Physical properties of snake gourd seed (*Trichosantes cucumerina* L) relevant in grading and seperation

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Abstract: The physical properties of *snake gourd* (*Trancosanties cucumerina L*) seed have been evaluated as a function of moisture contents,6.80%, 8.60%, 12.00%, 14.00% and 17.00% (db) moisture contents. The properties investigated include one thousand mass, dimensions (length, width and thickness), sphericity, volume, true density and bulk density. The results of the experiment showed that seed length increased from 11.30±0.3 to 12.4±0.50 mm, width (from 5.60±0.30 to 6.60± 0.30 mm), thickness (from 2.0±0.25 to 2.7±0.32 mm), one thousand mass (from 110.0±5.2 to 240.0±6.5 g), geometric mean diameter (from 5.02 ± 0.61 to 6.05±0.52 mm), sphericity (from 0.44±0.05 to 0.49±0.06), volume (from 38.98±4.1to 69.68±5.2 mm^3), true density (from 0.91±0.26 to 0.97±0.30) and bulk density (from 0.3360±0.022 to 0.3519±0.012). The kernel evaluated in the same range of moisture content showed length (5.20±0.67 to 6.60±0.8 mm), width (2.0±0.3 to 3.0±0.6 mm), thickness (0.30 ±0.02 to 0.70 0.041 mm),one thousand mass (60.3±3.0 to 180.4±5 g), geometric mean diameter (0.68±0.05 to 1.11±0.03 mm), sphericity (0.13±0.012 to 0.17± 0.015), volume (8.0±1.22 to 38±4.3 mm^3), true density (0.7563±0.12 to 0.8052 ±0.21 g mm^{-3}) and bulk density (0.4132±0.021 to 0.4462±0.011 g cm^{-3}). The result of analysis shows that the effect of moisture content is significant ($p<0.05$) on all the properties investigated. These data will be useful in design and development of grading and separation equipment for snake gourd seed and kernel.

Keywords: snake gourd, physical properties, moisture content, separation equipment, grading equipment

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1 Introduction

Snake gourd (*Trichosantes cucumerina L*) is generally believed to have originated from India (ECHO, 2006). It originated in a wild state, but later domesticated. The wild species could still be found in India and other parts of South East Asia and parts of Australia. This crop is presently cultivated in India, parts of South East Asia, Australia, West Africa, Latin America and the Caribbean (Huxley, 1992, Sahlin et al., 2004). Anonymous (2006) also reported that the snake gourd is known by different names in different parts of the world. In Nigeria it is known as snake tomato, pathakaya in India, pakupis in Philippines, buapngu in Thailand, pudalankaai in Tamil, paduvalakaayi in kannada and padavalanga in Malayam.

The snake gourd fruit comprises essentially the pulp and the seed. Unlike most oil producing crops, both the pulp and the seed are nutritionally useful.

The seed is a good source of edible oil (Oloyede and Adebooye, 2005). Many researchers have observed that the presence of antioxidants, such ascaroteniods, flavorioids, lycopene, phenolics and β-carotene in the oil, helps in protection against diseases like cardiovascular, diabetes, and so on (Velioghu et al., 1998; Liu et al., 2000;Konak, 2002; Amin et al., 2004; Zharg and Hemauzy, 2004). Perhaps the most interesting news is that the AIDS drug Compound Q is a refined protein called *trichonanthine* which is derived from the trichosanthes (snake gourd) family. It has been shown

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that the protein has the ability to kill an HIV infected cell without affecting surrounding tissue (Anonymours, 2006).

The snake gourd seed oil contains 26.2%-26.6% crude protein, 44.6%-57.7% fat, 7.8%-8.15% phosphorus and 0.012%-0.026% anti-nutritional oxalate (Adebooye et al., 2005). The oil content was compared favorably with that of most seed oil. It was noted that its anti-nutritional oxalate was low and safe for humans but the seed had not been exploited as there was dearth of information on the physical properties that would make the design of machine to mechanize the production of the crop possible.

The knowledge of various physical, mechanical and chemical properties of agricultural products are very essential to the design of suitable machines and equipment for the handling, processing and storage of these products (Akaaimo and Raji, 2006; Calisir et al., 2005; Idowu et al., 2012). Size and shape of the materials are useful in sizing, sorting and other separation process. Bulk and true densities of the materials are important in order to design equipment for its processing, sorting, grading, transporting and storing (Aydin, 2007; Idowu and Adejumobi, 2010). The angle of repose is important for designing package or storage structures and the coefficient of friction plays an essential role for transportation, handling and storage structures (Akaimo and Raji, 2006; Idowu and Adejumobi, 2010).

In recent years, many researchers have investigated the physical properties of some seeds, including the akee aple seed (Omobuwajo et al., 2009) sponge gourd seed (Ogunsina et al., 2009) and soya bean seed (Tavakoli et al., 2009). However, review of literatures shows that there is no information on the physical properties of snake gourd seed. Therefore, the objective of this study was to investigate the moisture dependent physical properties of the seed that will be needed in designing a grading, dehulling and separation equipment for the seed.

2 Materials and methods

2.1 Materials

Snake gourd (*Trichosanthes cucumerina* L) seeds used for the research were obtained from Department of Agricultural Engineering, Ladoke Akintola University of Technology, Ogbomoso, Oyo state, Nigeria. The seeds were collected between December, 2009 and January, 2010. It was manually cleaned to remove foreign matters, broken and immature seeds.

2.2 Methodology

This involves moisture content determination, moisture adjustment and determination of the properties of the material at different moistures.

2.2.1 Moisture content determination

The moisture content of the seed was determined by using oven drying method as adopted by Ogunsina et al. (2009); and Ozguven and Vursavus (2005) for similar oil seeds. A weighed sample of the seed was kept in an oven at a temperature of 105^0C for 6 h. The sample was weighed again at the end of the period to determine its final weight. This experiment was replicated five times and the average weight was recorded. The moisture content was calculated using the relationship below (Equation (1)).

$$Mc(d.b) = \frac{W_i - W_f}{W_f} \times \frac{100}{1} \quad (1)$$

where, W_i = initial weight; W_f = final weight; Mc = moisture content.

2.2.2 Moisture conditioning of the seed

The wetting techniques adapted by Shepherd and Bhardwaj (1986); Carman (1996); Deshpande et al. (1993); and Aydin (2007) was used to vary the moisture content of the seed. Sample of seed and kernel at desired moisture levels were prepared by adding calculated amounts of distilled water using Equation (2) and sealing in separate polyethylene bags.

$$Q = \frac{W_i(M_f - M_i)}{100 - M_f} \quad (2)$$

where, Q = quantity of water needed; W_i = weight of sample; M_i = Initial moisture content; M_f = required moisture content.

Lower moisture content was achieved by oven-drying to desired moisture. The samples were kept for 7 days at 5^oC in a refrigerator to enable the moisture to distribute uniformly throughout the sample and to avoid the growth of micro-organisms. Before starting a test, the required quantity of the sample was taken out of the refrigerator and allowed to warm up to room temperature. The final moisture content of the seed was then determined by oven drying method.

2.2.3 Determination of physical properties of snake gourd

The size was determined by measuring the linear dimensions in Figure 1; length, width, and thickness of 100 randomly selected snake gourd seeds and kernels, using a digital Electronic Vernier caliper (model SO 707 with accuracy of 0.01 mm). The geometric mean diameter (D_g), sphericity (Ø) andsurface area (S) were determined from the following relationships (Equation (3), Equation (4) and Equation (5)).

$$D_g = (LWT)^{\frac{1}{3}} \tag{3}$$

$$\phi = \frac{(LWT)^{1/3}}{L} \tag{4}$$

$$S = \pi D_g^{\ 2} \tag{5}$$

where, L is the length; W is the width and T is the thickness.

These relationships have been used by Moshenin (1986); Ogunsina et al. (2009); and Tavakoli et al. (2009).

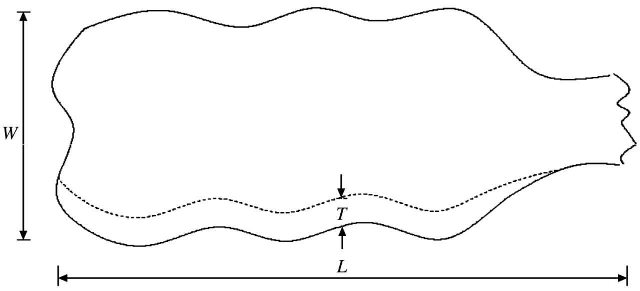


Figure 1 Measurement of length (*L*), width (*W*), thickness (*T*) of *T.cucumerina* seed

2.2.4 One hundred seed mass

The thousand seed mass was determined using a digital electronic balance Tubol 005 model having an accuracy of 0.001 g. To evaluate the thousand seed mass, 1,000 seeds were randomly selected from the bulk sample and weighed. The experiments were replicated thrice.

2.2.5 Volume, True density and Bulk density of the seed

The true volume of the seed was determined using the water displacement method (Moshenin, 1986; Ogunsina et al., 2009; Owolarafe et al., 2007). The seed was weighed in air and allowed to float in water. The volume of water displaced was recorded. This was repeated for the kernel withfivereplicates in each case. True density (ρ_t) of the seed and kernel were calculated using the relationship (Equation (6)):

$$p_t = (\frac{M_a}{M_a - M_w}) \times \rho_w \tag{6}$$

where, ρ_w is the density of water; M_a and M_w are masses of seed or kernel in air and water, respectively.

The bulk density was determined using the mass/volume relationship, by filling an empty plastic container of predetermined volume and weight. The seeds were poured into the container from a constant height with the container struck off ten times and weighed. This was also repeated for the kernel and the bulk density was calculated as Equation (7):

$$\rho_b = \frac{M}{V} \tag{7}$$

where, ρ_b is the bulk density; M and V are bulk mass of seed or kernel, g; and volume of the plastic container, respectively.

The density ratio (D_r) is the ratio of bulk density to true density expressed as a percentage as follows Equation (8):

$$D_r = \left(\frac{\rho_b}{\rho_t}\right) \times 100 \tag{8}$$

Porosity (P) was computed as (Mohsenin, 1986) Equation (9):

$$P = \left(1 - \frac{\rho_b}{\rho_t}\right) \times 100 \tag{9}$$

The experiment for all density characteristics were replicated 10 times.

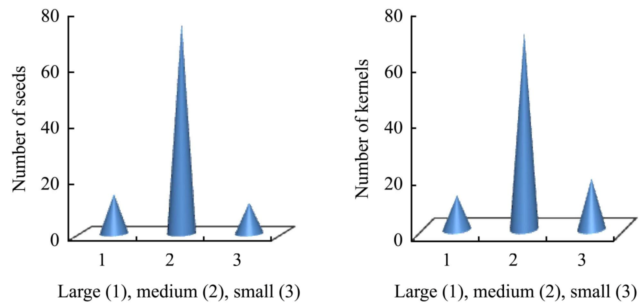
3 Results and discussion

3.1 Size distribution of the seed and kernel

The size distribution of the seed and kernel of snake gourd shows that about 14% of the seeds have a length ranging from 13.3 mm and above, while 75% are in medium size having a length between 11.9 and 13.3 mm. The small size was 11% with length of 11.9 mm and below. On the whole, the seed length is between 10 mm and 13.5 mm and kernel length is between 5.54 and 7.80 mm. The seed and kernel of snake gourd seed are smaller than the dimension of peanut seed and kernel as reported by Aydin (2007). The mean values of 100 measurements at 8.9% moisture content (d.b) (average harvesting moisture content) for length, width, thickness and unit mass of the snake gourd seed were found to be 11.3, 5.60, 2.0 mm and 0.04 g, respectively. The corresponding values for the kernel were 5.20, 2.0, 0.03 mm and 0.01 g, respectively

3.1.2 Distribution of snake gourd seed and kernel mass by percentage

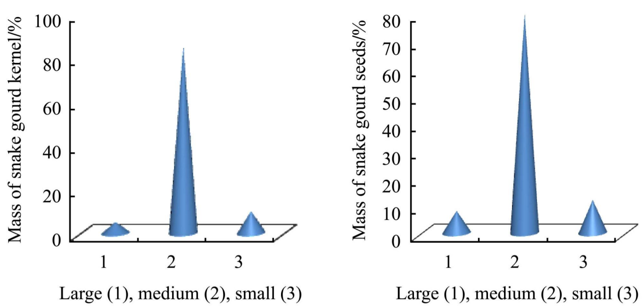
The medium size was observed to have the highest percentage by mass (Figure 2a and Figure 2b) while the large size and the small size has lower mass by percentage distribution in the samples. This shows a trend towards a normal distribution which agrees with earlier report by Ige (1977) for five varieties of cowpea, Akaaimo and Raji (2006) for prosopis Africana, Irtwange and Igbeka (2002) for African yam bean and Taser et al. (2005) for vetch seed. This is an indication that the seed mass are relatively uniform and these are useful in design of separating equipment. The kernel also follows the same trend. The mass distribution is shown in Figure 3a and 3b, respectively.



a. Distribution of snake gourd seeds by number

b. Distribution of kernel of snake gourd seeds by number

Figure 2 Distributionof size by count



a. Distribution of mass of snake gourd kernel by percentage

b. Distribution of mass of snake gourd seeds by percentage

Figure 3 Distribution of size by mass

3.2 Effect of moisture content on physical properties of snake gourds

The results of the experiment indicated that moisture contents have an effect on the shape and size of snake gourd seeds. The physical properties considered in the study responded differently to changes in moisture content.

3.2.1 Effect of moisture content on the length of seed and kernel of snake gourd

The length of the snake gourd seed and kernel was observed to increase from 11.30 to 12.4 for seed and 5.20 to 6.6 mm for kernel as the moisture increased from 6.3 to 17.0%d.b (Figure 4). This amount to a 9.7% increase for seed and a 7.69% increase for the kernel. It could be observed that increase in moisture content increased the length of snake gourd seed. This may be due to the fact that the seed absorbed water there by swelling. Similar results were obtained by Deshpande et al. (1993) on soybean, Amin et al. (2004) on lentis seed, Balasubramanian (2001) on cashew nut, Baryeh (2002) on millet, and Nimkar et al. (2005) on moth gram. The mathematical relationship between the length and the moisture is expressed using the regression equation (Equations (10) and (11)) below.

$$L_s(\text{mm}) = 0.101M_c + 10.72 \quad R^2 = 0.977 \tag{10}$$

$$L_k(\text{mm}) = 0.131M_c + 4.33 \quad R^2 = 0.987 \tag{11}$$

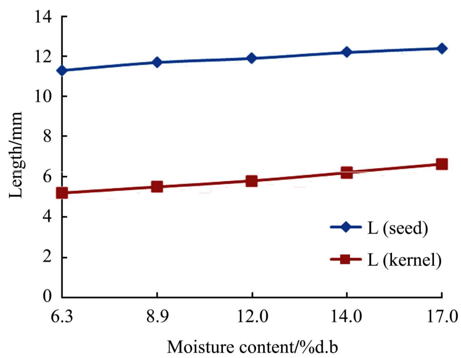


Figure 4 Effect of moisture content on length of snake gourd seed and kernel

Figure 5 below shows the changing trend of snake gourd seed and kernel with the increase in moisture. The width of the snake gourd seed and kernel was observed to increase from 5.6 to 6.6 mm and 2.0 to 3.0 mm, respectively as the moisture increase from 6.3 to 17% d.b. This amount to 17% increase for seed and

50% increase for the kernel. The value of width of seed and kernel increased linearly as is shown by the regression equation below (Equations (12) and (13)).

$$W_S(\text{mm}) = 0.26M_c + 5.3 \quad R^2 = 0.982 \tag{12}$$

$$W_L(\text{mm}) = 0.25M_c + 1.77 \quad R^2 = 0.995 \tag{13}$$

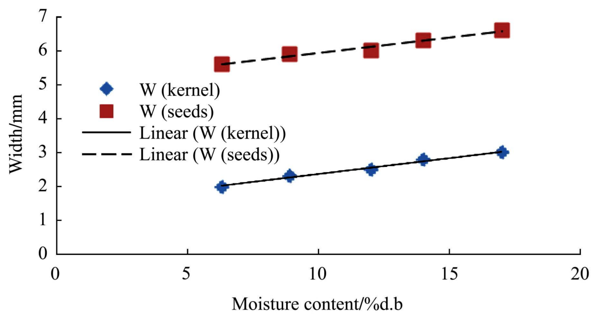


Figure 5 Effect of moisture content on width of snake gourd seed and kernel

These relationships were in agreement with earlier findings by Karababa and Coskuner (2007) on corn kernels. The effect of moisture content on the width of snake gourd seed and kernel was significant ($P<0.5$).

The variation of snake gourd seed and kernel thickness with the increasing moisture content is shown in Figure 6. It could be observed that the thickness of the seed increased from 2.0 to 2.7 mm, which is 35% increase while that of kernel increased from 0.3 to 0.7 mm which is 133% increase. The high increase in the thickness of the kernel to the seed may be due to the tougher seed coat compared to that of the kernel.

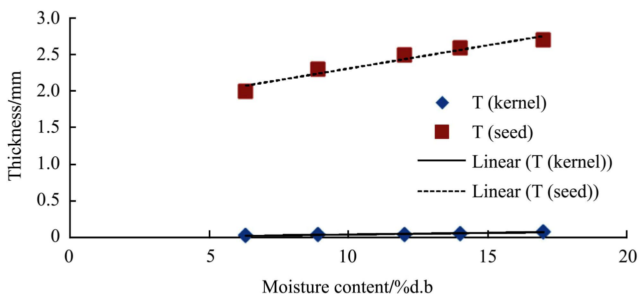


Figure 6 Effect of moisture content on thickness of snake gourd seed and kernel

The relationship was expressed using regression equation. The result is in agreement with earlier report by Coskumer and Karababa (2007) which also reported linear relationship. The mathematical relationships between the seed, kernel and the moisture content are shown below (Equation (14) and Equation (15)):

$$T_s(\text{mm}) = 0.064M_c + 1.672 \quad R^2 = 0.944 \tag{14}$$

$$T_k(\text{mm}) = 0.003M_c + 0.001 \quad R^2 = 0.917 \tag{15}$$

where, T_s = thickness of seed, and T_k = thickness of the kernel.

It was found that the effect of moisture content was more significant than the variations of sizes. This implies that in the design of processing equipments the effect of moisture content must be considered.

3.2.2 Effect of moisture content on geometric mean diameter

The relationship between the geometric mean diameter and moisture content of snake gourd seed and kernel is shown in Figure 7. The values of the geometrical mean diameter increased linearly with the increase in moisture content. The geometric mean diameter of snake gourd seed and kernel was observed to increase from 5.02 to 6.05 mm for seed meaning 20.5% increase, while the kernel increased from 0.68 to 1.11 mm which is about 63.24% increase as moisture content increased from 6.8 to 17.0% db. This result agrees with the earlier report by Karababa and Coskuner (2007) on sweet corn and Oje and Ugbo, 1991.

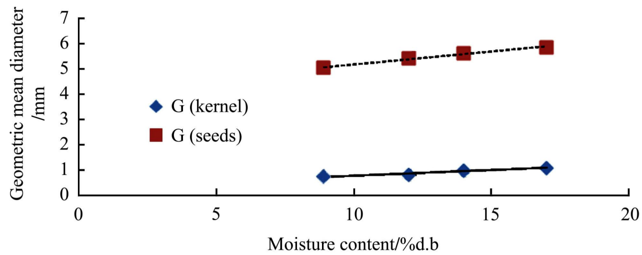


Figure 7 Effect of moisture content on geometric mean diameter of snake gourd kernel and seed

The regression equation for the effect of moisture content on geometric mean is shown in the following equations (Equation (16) and Equation (17)):

$$G_s(\text{mm}) = 0.608M_c + 5.011 \quad R^2 = 0.986 \tag{16}$$

$$G_k(\text{mm}) = 0.013M_c + 0.027 \quad R^2 = 0.996 \tag{17}$$

where, G_s = geometric mean diameter of snake gourd seed; and G_k = geometric mean of the kernel.

The effect of moisture content on the geometrical mean diameter of snake gourd seed and kernel was observed to be significant ($p<0.05\%$).

3.2.3 Effect of moisture variation on sphericity index

The relationship between sphericity index and moisture content of snake gourd seeds and kernel is presented in Figure 8. The sphericity of the snake gourd was observed to increase from 0.44 to 0.49 for seed which is about 11.3% increase in sphericity while the kernel sphericity increased from 0.13 to 0.17 which is about 30.76% increase. A linear relationship was observed for snake gourd seed and kernel which is in agreement with earlier report by Karababa and Coskuner (2007) on sweet corn (Equation (18) and Equation (19)).

$$S_s(\text{mm}) = 0.004M_c + 0.416 \quad R^2 = 0.919 \tag{18}$$

$$S_k(\text{mm}) = 0.003M_c + 0.105 \quad R^2 = 0.953 \tag{19}$$

where, S_k = seed sphericity; and S_k =kernel sphericity.

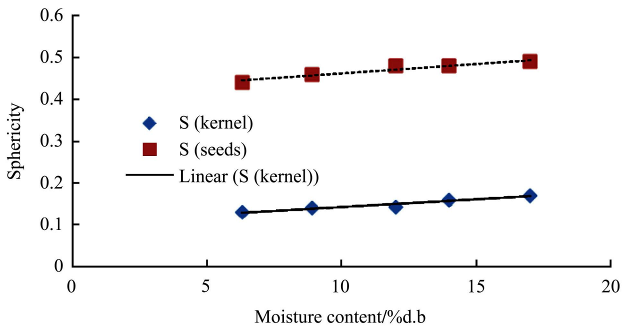


Figure 8 Effect of moisture content on sphericity of snake gourd seed and kernel

The greater difference in the axial dimension for the seed resulted in low sphericity. This implies that the seed cannot rotate easily during handling. The closer the sphericity to 1.0 the higher the tendency to roll about any of the three axes and the closer the ratio of the length, thickness to width is to 1.0, the higher the tendency to rotate about the major axes. Since the sphericity is low, the seed and the kernel have little tendency to rotate but they can slide.

The statistical analysis of the effect of moisture content on the sphericity of snake gourd seed and kernel indicated that the effect was significant (P<0.05).

3.2.4 Effect of moisture content on volume of snake gourd seeds and kernel

Figure 9 shows the relationship between moisture content and volume of snake gourd seed and kernel. The seed volume of a single seed of snake gourd seed varied from 38.98 to 69.68 mm^3, while the kernel volume increased from 8.0 to 38 mm^3 which is about 375% increase as the moisture content increased from 6.8% to 17.0% db.

The relationship between the volume of the seed and kernel of the seed with the moisture content is linear, which agrees with the findings by Altuntas et al. (2005), Baryeh (2002); Sahoo and Srivastava (2002) on fenugreek, millet and okra seeds, respectively, which were all linear. The regression equation for the relationship between the volume of the seed and the kernel are shown in the equations below (Equation (20) and Equation (21)).

$$V_s(\text{mm}) = 2.819M_c + 22.39 \quad R^2 = 0.988 \tag{20}$$

$$V_k(\text{mm}) = 2.737M_c + 12.06 \quad R^2 = 0.921 \tag{21}$$

where, V_k = volume of seed, and V_k = volume of kernel.

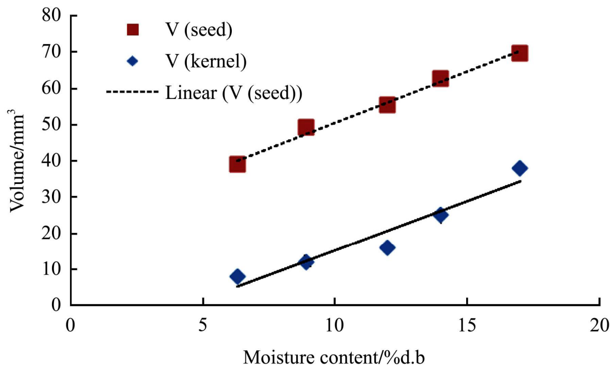


Figure 9 Effect of moisture content on volume of snake gourd seed and kernel

The statistical analysis of the effect of moisture content on the volume of snake gourd seed and kernel indicated that the effect was significant (p<0.05%).

3.2.5 Effect of moisture content on Surface area of snake gourd seeds and kernel

Figure 10 shows the effect of increase in moisture content on the increase of the surface area. The value of the surface area for different moisture levels of 6.3% to 17% varied from 79.21 to 114.90 mm^2 which is 45% for seeds and 14.5 to 38.7 mm for kernels which is 166% increase.

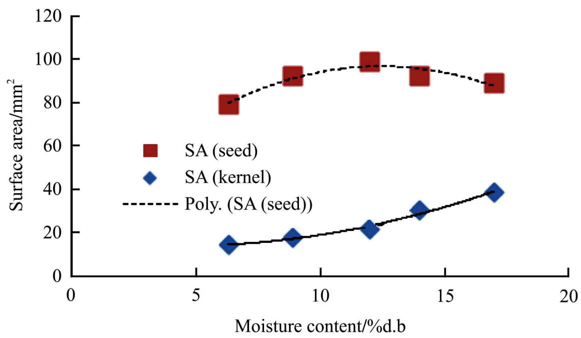


Figure 10 Effect of moisture content on surface area of snake gourd seed and kernel

The regression equations below (Equation (22) and Equation (23)) represent the relationship between the snake gourd surface area seed and kernel with moisture content. Although, Deshpande et al. (1993) found the surface area of soybean to increase linearly with grain moisture content but this report was polynomial for snake gourd which is in agreement with Edward (2000) on bambara groundnut.

$$S_{as}(\text{mm}) = -0.445M_c + 11.09 + 27.73 \quad R^2 = 0.896 \quad (22)$$

$$S_{ak}(\text{mm}) = 0.154M_c + 1.305 + 16.62 \quad R^2 = 0.986 \quad (23)$$

The statistical analysis shows that the effect of moisture content on the surface area is highly significant at 0.05% level.

3.2.6 Effect of moisture content variation on 1000 mass

Figure 11 shows the relationship between the moisture content and the 1000 mass of the seed and the kernel. The value of the one thousand seed weight increased from 110 to 240 g which is 118% increase while it increased from 60 to 180 g for kernel which is an increase of 200% as the moisture content increased from 6.8 to 17%d.b. Similar results were found by Calisar et al. (2005) for okra seed, Jain and Bal (1997) for pearl millet, Ogut (1998) for lentil seed, Aviara et al. (1999) guna seed, and Chandrasekar and Viswanathan (1999) for coffee. The relationships bellow (Equation (24) and Equation (25)) were found to exist between snake gourd seeds and kernel with moisture contents

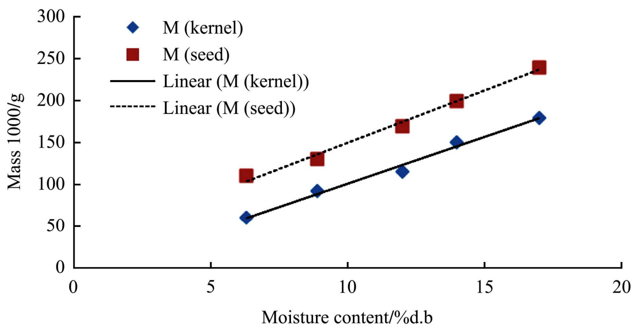


Figure 11 Effect of moisture content on mass of snake gourd seed and kernel

$$1000M_s(\text{mm}) = 12.43M_c + 25.25 \quad R^2 = 0.990 \quad (24)$$

$$1000M_k(\text{mm}) = 11.18M_c - 10.74 \quad R^2 = 0.988 \quad (25)$$

The effect of moisture content on the 1,000 mass was observed to be significant at 0.05 % level.

3.2.7 Effect of variation of moisture content on true density

Figure 12 shows the effect of variation of moisture content on true density. The true density of seed was found to increase from 0.91 to 0.97 g mm^{-3} for seed and 0.76 to 0.81 for kernel when the moisture content was increased from 6.3% to 17% d.b. This was due to the higher rate of increase in single seed volume than single seed weight. The regression equations below (Equation (26) and Equation (27)) show the relationship between the moisture content and true density of seed and kernel. The result agrees with the result of Sahoo and Bhanamdwaj (1986) for pegeaon pea, Masouml and Tabil (2003) for Chickpea, and Gupta and Das (1996) for sunflower seeds.

$$\rho_{Ts}(\text{mm}) = 0.005M_c + 0.728 \quad R^2 = 0.995 \quad (26)$$

$$\rho_{Tk}(\text{mm}) = 0.005M_c + 0.878 \quad R^2 = 0.982 \quad (27)$$

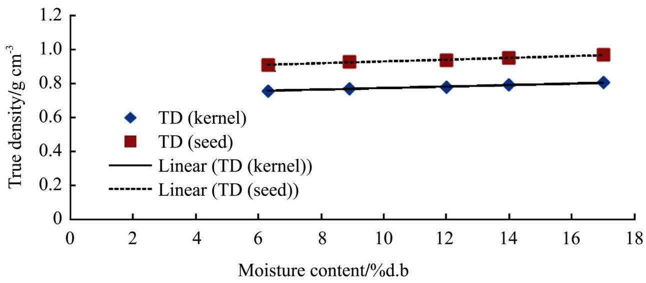


Figure 12 Effect of moisture content on true density of snake gourd seed and kernel

The result of true density indicates that the seed is lighter than water hence it will partially suspend in water. This is useful in design of cleaning and separation machines for the seed.

The statistical analysis of the effect of moisture content on the true density of snake gourd seed and kernel indicated that the effect was highly significant (p<0.05).

3.2.8 Effect of variation of moisture content on bulk density

The result of the effect of moisture on the bulk density of seed and kernel of snake gourd seeds is shown in Figure 13. The values of the bulk density for different moisture contents for seeds varied from 0.3360 to 0.3519 g/cm^3 which is 4.7% increase while that of kernel varied from 0.4131 to 0.4462 g/cm^3 which is about 8% increase when the moisture contents was increased from 6.8 to 17.0% d.b. The bulk density increased with the increase in moisture content. The increase in bulk density for snake gourd seed indicated that the increase in mass owing to moisture in the seed and kernel sample were higher than the accompanying volumetric expansion of the sample (Equation (28) and Equation (29)).

$$P_{Bk}(\text{mm}) = 0.007M_c + 0.329 \quad R^2 = 0.994 \qquad (28)$$

$$P_{Bs}(\text{mm}) = 0.008M_c + 0.404 \quad R^2 = 0.991 \qquad (29)$$

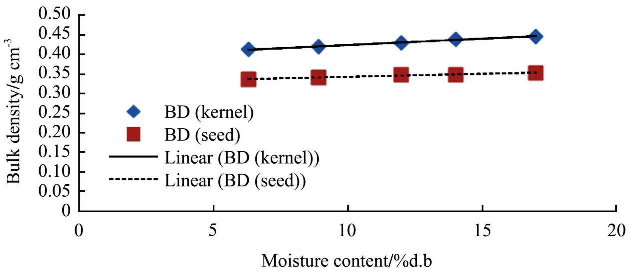


Figure 13 Effect of moisture content on bulk density of snake gourd seed and kernel

3.2.9 Effect of variation of moisture content on porosity

Figure 14 shows the effect of moisture content on porosity of the seed and the kernel. It could be assumed that the increase in moisture content does not affect the porosity of the seed while it reduced the porosity of the kernel. Similar trend were reported for caper (Sessiz et al., 2007), sunflower seed (Gupta and Das, 1997), soybean (Deshpad et al., 1993) and Turkish mahleb (Aydin et al., 2002). The relationships between the moisture content and the porosity of snake gourd seed and kernel were found to be linear relationships for some crops as reported in literature, Gupta and Prakash (1992) for sunflower seed, and Joshi et al. (1993), for pumpkin seeds.

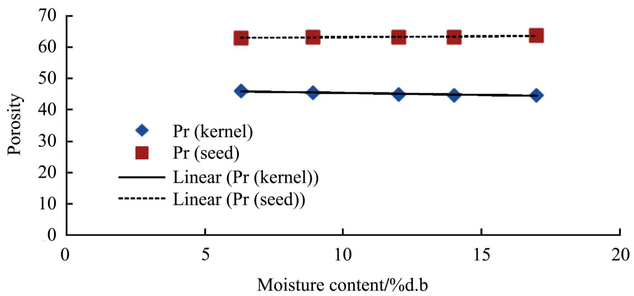


Figure 14 Effect of moisture content on porosity of snake gourd seed and kernel

The porosity of a seed depends on its bulk and true density and type of the seed (Equation (30) and Equation (31)) shows the relationship between the porosity and moisture content of snake guord seed and kernel.

$$P_{Rs}(\text{mm}) = 0.049M_c + 62.73 \quad R^2 = 0.767 \qquad (30)$$

$$P_{Rk}(\text{mm}) = 0.131M_c + 46.67 \quad R^2 = 0.933 \qquad (31)$$

Statistical analysis indicated that the effect of moisture content on the porosity of snake gourd seed and kernel was significant (p<0.05).

3.4.10 Effect of variation of moisture content on density ratio

The density ratio for seed decreased with the increase in moisture but for kernel the reverse was the case, the moisture content has little or no effect Figure 15. The reason may be that the kernel becomes softer with the increase in moisture at a faster rate than the seed. The mathematical relationships are shown below (Equation (32) and Equation (33)).

$$D_{Rs}(\text{mm}) = -0.003M_c - 0.014 \quad R^2 = 0.988 \qquad (32)$$

$$D_{Rk}(\text{mm}) = -0.078M_c + 0.821 \quad R^2 = 0.999 \qquad (33)$$

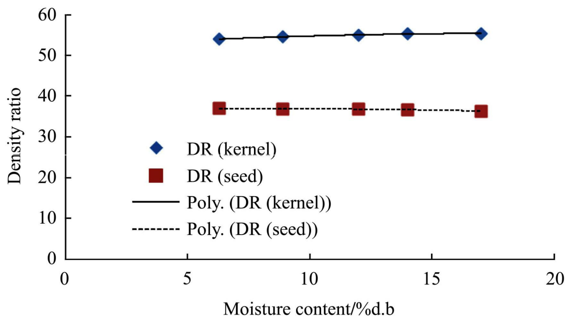


Figure 15 Effect of moisture content on density ratio of snake gourd kernel

The statistical analysis of the effect of moisture content on the density ratio of snake gourd seed and kernel indicated that the effect was highly significant (p<0.05).

4 Conclusions

From the investigation of effect of moisture content on the physical properties of snake gourd seed and kernel, the following results were obtained:

1) The grading of the snake gourd seed and kernel shows that the sample contain 14% big size of length above 13.5 mm, 75% for medium size of length 11.9-13.4 mm and 11% for smaller size of length less than 11.9 mm.

2) 1,000 mass, seed width, seed length, volume, spericity, geometrical mean and true density, bulk density, increased linearly with increase in moisture content.

3) The porosity and density ration decrease with

increase in moisture content.

4) Studies on effect of moisture content on surface area of the seed and the kernel shows a polynomial relationship with increase in moisture content.

References

Adebooye, O.C., F.M. Oloyede, J.T. Opabode, and O.O. Onagoruwa. 2007. Fruit characteristics and nutrient composition of landrace Mophotypes of snake gourds. *Journal of Vegetable Science,* 6(4): 6-7

Akaaimo, D.I., and A.O. Raji. 2006. Some physical and Engineering Properties of ProsopisAfricana seed. *Biosystems Engineering,* 95(2): 197-205.

Amin, M.N., M.A. Hossain, and C. Roy. 2004. Effects of moisture content on some physical properties of lentil seeds. *Journal of Food Engineering,* 65: 83 -87.

Anonymous. 2000. Snake Gourd. ECHO Plant Information Sheet USA http//www.echonet.org. (Acessed 5 June, 2013).

Aviara, N.A., M.I. Gwandzang, and M.A. Haque. 1999. Physical properties of guna seeds. *Journal of Agriculture Research,* 73: 105-111.

Aydin, C. 2007. Some engineering properties of peanut and kernel. *Journal of Food Engineering,* 79: 810-816

Balasubramanian, D. 2001. Physical properties of raw cashew nut. *Journal of Agricultural Engineering Research,* 78: 291-297.

Baryeh, E. A. 2002. Physical properties of millet. *Journal of Food Engineering,* 51: 39-46.

Calisir, S., T. Marakoglu, H. Ogut, and O. Ozturk. 2005. Physical properties of rapessed (*Brassica napusopeifera L.*). *Journal of Food Engineering,* 69(1): 61-66.

Carman, K. 1996. Some physical properties of lentil seeds. *Journal of Agricultural Engineering Research,* 6:87-92.

Chandrasekar, V., and R. Viswanathan. 1999. Physical and thermal properties of coffee. *Journal of Agricultural Engineering Research,* 73: 227-234.

Coskuner, V., and E. Karababa. 2007. Physical properties of coriander seeds (*Coriandrumsativum* L.). *Journal of Food Engineering,* 80: 408-416.

Desphande, S.D., S. Bal., and T.P. Ojha. 1993. Physical properties of soybean. *Journal of Agricultural Engineering Research,* 56: 89-98.

Dursun, E., and I. Dursun. 2005. Some physical properties of caper seed. *Biosystem Engineering,* 92(2): 237-245.

Edward, A. B. 2000. Physical properties of bambara groundnuts. *Journal of Food Engineering,* 47: 321–326.

Huxley. A.1992. The New RHS Dictionary of Gardening press. ISBN 0-335-47494-5.

Gupta, R.K., and S.K. Das. 1996. Physical properties of sunflower seeds. *Journal of Agricultural Engineering Research*, 66: 1-8.

Gupta, R.K., and S. Prakash. 1992. The effect of seed moisture content on the physical properties of JSF – 1 safflower. *Journal of Oilseeds Research,* 9: 209-216.

Idowu, D.O., and M. A. Adejumobi. 2009. Effect of processing variables on Angle of Repose and coefficient of Friction of dried fermented cassava Granues. *Journal of Engineering and Technology, Lautech, Ogbomoso*, 5(1): 23-27.

Idowu, D. O., Abegunrin, T. P., Ola, F. A., Adediran, A. A. and Olaniran, J. A. 2012. Measurement of some engineering properties of sandbox seeds (*Hura crepitans*). *Agriculture and Biology Journal of North America.* 3(8): 318-325.

Ige, M.T. 1977. Measurement of some parameters affecting the handling loses of some varieties of cowpea. *Journal of Agricultural Engineering Research,* 22: 127 – 133.

Irtwange, S.V., J. C. Igbeka. 2000. Some physical properties of two African yam bean (Sphenostylissternocarpa) accessions and their interrelations with moisture contents. *Applied Engineering in Agriculture.* 18(5): 567-576.

Jain, R.K., and S. Bal. 1997. Physical properties of pearl millet. *Journal of Agricultural Engineering Research,* 66: 85-91.

Joshi, D. C., S. K. Das, and R. K. Mukherje. 1993. Physical properties of pumpkin seeds. *Journal of Agricultural Engineering Research,* 54: 219-229.

Karababa, E., and Y. Coskunner. 2007. Moisture dependent physical properties of dry sweet corn kernels. *International Journal of Food properties.*10: 549-560.

Konak, M., K. Carman, and C. Aydin. 2002. Physical properties chickpea seeds. *Biosystem Engineering,* 82(1): 73-78.

Liu, S., W.C. Willett, M. J. Stampfer, F.B. Hu, Z.M. Fran, and L. Sampson. 2000. A prospective study of dietary glycenic load, carbohydrate intake, and risk of coronary heart diseases in US women. *American Journal of Clinical Nutrition*. 71(6): 1455-1461.

Masoumi, A.A., and L. G. Tabil. 2003. Physical properties of chickpea (C. arietnum) cultivars.An ASAE Meeting presentation, has vegas, Nevada, 27th– 30thJuly, U.S.A. paper No: 036058

Mohsenin, N. N. 1986. Physical properties of some plant and animal materials (2nded).New York, N.Y: Gordon and Breach Science Publishers.

Nimkar, P.M., S. Dipali, and R.M. Dudhe. 2005. Physical properties of moth gram. *Biosystems Engineering,* 9(2): 183-

189.

Ogunjimi, L. A. O., N.A. Aviara,and O.A.Aregbesola. 2002. Some engineering properties of locust bean seed. *Journal of Food Engineering,* 55: 95-99.

Ogunsina, B.S., I.O. Olaoye., O.O. Opeyemi, and A.O. Adegbenjo. 2009. Some nutritional,physical and mechanical properties of sponge gourd seeds. *Proceedings of 3rdInternational Conference of WASAE and 9th Conference of NIAE, January* 25th-29th, 2009, Ile-Ife, Nigeria.

Ogut, H. 1998. Some physical properties of lentil seeds. *Journal of Agricultural Engineering Research,* 63 (2): 87-92.

Oje, K., and E.C.Ugbor. 1991. Some physical properties of oil bean seed. *Journal of Agricultural Engineering Research,* 50: 305-315.

Oloyede, F. M. and O. C. Adebooye. 2005. Effect of season on growth, fruit yield and nutrient profile of two landraces of Trichosantes cucumerina L. *African Journal of Biotechnology,* 4(10): 1040-1044.

Omobuwajo, T.O., L.A Sanni,and J.O. Olajide. 2009. Physical properties of akee apple (Blighiasapida) seeds. *Journal of Food Engineering,* 45: 43-48.

Owolarafe, O.K., M.T. Olabige, and M.O. Faborode. 2007. Physical and mechanical properties of two varieties of fresh oil palm fruit. *Journal of Food Engineering,* 78: 1228-1237

Ozguven, F. and K. Vursavus. 2005. Some physical, mechanical and aerodynamic properties of pine (*Pinus Pinea*) nut. *Journal of Food Engineering*, 68: 191-196

Sahoo, P. K., and A.P. Srivastava. 2002. Physical properties of Okra seed. *Biosystems Engineering*, 83(4): 441-448.

Sedat, C., O. Musa, H.U. Haydar. 2004. A study on some physico-chemical properties of Turkey okra (*Hibiscus esculenta* L.) Seeds. *Journal of Food Engineering*, 68: 73-78

Sessiz, A.,R.Esgici, and S.Krizi. 2007. Moisture dependent physical properties of caper (capparis ssp.) fruit. *Journal of Food Engineering,* 79: 1426-1431.

Shepherd, H., and R.J.Bhardwaj. 1986. Moisture dependent physical properties of pigeon pea. *Journal of Agricultural Engineering Research,* 35: 227-234.

Sahlin.E., G.P. Savage, and G.E. Lister. 2004. Investigation of the antioxidant properties of tomatoes after processing. *Journal of Food Composition and Analysis,* 17: 635-647.

Tavakoli, H., A. Rajabipour, and S.S.Mohtasebi. 2009. Some moisture-dependent engineering properties of soybean grains. *Agricultural Engineering International: the CIGR Ejournal, Manuscript 1110. Vol. XI.*

Taser, O.F., E. Altuntas, andE. Ozgoz. 2005. Physical properties of Hungarian and common vetch seeds. *Journal of Applied Science,* 5(2): 323 – 326.

Velioghu, Y.S., G. Mazza, L. Gao and B.D. Oomah. 1998. Antioxidant activity and total phenolics in selected fruits, vegitables and grain products. *Journal Agricultural Food Chemistry,* 46: 4113-4117.

Zharg, D., and Y. Hamauzu. 2004. Phenollias, ascorbic acid, carotenoids and antioxidant activity of broccoli and their changes during conventional and microwave cooking. *Food Chemistry Journal,* 88: 503-509.