IJCRSSSL International Journal of Current Researches in Sciences, Social Sciences and Languages

Volume: 03 | Issue: 04 | 2023 | Open Access | Impact Factor: 5.735

Evaluation of Variation of Some Geometric Properties of Three Cultivars of Cowpea (Vigna Unguiculata) to Change in Moisture Content

Rotimi Emmanuel

Department of Agricultural and bio- Environmental Engineering Technology, Federal Polytechnic Bali, Taraba State, Nigeria

Abstract: Evaluation of the behavior of geometric properties of local cultivars of cowpea seed to changes in moisture content like any other biomaterial is important to local technicians in the designing and development of their harvesting, handling and processing machinery. Three sample of known cultivars namely Iron beans (Sample A), Brown beans (Sample) and Kananado (Sample C) were purchased from the local market in the study area, then all unwanted materials and bad seed moved. Moisture content of all three sample of was adjusted to 12%, 18% and 24% moisture content levels respectively. Seed dimension (Length, Width and thickness) was measured using a digital Vanier caliper then, values obtained was used to compute geometric shapes such as surface area, volume, percentage sphericity, arithmetic and geometric mean. All three experiment was conducted in three replicates at 0.05 significant levels. Summaries of all ANOVA results show that interactive effect between all three cultivars at different levels of moisture content was not significant at $P \leq 0.05$). But there is significant difference on the sizes of a given cultivar and between the three cultivars at different moisture level.

Keywords: Cowpea, Arithmetic and geometric mean, sphericity, biomaterials

INTRODUCTION

Cowpea (Vigna unguiculata) is an important grain legume, a major staple food crop for household nutrition in sub-Saharan Africa, especially in the dry savanna regions of Nigeria. Cowpea commonly popularly called beans as its household name by local farmers is Nigeria's most consumed grain legume and described with different varietal names. Cowpeas were domesticated in Africa [1] and are one of the oldest crops to be farmed. A second domestication event probably occurred in Asia, before they spread into Europe and the Americas. The seeds are usually cooked and made into stews and curries, or ground into flour or paste. Most cowpeas are grown on the African continent, particularly in Nigeria and Niger, which account for 66% of world production. Cowpeas are cultivated on 12.5 million hectares million acres) of land, have a worldwide production of 3 million tonnes and are consumed by 200 million people on a daily basis [2]. Insect infestation is a major constraint to the production of cowpea, sometimes causing over 90% loss in yield [3].

A study that involves grains respond to adjustment of moisture content is very essential in computing design parameters of agricultural equipment used in grain material handling processes. So, it is significant to determine physical (size and shape) properties of agricultural produce because they play an important role in designing and developing of specific handling and processing activity.

Cowpea is one of the most economically and nutritionally important indigenous African grain legumes produced throughout the tropical and subtropical areas of the world (GATE, 2008).In Africa, despite the values of cowpea, the methods involved in its production, harvesting and shelling are mostly manual. For instance, shelling is done by pounding in a mortar with a pestle or spreading the dried crop on the floor where it is beaten with a stick (Dauda, 2001). Most of the imported shelling machineries are very costly and hence beyond the reach of Nigerian small-scale farmers. Some have been found unsuitable for shelling the local varieties (Adewumi et al., 2007).

If there has to be increased production of cowpea, farmers have to be provided with the means by which their products can be processed with minimum drudgery, cost and achieving good quality products. Despite the economic potential of cowpea little is known about the physical properties of some of its

varieties though many researchers such as; Alonge and Adigun (1999), Adigun and Alonge (2000), Oje et al., (2001), and Alonge (2003) carried out studies on physical and mechanical properties of some agricultural products. This study was therefore carried out to determine the basic geometric (length, width, thickness, geometric mean diameter, arithmetic mean diameter, mass, and volume), complex geometric (sphericity, roundness, surface area, true density, bulk density, and porosity), and some mechanical (angle of repose, coefficient of friction and crushing strength) properties of four different varieties of cowpea for the purpose of multi crop shelling machine design.

Cowpea is one of the most economically and nutritionally important indigenous African grain legumes produced throughout the tropical and subtropical areas of the world (GATE, 2008).In Africa, despite the values of cowpea, the methods involved in its production, harvesting and shelling are mostly manual. For instance, shelling is done by pounding in a mortar with a pestle or spreading the dried crop on the floor where it is beaten with a stick (Dauda, 2001). Most of the imported shelling machineries are very costly and hence beyond the reach of Nigerian small-scale farmers. Some have been found unsuitable for shelling the local varieties (Adewumi et al., 2007).

If there has to be increased production of cowpea, farmers have to be provided with the means by which their products can be processed with minimum drudgery, cost and achieving good quality products. Despite the economic potential of cowpea little is known about the physical properties of some of its varieties though many researchers such as; Alonge and Adigun (1999), Adigun and Alonge (2000), Oje et al., (2001), and Alonge (2003) carried out studies on physical and mechanical properties of some agricultural products. This study was therefore carried out to determine the basic geometric (length, width, thickness, geometric mean diameter, arithmetic mean diameter, mass, and volume), complex geometric (sphericity, roundness, surface area, true density, bulk density, and porosity), and some mechanical (angle of repose, coefficient of friction and crushing strength) properties of four different varieties of cowpea for the purpose of multi crop shelling machine design.

Lack of adequate and technical knowledge about the physical and mechanical property of farm produce may reduce the functional precision locally developed equipment for handling, Processing, threshing and cleaning operations for rural farm dwellers within the study area. This is however linked with poor machine efficiency and high amount of losses during harvesting and post-harvest farm operations. Indirectly this discourages farmers from getting involved in mechanized agricultural production and may also be a main factor for high cost of production. Traditional method of farm operations which is time consuming and affects output and quality of crops, such as cowpea becomes the most preferred systems adopted by most farmers. The desire to increase output which also result in more labour requirement and financial investment for all farm operations, remains far beyond the reach of majority of local farmers.

Many problems associated with the design of a specific machine or analysis of the behavior of the materials during production, handling and processing requires the knowledge of mechanical and physical properties of the farm produce. A study of the physical and mechanical properties will stand as a basic knowledge to local technician in the development of machine for sizing, sorting, and grading, separation operation for agricultural produce.

The objective of this study is therefore to experimentally investigate some physical properties of three common cowpea cultivars within the study area. The properties for investigation include the size (length and width), sphericity, weight, and volume, and, moisture content, bulk, and true densities.

MATERIAL AND METHOD

In this experimental work, three local varieties of cowpea namely (iron beans, brown beans and Kananado Fari) which represent the common types of cowpea cultivated within the study area. Each cultivar Samples of the selected cultivars of cowpea was procured from the weekly market in the study area since the research work is aimed at assisting local technician with useful information needed in the construction of local equipment for handling and processing activities. After purchase, each of the samples was cleaned from all forms of unwanted materials, broken and bad seeds. Each of the samples was further

divided into four and a sample of 10 kg from each grain lots were taken and used at a moisture content between 9–10% to determine their physical and properties. The initial moisture content of each cowpea sample at the time of purchase from the local market was determined by using digital grain moisture meter with model number JGL-188.

STUDY AREA

Bali Local Government Area with its secretarial at Bali town is one of the sixteen Local Government Areas of Taraba State, a north eastern state in Nigeria. It has an area of 9,146 km2
and a population of 208,935 at the 2006 census.The area is generally situated on the banks of the upper course of River Taraba at about 150km from Jalingo the state headquarters. The Federal Polytechnic, Bali.is the only government owned higher institution in the town.

MATERIALS

The study was carried out using local cultivars of cowpea namely: (Iron beans to be identify as sample A, brown beans as sample B and Kananado as Sample C). An electronic balance was used in this study for measuring the weight of all the samples. An electronic digital Vernier caliper with a minimum scale reading of 0.1mm and a measuring range of 0- 150mm was used for measuring the dimensions of the cowpea seed. A Digital grain moisture meter JGL-188 hygrometer with measuring probe was used in measuring the moisture content in percentage of the studied three cultivars of cowpea seeds on wet basis.

METHOD

The entire experiment was conducted to determine and compute the geometric properties of three cultivars of cowpea seed cultivated and available within the study area. Grain dimensions (length, width and thickness) was obtained for computation of surface area, volume, geometric diameter, arithmetic diameter and percentage sphericity. All the experiments were replicated three times and values were recorded. The seed moisture content value at the time of purchase from the market was determined using a digital moisture meter. Three samples of 10kg each from all the three local cultivars was collected and subjected to moisture adjustment of 12%, 18% and 24% wet base respectively. A portion of each cultivar was placed in a plastic bag. Calculated amount of water was added into each of the portion of seed and placed into a separate polythene bag and sealed [4]. The grain was allowed to absorb the moisture for a specific period of (30 to 180minutes). After the waiting period, the moisture content was observed using the moisture meter. The process was repeated until the desired moisture level is reached. The amount of water to be added was obtained using the expression below,

$$Dry = \frac{WET \times (100 - PW)}{100 - PD}$$

Where; -
Dry = Dry grain weight in kilograms
Wet = Wet grain weight in kilograms
PW = Percentage moisture content wet base
PD = Percentage moisture content wet base
The linear dimensions of each sample of all three cultivars were determined by selecting twenty (20) grains randomly from each of the three cultivars at each moisture level and the three main dimensions of each grain, namely, length (L), width (W) and thickness (T) were measured using a digital Vanier caliper. The size was used to calculate the volume (V), geometric diameter (Dg), arithmetic diameter (Da), percent of sphericity (S) and area of surface (AF) of the individual seeds. The following equations were used to calculate the values of the above-mentioned properties:[5][6][7]:

$V = \frac{\pi}{6}(LWT)$, mm^3

IJCRSSSL International Journal of Current Researches in Sciences, Social Sciences and Languages

Volume: 03 | Issue: 04 | 2023 | Open Access | Impact Factor: 5.735

$Dg = (LWT)^{1/3}$, mm

$Da = \frac{(L+W+T)}{3}$, mm

$S = \frac{(LWT)^{1/3}}{L} \times 100$, %

$A_f = \frac{\pi}{4} LW$, mm²

Where:

L= length of seed in mm; W= Width of seed in mm and T = thickness of seed in mm

Data collected from the experiment to determine all the geometric properties was analyzed using Two-Factor ANOVA With Replication and gragh.

RESULT

Table 1: Showing result of three cultivars of cowpea seed percentage sphericity at three different moisture content

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Sample	20.33763	2	10.16882	60.41081	5.44E-07	3.885294
Columns	273.0006	1	273.0006	1621.839	3.55E-14	4.747225
Interaction	15.83608	2	7.918039	47.03941	2.1E-06	3.885294
Within	2.019933	12	0.168328			
Total	311.1942	17				

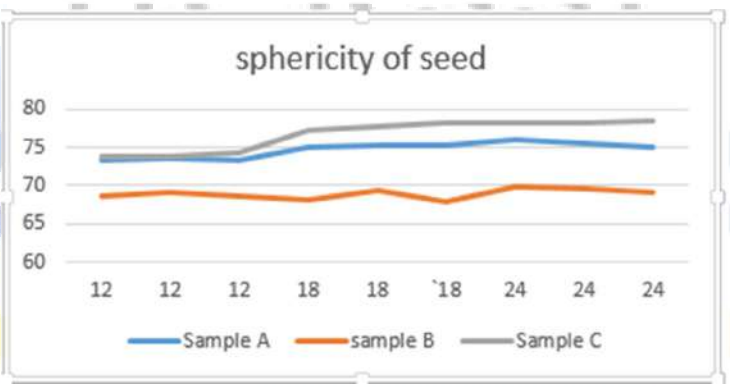


Table 2: Showing result of Arithmetic diameter of three different cultivars of cowpea seed at three different moisture content

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Sample	0.052811	2	0.026406	86.41818	7.49E-08	3.885294
Columns	0.00605	1	0.00605	19.8	0.000793	4.747225
Interaction	0.007233	2	0.003617	11.83636	0.001449	3.885294
Within	0.003667	12	0.000306			
Total	0.069761	17				

IJCRSSSL
International Journal of Current Researches in Sciences, Social Sciences and Languages
Volume: 03 | Issue: 04 | 2023 | Open Access | Impact Factor: 5.735

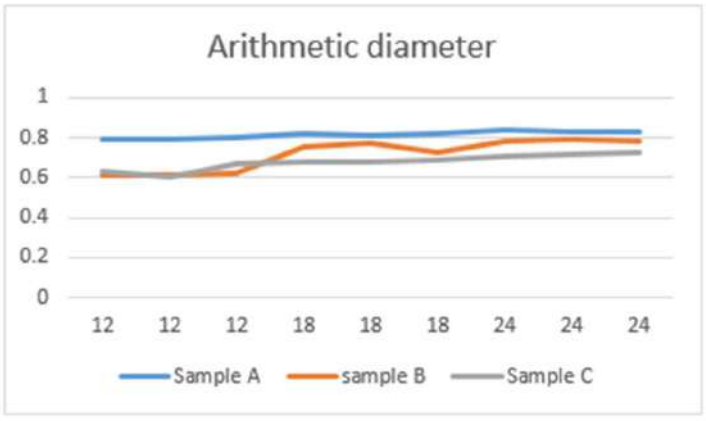


Table 3: showing result of Geometric Mean of three different cultivars of cowpea seed at three different moisture content

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Sample	0.045733	2	0.022867	514.5	2.35E-12	3.885294
Columns	0.002006	1	0.002006	45.125	2.14E-05	4.747225
Interaction	0.009378	2	0.004689	105.5	2.43E-08	3.885294
Within	0.000533	12	4.44E-05			
Total	0.05765	17				

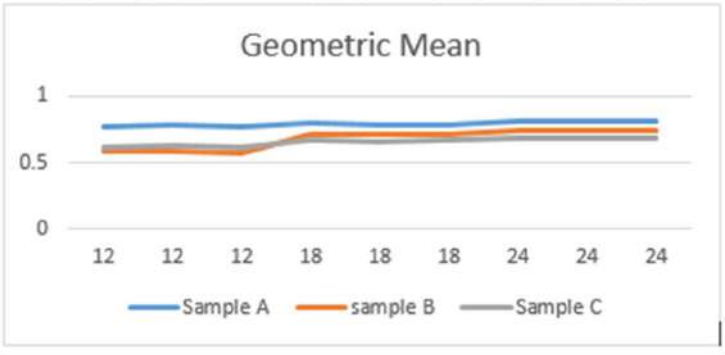


Table 4: showing result of Volume of three different cultivars of cowpea seed at three different moisture content

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Sample	0.021811	2	0.010906	196.3	6.81E-10	3.885294
Columns	0.0002	1	0.0002	3.6	0.082097	4.747225
Interaction	0.0025	2	0.00125	22.5	8.71E-05	3.885294
Within	0.000667	12	5.56E-05			
Total	0.025178	17				

IJCRSSSL
International Journal of Current Researches in Sciences, Social Sciences and Languages
Volume: 03 | Issue: 04 | 2023 | Open Access | Impact Factor: 5.735

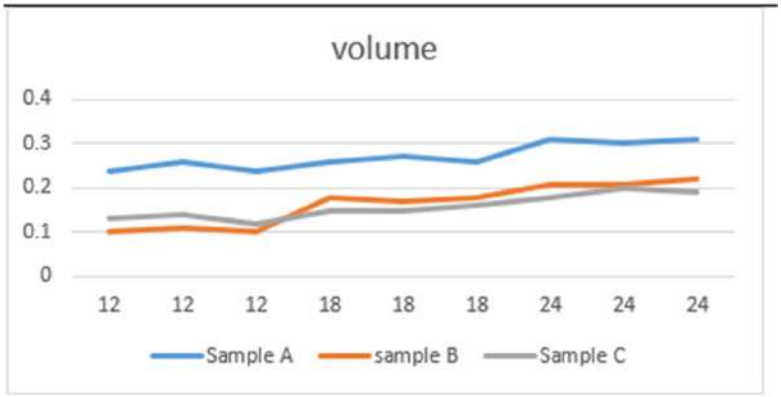
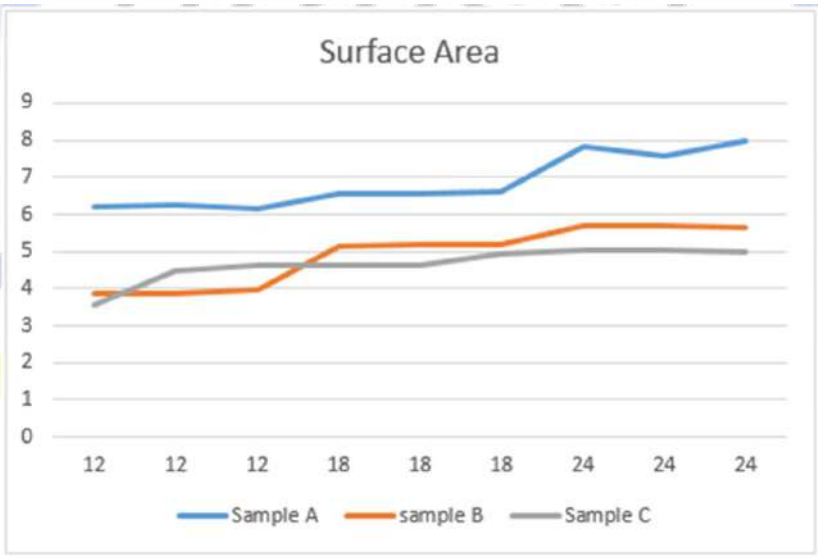


Table 5: showing result of surface area of three different cultivars of cowpea seed at three different moisture content

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Sample	5.110533	2	2.555267	41.86674	3.88E-06	3.885294
Columns	0.322672	1	0.322672	5.28682	0.040248	4.747225
Interaction	0.785244	2	0.392622	6.432915	0.012632	3.885294
Within	0.7324	12	0.061033			
Total	6.95085	17				



DISCUSSION OF RESULT

The data in Tables 1-5 above shows the percentage sphericity, arithmetic mean diameter, geometric mean diameter, volume and surface area of cultivars of cowpea seed. All these dimensions presented here are important in selecting and designing a suitable size of screen perforations and in the determination of proper method during grading and separation of grains. The graph shows that that for optimum performance of any handling and processing machine, the design parameters are common for two of the cultivars that is sample B (Brown Beans) and sample C (Kananado Fari) and at 12% moisture level there is less variation in the sizes of all three cowpea cultivars mentioned above.

The summaries of all ANOVA results show that interactive effect between all three cultivars at different levels of moisture content was not significant at P≤ 0.05). But there is significant difference in the sizes of a given cultivar and between the three cultivars at different moisture level. The increase or changes observed in the linear dimensions and sizes of three local cultivars in this study with increase in moisture content may be due to increase in the volume of the grains as moisture content increases. [6] and [8] have reported similar observations for both cowpea varieties and rice seed at different moisture ranges respectively.

CONCLUSION

Below are conclusions at the end of this investigation:

- The sizes of the three cultivars of cowpea are related to their moisture contents and responds to in moisture content in the moisture content range of 12 to 34% wet base. However, there is a significant difference among the three cultivars.
- All three local cultivars in this investigation shows a significantly with their physical properties at different levels of moisture content with the exception of surface area which is slightly not significant in respect to variation in moisture content.
- When designing the screen of a thresher or other processing and handling equipment, the average value of the geometric sizes of all three local cultivars of cowpea should be considered for functional precision and reduction in seed damage.

ACKNOWLEDGEMENT

My profound gratitude goes to the management of our great institution, Federal Polytechnic Bali for giving me the opportunity to be a beneficiary of TETFund sponsored research work. It is with great joy to extend my greetings to the department of Agricultural and Bio-environmental Engineering Technology for its immense support. i appreciate the effort of my fellow colleague who in one way or the other assisted me during the research work.

REFERENCES

[1] Gómez, Carlos (2004). "Cowpea Post-harvest Operations" (PDF). Food and Agriculture Organization of the United Nations. Retrieved 2017-04-19.

[2] Small, Ernest (2009). Top 100 Food Plants (https://books.google.com/books?id=nyWY_YkV7qAC&q=%27%27Vigna+unguiculata%27%27++%27%27Vigna%27%27+small+claw&pg=PA104). NRC Research Press. p. 104. ISBN 978-0-660-19858-3.

[3] Padulosil, S.; Ng, N. Q. (1997). "Origin, taxonomy, and morphology of Vigna unguiculata (L.) Walp."(http:// pdf.usaid.gov/pdf.docs/pnacb024.pdf) (PDF).

[4] Coşkun MB, Yalçin I, Özarslan C (2005). Physical properties of sweet corn seed (Zea mays saccharata Sturt.). J. Food Eng., 74(4): 523- 528.

[5] El Fawal ,Y.A. ; M.A. Tawfik and A.M. El Shal (2009) study on physical and engineering properties for grains of some field crops, Misr J. Ag. Eng., 26(4): 1933- 1951.

[6] Aderinlewo A.A, Raji A.O. And Olayanju T.M.A. (2011). Effect of moisture content on some physical properties of cowpea (Vigna unguiculata), Journal of Natural Sciences, Engineering and Technology. 10(2): 133-145, ISSN: Print - 2277 - 0593 Online - 2315 – 7461.

[7] Javad Tarighi , Asghar Mahmoudi , and Naser Alavi, (2011). Some mechanical and physical properties of corn seed (Var. DCC 370). African Journal of Agricultural Research Vol. 6(16), ISSN 1991-637X ©2011 Academic Journals, pp. 3691-3699, DOI: 10.5897/AJAR10.521.

[8] Nalladurai, K., Alagusundaram, K., Gayathri, P. (2003). Effect of variety and moisture content on the engineering properties of paddy and rice. Agricultural Mechanization in Asia, Africa and Latin America, 34(2): 47-52