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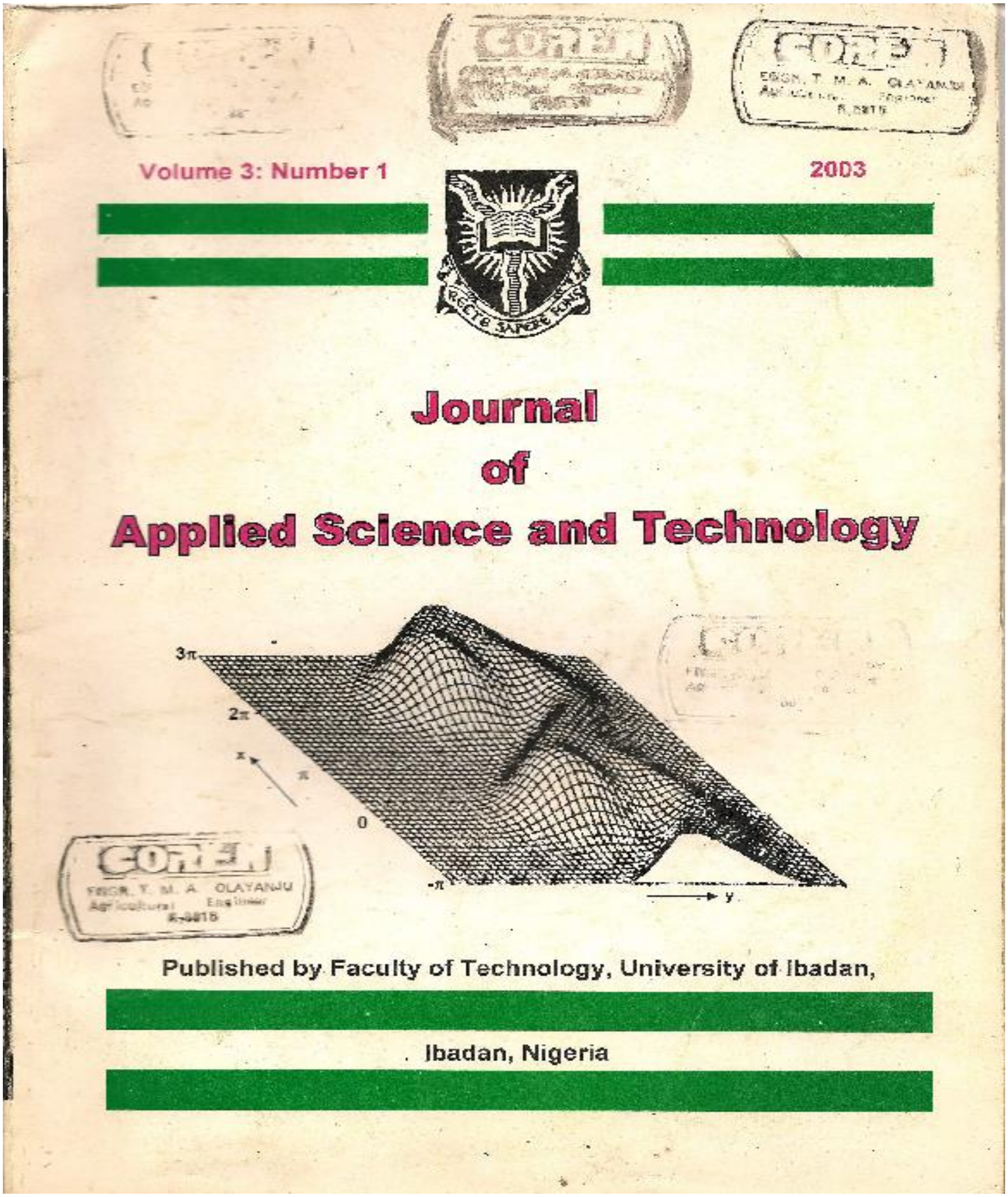

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CONTENTS

EFFECT OF MOISTURE CONTENT ON SOME PHYSICAL PROPERTIES OF TWO BENISEED ACCESSIONS

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ABSTRACT

Some physical properties of two beniseed accessions (Yandev-55 and E8) were determined at moisture content levels of 5.3, 10.6, 16.1, 22.4, and 28.3 per cent (wet basis). The properties were spatial dimensions, bulk density, true density, porosity and thousand-kernel weight. A-2 x 5 factorial experiment in completely randomized design was used for the study.

The spatial dimensions of major, intermediate and minor diameters were 2.80, 1.83 and 0.66mm for Yandev-55; 3.30, 2.13 and 0.75mm for E8 respectively. The corresponding geometric mean sizes were 1.49 and 1.73mm at 5.3% moisture content level. These values increased linearly with increase in moisture content. The sphericity values for the two accessions were in the range 0.52 to 0.55 (SD - 0.03). The bulk and true densities decreased from 0.698 to 0.613g/cm^3 and 1.042 to 0.981g/cm^3 for Yandev-55; 0.674 to 0.528g/cm^3 and 1.050 to 0.988g/cm^3 for E8 respectively with increase in moisture content from 5.3 to 28.3%. The porosity and thousand-kernel weight increased with increase in moisture content and are within the range of 34.52 to 46.56% and 2.53 to 3.50g respectively. The effect of moisture content of beniseed was highly significant on all the parameters except on major diameter and sphericity.

The parameters obtained are necessary inputs into the design of an efficient oil expeller for the seed.

Keywords: *Beniseed, Moisture content, Physical property, Accession*

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INTRODUCTION

Beniseed (***Sesame seed***) is grown in the Middle Belt and Northern Areas of Nigeria. It is an annual plant, which matures within 4 months reaching a height of 0.6 to 0.8m. The fruits are dehiscent axial capsules, 3 to 4cm long containing 4 segments with each housing 20 to 25 small flat seeds. The seeds are pear shaped, ovate, small, slightly flattened and thinner towards the hilium (Olayanju *et. al*, 2000).

There are different types of beniseeds, each with its peculiar properties. The colour varies from white through brown to black. Beniseed is a priced seed in the world because of the products that are derived from it. These are the dehulled seed, the oil and the cake. The seed is a rich source of oil, protein, phosphorous and calcium. The oil reacts rapidly on exposure to air, but forms a soft film after long exposure. This unique characteristic makes it one of the major edible oils in the semi – drying oil (Yen and Shyu, 1989). The seed contains about 50 – 55% oil; 20 – 25% protein, 20 –25% carbohydrates; 5 – 6% ash while the hull content accounts for about 20% of the seed (Kinsella, 1985 and Sahay, 1998).

Beniseed has been reported by Coote (1998) as having high economic potential both as source of oil and foreign exchange earner for the country. Raw beniseed is sold in world market at a price of US$550/MT while the processed oil from the seed can be sold at a price of about US$3, 500/MT (Coote, 1998). Therefore, the mechanization of its processing has recently generated much interest. In order to actualise this, it is necessary to establish some of its physical properties.

Several investigators have described the physical properties of different crops they worked with by measuring their three principal dimensions - major, intermediate and minor diameters; bulk and true densities; porosity, weight and volume. Duttal *et. al.* (1988) obtained sphericity of gram seed by drawing a shadowgraph of twenty replicate grams and then, the diameter of various inscribed and circumscribed circles of the projected areas were measured. The sphericity was later computed using standard equations as given by Mohsenin (1986). Joshi *et al.* (1993) investigated several physical properties of pumpkinseeds and kernels to facilitate the development of equipment for processes such as dehulling.

The knowledge of the physical properties of beniseed like any other biomaterial is fundamental because mechanical, rheological, thermal and other properties also depend on them. Therefore, the objective of this study is to determine some of the physical properties of beniseed as they relate to mechanical oil expression. The selected properties are major diameter, intermediate diameter, minor diameter, geometric mean size, sphericity, bulk density, true density, porosity and thousand-kernel weight.

MATERIALS AND METHOD

One kilogram, each of the two commonly grown beniseed accessions - Yandev 55 and E8 were obtained from the National Cereal Research Institute (NCRI) Bacegg in Niger State. These were conveyed to the experimental site in wet jute bags in order to prevent dehydration. The seeds were cleaned using a specific gravity separator to remove dust, sand, dry leaves and empty capsules. The moisture contents of the samples of the two beniseed accessions were determined by the oven drying method (ASAE Standards, 1996). Methods described by Kachru et. al., (1994) were used to adjust seeds to the desired moisture content.

Fifty replicate samples of cleaned beniseeds were randomly selected. The three principal dimensions of each seed namely major, intermediate and minor diameters were measured with a micro meter screw gauge, reading to 0.01mm. The geometric mean size and sphericity of each seed were determined using the following equation proposed by Mohsenin (1986):

Geometric Mean Size, $D_m = (L.B.T)^{1/3}$ (1)

and

Sphericity, $\psi = ((L.B.T)^{1/3})/L$ (2)

where: L = Longest intercept, (Length) in mm;
B = Longest intercept normal to 'L' (Breadth) in mm;
T = Longest intercept normal to 'L' and 'B' (Thickness) in mm.

A - 2 x 5 factorial experiment in Completely Randomized Design (CRD) with a total of 500 observations (2 accessions x 5 moisture content levels x 50 samples) was used for each of the parameters.

The bulk density of beniseed at different moisture content was determined by filling a container of known self-weight and volume to the brim with beniseeds and weighing to determine the net weight of the seeds. Uniform density was achieved by tapping the container 10 times in the same manner in all measurements. The bulk density was calculated as

$$\text{Bulk Density} = \frac{\text{Weight of sample (g)}}{\text{Volume occupied (cm}^3)} \quad (3)$$

The true or solid density defined as the ratio of a given mass of sample to its volume was determined by the water displacement method. Accordingly, a known weight (50g) of sample was poured into a 100cm^3 fractionally graduated cylinder containing 50cm^3-distilled water. The volume of water displaced by the seeds was observed. The true density was calculated as

$$\text{True Density} = \frac{\text{Weight of the sample (g)}}{\text{Volume of distilled water displaced (cm}^3)} \quad (4)$$

The porosity of an unconsolidated agricultural material can either be determined experimentally using the porosity tank method or theoretically from bulk and true densities of the material. Results from both methods have been found to be in close agreement (Waziri and Mittal, 1983). The porosity of beniseed in this work was determined using the relationship presented by Mohsenin (1986) as follow:

Porosity = (1 – (Bulk Density/ True Density))/100 (5)

For small seeds like beniseed, 1000 kernels were weighed and a parameter known as the thousand kernel weight (TKW) was determined. An electronic weighing balance having a sensitivity of 0.10g was used. A- 2 x 5 factorial experiment in CRD with a total number of 30 observations was used for each of the gravimetric properties.

RESULTS AND DISCUSSION

A summary of the results obtained on the investigated physical properties of beniseed at different moisture contents is as shown in Table 1. The analysis of variance (ANOVA) tables are summarized in Table 2.

The result indicates that moisture content has highly significant effect on all the parameters but non-significant on major diameter and sphericity at the 0.05 level. The regression equations in the moisture range of 5 to 30% as presented in Table 3 shows a positive correlation of all the parameters (apart from bulk and true densities) with moisture content, all having high correlation coefficients.

Figure 1 shows the effect of moisture content on the size of Yandev – 55 accession. The size indices exhibit linear increase with increase in moisture content. This could be due to increase in axial dimensions while gaining moisture. A similar trend was observed for E8 accession. Other investigators such as Gowda et al. (1990) and Arora (1991) have reported similar observation for linseed (*Linum usitatissimum*) CV. S-36 in the moisture range of 4.5 – 15% and for 3 varieties of rough rice (*Oryza sativa L.*) at 5% moisture content level.

Table 1: Some Physical Properties of Two Beniseed Accessions at Different Moisture Levels

Material	Moisture Content	Major Dia	Inter-mediate	Minor Dia	Geom. Mean	Sphericity	Bulk Density	True Density	Porosity	Thousand Kernel Wt.
	(%, wb)	(mm)	(mm)	(mm)	(mm)		(kg/m^3)	(kg/m^3)	(%)	(g)
Yandev 55	5.30	2.80	1.83	0.68	1.52	0.541	688	1042	33.97	2.63
	10.60	2.91	1.88	0.71	1.57	0.539	682	1031	34.11	2.72
	16.10	3.07	1.53	0.75	1.64	0.536	668	1017	34.32	2.88
	22.40	3.15	2.00	0.80	1.71	0.544	645	1010	36.13	2.93
	28.30	3.30	2.05	0.87	1.61	0.547	613	981	37.51	2.96
E8	5.30	3.30	2.13	0.75	1.74	0.537	674	1050	35.81	2.98
	10.60	3.42	2.21	0.78	1.81	0.528	638	1025	37.76	3.02
	16.10	3.56	2.24	0.83	1.88	0.518	594	1015	41.48	3.08
	22.40	3.65	2.38	0.87	1.99	0.519	553	1002	44.81	3.48
	28.30	3.93	2.82	1.00	2.18	0.554	528	988	48.58	3.50

Table 2: Summary of Analysis of Variance for the Physical Properties*

Source of variation	Degree of Freedom	Major Diameter (mm)	Intermediate Diameter (mm)	Minor Diameter (mm)	Geom. Mean (mm)	Sphericity	Bulk Density (kg/m^3)	True Density (kg/m^3)	Porosity (%)	Thousand Kernel Wt. (g)
Treatment	9									
Accession (A)	1	7.94^{**}	9.15^{*}	1.20^{NS}	4.51^{NS}	0.40^{NS}	2876^{**}	13.03^{**}	489.73^{**}	974.61^{**}
Moisture Content (M)	4	2.70^{NS}	65.0^{**}	60.0^{**}	20.50^{**}	0.25^{NS}	359.77^{**}	73.567^{**}	19.19^{**}	1471.79^{**}
Interaction (AXM)	4	0.03^{NS}	0.10^{NS}	0.03^{NS}	0.05^{NS}	0.30^{NS}	6.95^{**}	1.03^{NS}	3.52^{**}	0.97^{NS}
Error	490									

*values represent F – calculated; **highly significant difference; NS - non significant difference

Table 3: Regression Equations for Some Physical Properties of Beniseed in the Moisture Content Range of 5.3 to 28.3%

Property	Beniseed Accession: Yandev - 55 Linear Regression Equation	R^2	r	E8 Linear Regression Equation	R^2	r
Major Diameter, mm	2.692 + 0.021M	0.989	0.995	3.096 + 0.029M	0.896	0.946
Intermediate Dia., mm	1.778 + 0.009M	0.998	0.999	1.984 + 0.020M	0.907	0.953
Minor Diameter, mm	0.627 + 0.008M	0.981	0.991	0.676 + 0.010M	0.922	0.961
Geometric Mean, mm	1.444 + 0.012M	0.990	0.995	1.617 + 0.018M	0.962	0.981
Sphericity	0.535 + 0.0003M	0.427	0.653	0.523 - 0.0004M	0.082	0.287
Bulk Density, kg/m^3	0.687 - 0.002M	0.815	-0.922	0.681 - 0.002M	0.908	-0.956
True Density, kg/m^3	1.055 - 0.005M	0.959	-0.988	1.073 - 0.005M	0.906	-0.900
Porosity, %	34.35 - 0.174M	0.920	0.905	36.32 - 0.097M	0.859	0.964
1000 - Kernel Wt., g	2.518 + 0.072M	0.988	0.909	2.805 + 0.072M	0.959	0.979

M - moisture content, % wb, R^2 - coefficient of determination, r – correlation coefficient

The sphericities of the two accessions as shown in Figure 2 decreased as the moisture content increased from 5.3 to 16.1% and then increased with a further increase in moisture content to 28.3%. This observation was different from that of raya, toria and gobi sarson seeds reported by Sethi et al. (1992), where the sphericities were found to increase with increase in moisture content throughout the range of the studied moisture contents and that reported by Gowda et al. (1991) for pigeon pea in the moisture range of 8.24 to 29.07%. The observed trend for the studied accessions could be attributed to the large increase in seed length relative to width and thickness between 5.3 and 16.1% moisture content for the two accessions.

The sphericity values of beniseed for the two accessions are within the range 0.52 and 0.55. This falls within the range of 0.32 and 1.00 reported by Mohsenin (1986) for most agricultural crops. As sphericity is nearly constant within the harvest and storage moisture content of 16.1 and

5.3% wet basis, beniseed can be said to exhibit isometric shrinkage during drying.

The medium sphericity values for the seed indicate characteristics not that favourable for rolling of seeds to take place and thus has practical implication in the design of processing and storage equipment, especially in handling operations such as conveying and discharge from chutes.

The bulk and true densities decreased with increase in moisture content (Figure 3). This is similar to the trend obtained by Arora (1991) for 3 varieties of rough rice (Oryza sativa L.) at 5 moisture levels. However, for pistachios (Pistachio vera L.), Hsu *et al.* (1991) reported that bulk density increased linearly with moisture content while Kaleemullah (1992) reported a curvilinear decrease for groundnut CV. ICGS-44 with increase in moisture content. The reason for the different trends of agricultural products could be that some seeds, on application of moisture increase in volume much more than the corresponding weight gain and vice versa.

Figure 1: Effect of moisture content on the size of Yandev-55 Accession

Figure 2: Effect of moisture content on the sphericities of two beniseed Accessions

Figure 4 shows that the porosity and thousand-kernel weight (TKW) increased with increase in moisture content for the two accessions. The observation on porosity could be due to large increase in bulk density relative to true density as the moisture content increases for the two accessions. Gowda *et al.* (1990) as well as Arora and Singh (1991) have reported similar trends for linseed, sunflower and groundnuts. However, Sethi *et al.* (1992) and Joshi *et al.* (1993) reported a decrease in porosity of raya, toria, gobi sarson and pumpkinseeds with increasing moisture content. The differences may be attributable to the size and shape of individual seeds at high moisture contents. The E8 accession has higher porosity values than Yandev-55. This could be due to the larger size of the former.

The increase in thousand kernel weight with increase in moisture content is because increase in moisture content increases the water content (by weight) of the grain leading to an increase in the size of the grain. Similar results were reported by Gowda *et al.* (1990) and Gowda *et al.* (1991) for linseed (*Linum usitatissimum*) CV. S-36 seeds and pigeon pea within the moisture contents of 4.5 – 15% wb. Pan et al. (1996) reported the thousand-kernel weight of six low – temperature dried, high–oil maize hybrids (HOS) as ranging from 26.6 – 20.2g at 12.5% moisture content. The maximum values of 1000 - kernel weight for beniseed are 2.96g for Yandev-55 and 3.5 for E8 at 28.3%. The reported values for most of the seeds are very much higher than beniseed in relative comparison.

CONCLUSIONS

Vital values of some physical properties of beniseed had been established. This would enable engineers, food scientists and processors to get on with work on the mechanisation of production and utilisation processes of Nigerian grown beniseed. The following conclusions are drawn:

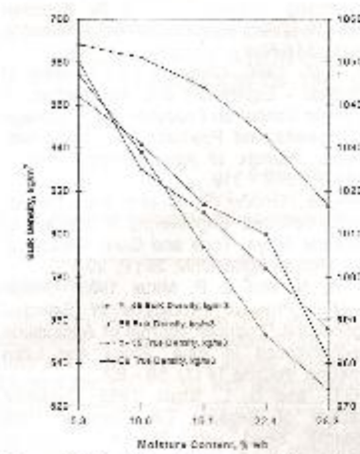

Figure 3: Effect of moisture content on the bulk and true densities of two beniseed Accessions

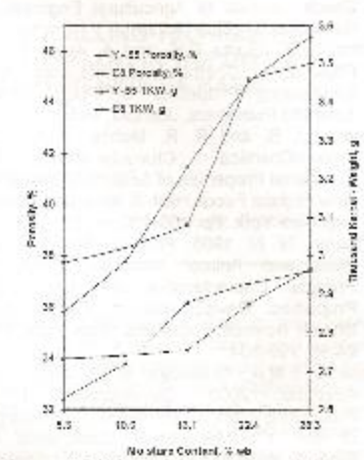

Figure 4: Effect of moisture content on the porosity and thousand kernel weight of two beniseed Accessions

- The linear dimensions and geometric mean size of beniseed increased linearly with increase in moisture content while sphericity decreased with increase in moisture content from 4.1 to 5.3% and then increased with further increase in moisture content to 10.3%.
- The bulk and true densities ranged from 528 to 682 kg/m³ and 981 to 1050kg/m³ respectively and are negatively correlated with moisture content.
- The porosity and thousand-kernel weight increased with increase in moisture content and are within the range of 34.52 to 46.56 and 2.63g at 5.3% to 3.5g.
- The analysis of variance result shows that there is a highly significant difference in accession and moisture content means for all the parameters except for major diameter and sphericity.

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