVCsMeL2	5	0	5	0	pale grey	0	0	1	2	2
OVCsMeL3	5	0	5	0	pale grey	0	0	1	2	2
OVCsMoL1	5	0	5	0	pale grey	0	0	1	2	2
OVCsMoL2	5	0	5	0	pale grey	0	0	1	2	2
OVCsMoL3	5	0	5	0	pale grey	0	0	1	2	2
EGCsMuL1	5	0	5	0	pale grey	0	0	1	2	2
EGCsMuL2	5	0	5	0	pale grey	0	0	1	2	2
EGCsMuL3	5	0	5	0	pale grey	0	0	5	6	2
EGCsMeL1	5	0	5	0	pale grey	0	0	1	2	2
EGCsMeL2	5	0	5	0	pale grey	0	0	1	2	2
EGCsMeL3	5	0	5	0	pale grey	0	0	1	2	2

Table 7: Modal phenotypic and qualitative parameters of V. unguiculata var. "Sokoto White" seeds collected at sampling sites

Seed shape - 1 kidney, 2 ovoid, 3 crowder, 4 globose, 5 rhomboid; Splitting of testa - 0 absent, 1 present; testa texture – 1 smooth, 3 smooth to rough, 5 rough (fine reticulation); 7 rough to wrinkled; testa colour variegation – 0 absent, 1 present; pattern of testa variegation 1 dense black uneven spot/dot on brown background basal colour with clean eye, 2 sparse black dots on creamy brown background with a concentration around the hilum, 3 patchy light brown dots on dark brown background; basal colour of variegated seeds – 0 non variegated seeds, 1 cream, 2 brown, 3 black; eye colour – 0 eye absent (white, cream), 1 brown splash or grey, 2 tan brown, 3 red; eye pattern – 0 absent, 1 very small, 2 kabba group (the eye fills the narrow groove all around the hilum and the body has some form of speckling and a blue hallow is found around the hilum), 3 narrow eye (hilum ring. Eye fills the narrow groove around the hilum and spills out of this grove in front of the hilum but for a short distance but has an indistinct front margin), 4 small eye, 5 Holstein group (the eye circles the back of the hilum in a narrow ring, widens at the sides and then extends. The margin of the eye is very distinct), 6 Watson group (eye encircles the back of the hilum as a narrow ring, widens at the sides and spills over the non micropylar end of the seed with an indistinct margin. The extra width at the sides of the hilum distinguishes this group from 3, narrow eye). Brilliance of the seed – 1 shiny, 2 medium, 3 matt.

The measurable mean and coefficient of variation (CV) of Vigna unguiculata seeds collected from the various markets have been presented on Table 8. The results showed a mean of 1.27cm for seed length, amounting to a CV of 4.97 for "Ife Brown". Compared to "Ekpoma Local", mean seed length was 0.81, with a CV of 3.28; whereas, for "Sokoto White", the seed length was similar to "Ekpoma Local" (0.81cm) with a CV of 5.53. The implication of this is that the variability was more in regards to seed length in "Sokoto White", then "Ife Brown" before "Ekpoma Local". In terms of seed dry weight, the mean value of "Ife Brown" was 3.47g, which eventually was the highest when compared with seed weight of "Ekpoma Local" (1.61g) and "Sokoto White" (1.64g). In terms of CV, the results showed that seed volume of "Sokoto White" presented the highest amount of variation. The lowest CV was recorded in the seed thickness of "Ekpoma Local" variety (2.62) (Table 8).

Table 9 shows the assessment of sum of squares in an attempt to compare genetic capabilities and genetic characteristics of the seeds. The results indicate that in regards to mean sum of squares,

when opposed to the "Ekpoma Local" variety and the "Sokoto White" variety, "Ife Brown" has the greatest variability. Plates 8 – 37 show some of the seed samples collected from the various sampling sites.

Cowpea variety	Plant Quantitative Parameter	Mean	SD	95% C.I.		CV
				Lower Bound	Upper Bound	
Vigna unguiculata var. "Ife Brown"	Seed length (cm)	1.27	0.06	1.24	1.29	4.97
	Seed width (cm)	0.85	0.04	0.84	0.87	4.47
	Seed volume (ml)	5.79	0.76	5.5	6.07	13.15
	Seed thickness (cm)	0.58	0.03	0.57	0.59	5.14
	Seed weight (g)	3.47	0.35	3.34	3.6	9.96
Vigna unguiculata var. "Ekpoma Local"	Seed length (cm)	0.81	0.03	0.8	0.82	3.28
	Seed width (cm)	0.62	0.02	0.62	0.63	2.75
	Seed volume (ml)	2.71	0.36	2.58	2.85	13.37
	Seed thickness (cm)	0.45	0.01	0.45	0.46	2.62
	Seed weight (g)	1.61	0.07	1.59	1.64	4.19
Vigna unguiculata var. "Sokoto White"	Seed length (cm)	0.81	0.04	0.79	0.82	5.53
	Seed width (cm)	0.63	0.03	0.62	0.64	4.81
	Seed volume (ml)	2.93	0.41	2.78	3.09	14.14
	Seed thickness (cm)	0.47	0.03	0.46	0.48	5.9
	Seed weight (g)	1.64	0.12	1.6	1.69	7.4

SD- Standard Deviation; CI- Confidence Interval; CV-Coefficient of variation

Table 8: Measurable mean and coefficient of variation of V. unguiculata seeds collected at sampling sites

Source of variation	Type III Sum of Squares	Df	Mean Square	F	p-value
***V. unguiculata* var. "Ife Brown"**					
Corrected Model	587.8a	4	146.95	1042.6	<0.001
Intercept	857.9	1	857.87	6086.6	<0.001
Group	587.8	4	146.95	1042.6	<0.001
Error	20.4	145	0.14		
Total	1466.1	150			
Corrected Total	608.2	149			
[a].R Squared = 0.966 (Adjusted R Squared = 0.965)					
***V. unguiculata* var. "Ekpoma Local"**					
Corrected Model	104.8b	4	26.18	953.8	<0.001
Intercept	231.9	1	231.91	8448.3	<0.001
Group	104.7	4	26.18	953.8	<0.001
Error	3.9	145	0.03		
Total	340.6	150			
Corrected Total	108.7	149			
[b].R Squared = 0.963 (Adjusted R Squared = 0.962)					
***V. unguiculata* var. "Sokoto White"**					
Corrected Model	124.9c	4	31.22	819.9	<0.001
Intercept	252.2	1	252.18	6622.2	<0.001

Group	124.9	4	31.23	819.9	<0.001
Error	5.5	145	0.04		
Total	382.6	150			
Corrected Total	130.4	149			
[c].R Squared = 0.958 (Adjusted R Squared = 0.956)					

Table 9: Assessment of sum of squares of measured parameters of Vigna unguiculata collected at sampling sites

Discussion

With the exception of seed volume and seed weight, there were no significant differences in the parameters calculated for Vigna unguiculata var. "Ife Brown". There were no significant differences within *V. unguiculata* var. "Ekpoma Local". This is true for *V. unguiculata* var. "Sokoto White" as well. *V. unguiculata* var. "Ife Brown" had a variety of testa basal colours, while the other parameters were distributed uniformly. It was the only variety that displayed testa splitting. Due to the obvious large size of "Ife Brown", the splitting can be traced to inadequate sorting and handling procedures. Hence, better handling procedures should be adopted. The existence of variegation set the Vigna unguiculata var. "Ekpoma Local" apart. The colour difference in the testa was predominantly dark brown, while the other parameters were uniformly distributed. Var. "Sokoto White" also had uniformly distributed parameters. The seed volume had the highest coefficient of variation among the three varieties (CV). This implies that the seed volumes for each variety have the greatest degree of heterogeneity. Although Vigna unguiculata var. "Sokoto White" had the highest CV for seed volume, var. "Ife Brown" had the highest number of squares, while var. "Ekpoma Local" had the lowest sum of squares. The difference between var. "Ekpoma Local" and var. "Sokoto White" was low. Vigna unguiculata var. "Ife Brown" had the most variation. Though var. "Ekpoma Local" and var. "Sokoto White" are similar in size, they differ significantly in testa basal colour, variegation presence, eye colour, and pattern. The pale grey testa basal colour, lack of colour variegation, and greyish eye colour var. "Sokoto White" has all been identified as significant differences. Var. "Ekpoma Local" has a dark brown basal testa colour as well as a variegated testa. Clearly, the three varieties are not the same.

Generally speaking, there is a high chance of variations arising within legume species, and these differences can be attributed to environmental, physiological, and genetic influences. The environmental influences also include the agricultural production preferences of the farmer. As a consequence, our results may be affected by these factors.

Variety "Ife Brown" has different testa basal colours, which may be due to the expression of many genes, as seed testa colour expression in cowpea is regulated by many genes. Many genes are thought to be involved in the inheritance of seed testa colour in cowpea. According to reports, the testa colour trait is polygenic and influenced by multiple genes in a variety of plant species, including legumes such as cowpea, bean, and soybean. This expression of multiple genes results in varying levels of several colour pigments in the seed testa, explains the observed colour changes in seed testa. Environmental factors may also have an effect on the production of these pigments. According to seed colour has also been stated to play a role in seed dormancy and germination. As a result, further research should be conducted to examine the relationship between seed testa colour and dormancy as well as germination. Furthermore, seed size and seed coat colour have been used to establish a simple method of improving seed quality for many crop species, including common bean, cowpea, rapeseed, flax, and Arabidopsis [18]. In the agricultural sector, where uniformity is preferred, seed differences cause uncertainty. If these differences have a negative impact on crop yield, the farmer will encounter issues. These seed differences can also be unfavourable to the seller, particularly when they are undesirable to the consumers.

The inference from the acquired result is that the three prominent varieties of Vigna unguiculata, sold in Benin City, Edo state do not originate from the same source. Variety "Ife Brown" is the most diverse, originating from various sources while varieties "Ekpoma Local" and "Sokoto White" may have originated from the same respective sources. Molecular characterization should additionally be done in order to establish the genetic distinctness of the variants.

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Author's Contribution

ZEO and BI designed the study, ZEO carried out the research under the supervision of BI. BI carried out the statistical analysis and interpretation of data. ZEO wrote the first draft. BI edited the final draft. The authors read and approved the final manuscript.

Additional Information

Conflict of Interests

The authors declare no conflict of interest.

References

1. Adewale, B. D., Adeigbe, O. O., & Aremu, C. O. (2011). Genetic distance and diversity among some cowpea (Vigna unguiculata L. Walp) genotypes. International Journal of Research in Plant Science, 1(2), 9-14.
2. Adewale, D. B., & Dumet, D. J. (2011). Descriptors for African yam bean, Sphenostylis stenocarpa (Hochst ex. A. Rich.) Harms. IITA Newsletter. Pp, 1-12.
3. Admas, S., Tesfaye, K., Haileselassie, T., Shiferaw, E., & Flynn, K. C. (2021). Phenotypic variability of chickpea (Cicer arietinum L) germplasm with temporally varied collection from the Amhara Regional State, Ethiopia. Cogent Food & Agriculture, 7(1), 1896117.
4. O M, A., & Egho, E. O. (2012). Evaluation of eight varieties of cowpea (Vigna unguiculata (L.) Walp) in Asaba agro-ecological environment, Delta State, Nigeria. European Journal of Sustainable Development, 1(2), 303-303.
5. Balkaya, A., Yanmaz, R., & Özbakir, M. (2009). Evaluation of variation in seed characters of Turkish winter squash (Cucurbita maxima) populations. New Zealand Journal of Crop and Horticultural Science, 37(3), 167-178.
6. Bhatt, A., Gairola, S., & El-Keblawy, A. A. (2016). Seed colour affects light and temperature requirements during germination in two Lotus species (Fabaceae) of the Arabian subtropical deserts. Revista de Biología Tropical, 64(2), 483-492.
7. Claessens, G. Characterization (2003). Crop Genebank Knowledge Base.
8. Egbadzor, K. F., Yeboah, M., Gamedoagbao, D. K., Offei, S. K., Danquah, E. Y., & Ofori, K. (2014). Inheritance of seed coat colour in cowpea (Vigna unguiculata (L.) Walp). International Journal of Plant Breeding and Genetics, 8(1), 35-43.
9. Gondwe, T. M., Alamu, E. O., Mdziniso, P., & Maziya-Dixon, B. (2019). Cowpea (Vigna unguiculata (L.) Walp) for food security: An evaluation of end-user traits of improved varieties in Swaziland. Scientific reports, 9(1), 15991.
10. Iseghohi, I. O., Adesoye, A. I., Oludare, D. A., Agunbiade, F. V., & Unachukwu, N. (2019). Assessment of genetic diversity of selected cowpea landraces from Nigeria based on simple sequence repeat markers. Nigerian Journal of Biotechnology, 36(2), 33-44.
11. Long, J., Zhang, J., Zhang, X., Wu, J., Chen, H., Wang, P., & Du, C. (2020). Genetic diversity of common bean (Phaseolus vulgaris L.) germplasm resources in Chongqing, evidenced by morphological characterization. Frontiers in genetics, 11, 697.
12. Magashi, A. I., Shawai, R. S., Muhammad, A., & Ibrahim, M. B. (2019). Genetic variability studies of some quantitative traits in cowpea (Vigna unguiculata l.[walp]) under water stress. African Journal of Plant Science, 13(2), 25-33.
13. Mavi, K. (2010). The relationship between seed coat color and seed quality in watermelon Crimson sweet. Horticultural Science, 37(2), 62-69.
14. Mitchell, J., Johnston, I. G., & Bassel, G. W. (2016). Variability in seeds: biological, ecological, and agricultural implications. Journal of experimental botany, 68(4), 809-817.
15. Omoigui, L. O., Kamara, A. Y., Kamai, N., Ekeleme, F., & Aliyu, K. T. (2020). Guide to cowpea production in Northern Nigeria.
16. Tetsuka, T., & Uchino, A. (2005). Variation in seed shape and husk color in Japanese native cultivars of common buckwheat (Fagopyrum esculentum Moench). Plant production science, 8(1), 60-64.
17. The International Board for Plant Genetic Resources (1983). Descriptor for cowpea.
18. Yildiz Tiryaki, G., Cil, A., & Tiryaki, I. (2016). Revealing seed coat colour variation and their possible association with seed yield parameters in common vetch (Vicia sativa L.). International Journal of Agronomy, 2016.