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VARIETAL CHARACTERIZATION OF THE PHYSICAL PROPERTIES, PROXIMATE AND MINERAL COMPOSITION OF IMPROVED SESAME (*Sesamun indicum*) SEEDS

[1]A. A. ADEBOWALE*,[1]G.O. FETUGA, [1]O.A. FALORE, [2]M.O. ADEGUNWA AND [3]S.A. SANNI

[1]Department of Food Science and Technology,
[2]Department of Foodservice and Tourism,
[3]Department of Nutrition and Dietetics,
Federal University of Agriculture, P. M. B. 2240, Abeokuta, Ogun State, Nigeria.
***Corresponding author:** deboraz2002@yahoo.com **Tel:** +2348034404207

ABSTRACT

The study was conducted to characterize the physical properties, proximate and mineral composition of improved sesame varieties. Fourteen improved varieties of sesame seeds were analyzed for their physical properties, proximate and mineral composition following standard analytical procedures. The arithmetic mean diameter (AMD), sphericity, geometric mean diameter (GMD), aspect ratio and surface area were in the range 1.51-1.91 mm, 0.57-0.64 mm, 1.32-1.70 mm, 61.50- 75.00%, and 84 - 8.94 mm^2, respectively. Ca, Fe, Mg and K contents were also in the range 5.4-20.2 mg/kg, 0.5-3.0 mg/kg, 1.5-7.4 mg/kg, and 2.9-12.9 mg/kg, respectively. There was significant varietal differences ($P<0.05$) in the physical properties, proximate and mineral composition of the improved sesame seeds. The improved sesame varieties were characterized into three groups with distinct physical properties, proximate and mineral composition using hierarchical clustering procedure. Cluster 1 consists of varieties with relatively low proximate and mineral composition while cluster 2 comprises varieties with higher amounts of these nutrients. The variety in cluster 3 was characterized with exceptionally low content of minerals. The diversity obtained in the physical properties and proximate composition of the improved sesame seeds from this study underscores the huge potentials of the improved sesame seeds in food and non food use.

Keywords: Sesame, variety, proximate, mineral, physical, properties, cluster.

INTRODUCTION

Sesame (*Sesamun indicum* L) is a flowering plant in the genus '*sesamin*'. It is one of the most important oilseed crops worldwide, and has been cultivated in Korea since ancient times for use as a traditional health food (Nzikou, 2009). India, Sudan, China and Burma are considered to be the major producers of sesame (Abou-Gharbia *et al*., 2000). It is cultivated in some parts of Benue, Plateau, Kwara, and Niger states of Nigeria. Sesame is an excellent source of high quality oil and protein (Kahyaglu & Kaya, 2006). Its oil is odourless and close in quality to olive oil. It is used widely as cooking oil and as a raw material in the manufacture of inks, paints, margarine and pharmaceuticals.

Sesame oil is excellent edible oil that has high preservative qualities (Abou-Gharbia *et al.,* 1997). It prevents rancidity, even though the seeds are prone to rancidity, the oil is resistant to oxidation and this is because of the natural preservative within the oil called sesamol (Yoshida & Takagi, 1999). Sesame seed protein is a cheap source of protein that is rich in methionine and tryptophan (Lu *et al.,* 2010). Sesame protein isolates or sesame meal is used with other ingredients in the manufacture of bread and biscuit. Partial replacement of milk protein with sesame protein isolate has been reported to enhance the overall textural characteristics of fresh cheese (Lu *et al.,* 2010). Kim *et al.* (2009) reported that black sesame seed methanol extract possess 2,2´-diphenyl-1-pycryl-hydrazil (DPPH) and 2,2 -azino-bis [3-ethylbenzthiazoline-6-sulphonic acid] (ABTS) radical scavenging activities and induced colon cancer cell apoptosis.

Sesame oil extraction is done traditionally by pounding the seeds in a mortar and pouring water into it. This causes the oil to float to the surface from where it can be removed by skimming. The method is slow and laborious and results in low oil yield. There is therefore the need to develop equipment that will remove the drudgery involved in oil processing and also optimize oil yield. Kachru *et al*. (1994) observed that for proper design of equipment for handling, conveying, separation, dehulling, drying and mechanical expression of oil, some of the physical properties of the oil seeds have to be known.

There are numerous high yielding and drought tolerant improved sesame varieties and cultivars adaptable to various agro-ecological conditions. However, the cultivation of improved sesame varieties has been reported to be limited due to insufficient genetic information, grain qualities and nutritional composition (Nzikou *et al*, 2009). Two studies that used morphological characters to group genotypes into clusters (Patil & Sheriff, 1994; Ganesh & Thangavelu, 1995) found a wide genetic diversity in Indian sesame cultivars. There is limited scientific information on the varietal characterization of the physical properties, proximate and mineral composition of improved sesame seeds. This information is needed to allow plant breeder to develop improved cultivars by selecting from existing populations within specific geographic regions (Souza & Sorrels, 1991). Also, in order to provide useful scientific information that will enhance the adoption of improved sesame varieties for various end uses, knowledge of the physical properties and nutrient composition of the seeds are important. The improved sesame varieties selected for this study are high yielding, early maturing and drought resistance. They have also been found to be suitable for diverse agro-ecological conditions (Olowe, 2004 and 2007). The objective of this study was to characterize different improved sesame varieties based on their physical properties, proximate and mineral composition.

MATERIALS AND METHODS

Source of Improved sesame seeds

Fourteen improved varieties of sesame seeds were used for this study. The seeds were obtained from National Centre for Genetic Resources and Biotechnology (NACGRAB), Moor Plantation, Ibadan, Oyo State, Nigeria.

Experimental Procedures

Physical properties of sesame seeds

1000 Seed weight: One thousand seeds were randomly selected and the weight was measured using an electronic balance (Metler

AE240S; Metler-Toledo, Greifensee, Switzerland) of 0.001g accuracy.

Linear Dimensions: Measurements of the three major linear dimensions, namely length (L, mm), width (W, mm) and thickness (T, mm), were carried out with a micrometer screw gauge to an accuracy of 0.001 mm. The arithmetic mean diameter (De) and the geometric mean diameter (Dg) of the seeds were calculated using equations (1) and (2), respectively (Mohsenin, 1978) .

$$De = \frac{L+W+T}{3} \quad (1)$$

$$Dg = LWT^{1/3} \quad (2)$$

Aspect ratio (%R_a): This was obtained using the following relationship (Maduako & Faborode, 1990):

$$\%R_a = \left(\frac{W}{L}\right) x\ 100 \quad (3)$$

Sphericity (Φ): This was obtained using the formula given by Jain and Bal (1997) as follows:

$$\Phi = \frac{(LWT)^{1/3}}{L} \times 100 \quad (4)$$

Surface area: The Surface area (S, mm^2) of seeds was calculated using equation (5) (Jain & Bal, 1997):

$$S = \pi(Dg^2) \quad (5)$$

Volume: Seed volume was calculated using equation (6) (Jain & Bal, 1997):

$$V = \frac{WT^{1/2}L^2}{6(2L - WT^{1/2})} \quad (6)$$

Determination of proximate and mineral composition

Moisture, crude protein, fat, crude fibre and total ash contents were determined by the method of AOAC (1990). Carbohydrate was calculated by difference. Mineral content was determined following the procedures of AOAC (1990) method. Calcium, magnesium and iron were determined with atomic absorption spectrophotometer (AAS Model 403). Potassium was determined by flame photometry.

Statistical Analysis

All data were subjected to one-way Analysis of Variance (ANOVA) and means separated with Duncan's Multiple Range Test (DMRT) and Pearson's correlation matrix using SPSS Statistics version 17.0, SPSS Inc., US. Hierarchical clustering was performed to classify the varieties based on all the measured properties using Squared Euclidean Distance as the measure of dissimilarity.

RESULTS AND DISCUSSION

Physical properties of improved varieties of sesame seeds

Table 1 presents the physical properties of improved sesame seeds. The result showed that there were significant varietal differences ($P<0.05$) in all the measured physical properties. Variety NG/SA/07/095 had the highest value of 1000 seed weight (3.12 g) and YANDEF 55, had the lowest (1.09 g). The length of YANDEF 55 was the lowest (2.26 mm) while that of NCRI BEN 01M was the highest (3.01 mm). The breadth ranged from 1.55 to 1.86 mm, with KANO 05 having the least value and NG/SA/07/095 having the highest value. The thickness also ranged between 0.65 and 0.97 mm. Similar results were reported for black cumin seeds (Al-Mahasneh *et al.,* 2007) millet and local varieties of sesame seeds (Baryeh, 2002; Tunde-Akintunde & Akintunde, 2007).

Sesame seed can be cleaned based on properties of the desirable seed and contaminants. According to Sahay (1998), vibration screens separate products on the basis of differences in size of various constituents whereas air screen cleaners separate material on the basis of difference in size and weight. If any of these principles are to be applied in equipment design; one of the important factors that must be considered, based on the findings from this study, is variety of sesame seed. Handling losses during cleaning are affected by size and shape of sesame seed. If the hole is too big, this may result in uncleaned seeds while too small a hole may lead to lesser efficiency. For optimum performance of the cleaner, the sizes of perforations have to be carefully selected and this can be enhanced by the knowledge of the physical dimensions of the seeds.

The arithmetic mean diameter (AMD) and geometric mean diameter (GMD) which are dependent on the length, breadth and thickness were in the range 1.51-1.91 mm and 1.32-1.70 mm, respectively. The values were lower than that of millet and sorghum (Baryeh, 2002; Simonyan *et al*, 2007). The AMD and GMD can be used to determine the average diameter of sesame seeds, which is useful in determining the aperture size of sieve holes. The degree of sphericity which is indicative of the seed shapes towards a sphere, ranged between 0.57 and 0.65 which is similar to values obtained by Tunde-Akintunde & Akintunde 2004; 2007) for traditional varieties of sesame as well as that of sunflower seeds but it is lower than that of millet grains (0.78 – 0.83) and soybean seeds which was 0.81 – 0.82 (Deshpade *et al.*, 1993). Hence, the shape of sesame seeds (round at bottom and tappers at top) is similar to that of sunflower seeds (Gupta & Das 1997) while that of millet and soybean seeds are more spherical (Deshpade *et al.,* 1993; Baryeh, 2002).

The aspect ratio which relates the seed width to length ranged between 61.50 and 75.00%. The high aspect ratio obtained for most of the improved sesame seeds is indicative that the seeds will rather roll than slide on flat surfaces. Surface area (SA) which is very important in the determination of heat and mass transfer ranged from 5.84 - 8.94 mm^2 with KANO 05 having the least and NG/SA/07/052 having the highest. The values obtained were in close agreement with the result obtained by Tunde-Akintunde & Akintunde (2007) for local varieties of sesame seeds. This implied that the improved sesame varieties studied would not pose much problem in designing machines for processing as their dimensions are not considerably different from the existing traditional varieties.

Table 1: Physical properties of improved sesame variety seeds

Variety	1000 seed weight (g)	Length (mm)	Breadth (mm)	Thick-ness (mm)	Aspect Ratio (%)	Arithmetic Mean Di-ameter (mm)	Geometric Mean Di-ameter (mm)	Degre of Spheric-ity	Surface Area (mm^2)	Volume (mm^3)
NCRI BEN 01M	2.68^{f}	3.01^{f}	1.84^{d}	0.88^{cde}	61.50^{a}	1.91^{e}	1.70^{g}	0.57^{ab}	9.05^{g}	1.64^{f}
NGB/04/026	1.92^{d}	2.56^{bc}	1.68^{b}	0.79^{bc}	65.87^{abc}	1.67^{bc}	1.50^{cde}	0.59^{abc}	7.08^{cde}	1.15^{cd}
NCRI BEN 03L	1.57^{b}	2.40^{ab}	1.70^{b}	0.76^{b}	71.06^{cde}	1.62^{b}	1.45^{cd}	0.61^{bcde}	6.65^{bcd}	1.07^{bc}
NG/SA/07/179	1.93^{e}	2.51^{bc}	1.55^{a}	0.76^{b}	61.81^{a}	1.60^{b}	1.43^{bc}	0.57^{ab}	6043^{bc}	0.99^{abc}
NG/SA/07/090	3.09^{m}	2.79^{de}	1.72^{bc}	0.92^{de}	62.07^{a}	1.81^{d}	1.64^{fg}	0.59^{abc}	8.46^{fg}	1.51^{efg}
NG/SA/07/095	3.12^{n}	2.94^{ef}	1.86^{d}	0.91^{de}	63.63^{ab}	1.91^{e}	1.71^{g}	0.59^{abc}	9.17^{g}	1.69^{f}
NG/SA/07/106	3.05^{l}	2.71^{cd}	1.83^{cd}	0.97^{e}	68.02^{abcd}	1.84^{de}	1.68^{g}	0.63^{de}	8.90^{g}	1.67^{f}
NG/SA/07/052	2.96^{k}	2.86^{def}	1.78^{bcd}	0.95^{de}	62.45^{a}	1.86^{de}	1.69^{g}	0.59^{abc}	8.94^{g}	1.63^{f}
NG/SA/07/137	2.77^{h}	2.69^{cd}	1.77^{bcd}	2.95^{de}	65.89^{abc}	1.80^{d}	1.65^{fg}	0.61^{bcde}	8.50^{f}	1.54^{fg}
OM1	2.88^{i}	2.85^{def}	1.75^{bcd}	0.89^{de}	61.81^{a}	1.83^{de}	1.64^{fg}	0.58^{ab}	8.50^{fg}	1.50^{efg}
YANDEF 55	1.09^{a}	2.26^{a}	1.57^{a}	0.65^{a}	69.51^{dcde}	1.50^{a}	1.32^{a}	0.58^{ab}	5.50^{fg}	0.79^{a}
OKENE MKT	2.93^{j}	2.38^{ab}	1.76^{bcd}	0.86^{cd}	75.00^{e}	1.66^{bc}	1.52^{de}	0.65^{e}	7.34de	1.29^{cd}
NCRI BEN 02M	2.71^{g}	2.48^{b}	1.79^{bcd}	0.88^{cde}	73.00^{de}	1.71^{c}	1.57^{ef}	0.64^{de}	7.71^{ef}	1.36^{def}
KANO 05	1.86^{c}	2.26^{a}	1.53^{a}	0.ab	67.83^{abcd}	1.51^{a}	1.36^{ab}	0.60^{abcd}	5.84^{ab}	0.88^{ab}

Values are means of ten replicates

Mean values having different superscript within column are significantly different ($P<0.05$)from on another

Proximate and mineral composition of improved varieties of sesame seeds

Table 2 shows that significant varietal differences existed in the proximate composition as well as the mineral content ($P<0.05$). The moisture content ranged between 5.0 and 8.8%. Lower moisture content is an indication of longer shelf-life. The moisture content of all the seed were lower than 10% which implied that they are shelf stable.

The ash content of the seeds ranged from 4.0 to 7.0% with NG/SA/07/106 having the least value and YANDEF 55 having the highest value. The ash content is an indication of the mineral content of food comodities. NCRI BEN OIM had the highest fat content of 20.5% while YANDEF 55 had the least value of 11.5%. The fat content of the improved sesame seeds was lower than values reported by Yoshida (1994) and Tokusoglu *et al.* (2004) for traditional sesame seeds. Therefore, the improved seed should be further explored to develop a high crude oil yield variety that would have immense nutritional and economic advantages. The crude protein content of NG/SA/07/106 was found to be the highest (23.0%) while NG/SA/07/179 had the lowest (12.7%). The crude fibre content ranged from 1.7 - 2.5%. The crude fibre content is an indication of the roughages/bulkiness of the seed meal, the higher the crude fibre content, the more bulky the meal. Carbohydrate content of NCRI BEN OIM was the lowest (41.6%) while that of NCRI BEN 02M was the highest (58.2%).The variation in the values could be a reflection of variations in the genetic makeup of the seeds (Yoshida, 1994).

The mineral composition is also presented in Table 2 and all the mineral contents of the varieties are significantly different ($P<0.05$) from each other. YANDEF 55 had the lowest iron content (0.5 mg/kg) while OM1 had the highest (2.2 mg/kg). Iron is an important component of the red blood cells, which enhances the oxygen-carrying capacity of the red blood cells. Despite the presence of abundant quantities of iron in the physical environment and the relatively low requirements of the body for iron, iron deficiency remains one of the commonest nutritional problems among vulnerable groups especially in developing countries. There is a high genetic diversity in the iron contents of the improved sesame seeds. Virtually all the sesame seed varieties had higher values of calcium content, (NG/SA/07/106 had the highest value of 20.2 mg/kg while YANDEF 55 had the least value of 5.4 mg/kg). This implied that NG/SA/07/106 is very rich in calcium and preferably good for strong bone and teeth compared to others. Magnesium content ranged from 1.5 – 6.6 mg/kg, with YANDEF 55 having the least and NCRI BEN 01M had the highest. Potassium content ranged from 2.9 - 12.9%. Calcium, magnesium and potassium, are the macro minerals needed in highest amounts by the body. High amounts of these macro minerals obtained in some sesame varieties in this study would be of important nutritional significance.

Table 2: Proximate and mineral contents of improved sesame variety seeds

Variety	Moisture (%)ns	Ash (%)	Fat (%)	Protein (%)	Crude fibre (%)	Carbohy-drate (%)	Ca (mg/kg)	Fe (mg/kg)	Mg (mg/kg)	K (mg/kg)
NCRI BEN 01M	8.6^{de}	6.8^{de}	20.5^{d}	20.3^{gh}	2.2^{j}	41.6^{a}	19.3^{l}	1.4c	6.6^{fg}	11.5^{j}
NGB/04/026	5.0^{a}	5.0^{abc}	15.5^{abc}	16.6^{bc}	2.2^{i}	55.9^{d}	17.6^{g}	1.1^{b}	7.0^{h}	12.6^{l}
NCRI BEN 03L	7.0^{c}	6.3^{cde}	16.0^{bc}	22.1^{f}	2.0^{e}	46.7^{abc}	16.2^{c}	1.9^{f}	5.7^{c}	9.6^{c}
NG/SA/07/179	6.0^{b}	4.3^{ab}	17.0^{cd}	12.7^{a}	1.9^{a}	58.2^{d}	13.2^{b}	1.9^{e}	5.9^{d}	10.4^{e}
NG/SA/07/090	8.0^{d}	5.5^{bcd}	14.5^{abc}	16.3^{b}	2.0^{d}	53.8^{bcd}	19.9^{m}	2.0^{i}	6.0^{d}	9.9^{d}
NG/SA/07/095	6.3^{b}	4.3^{ab}	13.0^{abc}	19.4^{fg}	1.9^{b}	55.2^{cd}	16.5^{d}	2.4^{k}	6.7^{g}	11.2^{h}
NG/SA/07/106	7.5^{cd}	4.0^{a}	12.5^{ab}	23.0^{i}	2.0^{h}	49.9^{abcd}	20.2^{n}	3.0^{l}	7.1^{h}	12.9^{n}
NG/SA/07/052	5.5^{ab}	5.3^{abc}	14.0^{abc}	18.2^{e}	2.3^{l}	54.9^{cd}	19.1^{k}	3.0^{l}	6.6e^{fg}	10.6^{f}
NG/SA/07/137	6.5^{bc}	5.0^{abc}	13.0^{abc}	18.4^{ef}	1.9^{c}	55.2^{cd}	16.5^{e}	1.9^{g}	5.2^{b}	9.3^{b}
OM 1	7.0^{c}	4.3^{ab}	12.5^{ab}	17.5^{cde}	2.2^{k}	58.5^{d}	17.8^{i}	2.2^{j}	6.5^{ef}	11.1^{g}
YANDEF 55	8.3^{d}	7.0^{e}	11.5^{a}	20.1^{gh}	2.0^{f}	51.1^{bcd}	5.4^{a}	0.5^{a}	1.5^{a}	2.9^{a}
OKENE MKT	6.0^{b}	5.3^{abc}	14.5^{abc}	17.1^{bcd}	2.1^{g}	54.9^{cd}	17.5^{f}	2.1j	7.4^{i}	12.5^{m}
NCRI BEN 02M	7.0^{c}	5.8^{cde}	14.^{abc}	13.3^{a}	2.4^{m}	57.0^{d}	18.1^{j}	1.9^{h}	6.5^{e}	11.6^{k}
KANO 05	8.3^{d}	6.0^{cde}	16.5^{bcd}	20.8^{h}	2.5^{n}	45.9^{ab}	17.7h	1.6d	7.3^{i}	11.4^{i}

Values are means of three replicates

Mean values having different superscript within column are significantly different ($P<0.05$) from one another

Varietal characterization of the improve sesame seeds

Table 3 shows the coefficient of correlation between the physical properties, proximate and mineral composition of improved sesame seeds. The ash content negatively (P<0.05) correlated with iron, potassium, 1000 seed weight and thickness. All the physical properties except length and degree of sphericity significantly correlated (P<0.05) with the iron content of the improved sesame seeds. A strong significant (P<0.05) positive correlation was recorded between the 1000 seed weight and the physical dimensions (i.e. length, breadth, thickness, geometric mean diameter and surface area) of the improved sesame seeds.

Since the ANOVA results have shown that there were significant (P<0.05) differences among the improved sesame seeds in terms of the physical properties, proximate and mineral composition determined, it means that each of the parameters is a potential variable that could be used in characterizing the improved varieties into distinct groups. Therefore, hierarchical clustering was performed to classify the varieties based on all the measured properties using Squared Euclidean Distance as the measure of dissimilarity. The classification achieved is presented in form of a dendogram (Fig. 1). Cluster 1 is the largest consisting of 7 varieties [NGB/04/026 (2), NG/SA/07/090 (5), NG/SA/07/095 (6), NG/SA/07/052 (8), NG/SA/07/137 (9), OM1 (10), OKENE MKT (12)]; Cluster 2 consists of 6 members [NCRI BEN 01M (1), NCRI BEN 03L (3), NG/SA/07/179 (4), NG/SA/07/106 (7), NCRI BEN 02M (13), KANO 05 (14)] while variety YANDEF 55 (11) form a separate distinct cluster (cluster 3). YANDEF 55 (11) is characterized by exceptionally low contents of Ca, Fe, Mg and k with low values of volume and surface area. Members of cluster 1 possessed low moisture content, ash, fat, carbohydrate, 1000 seed weight, aspect ratio and low mineral content (Ca, Fe, Mg and k) while varieties in cluster 2 are characterized by relatively higher amounts of these nutrients.

Table 3: Pearson's correlation coefficient between physical properties, proximate and mineral composition of improved sesame varieties

	MC	Ash	Fat	Protein	CF	CHO	Ca	Fe	Mg	K	Seed 1000	Length	Breadth	Thick-ness	GMD	DSP	SA
MC	1																
Ash	0.56*	1															
Fat	0.19	0.35	1														
Protein	0.43	0.23	-0.09	1													
CF	0.20	0.29	0.18	0.06	1												
CHO	-0.70**	-0.62	-0.52	-0.74**	-0.23	1											
Ca	-0.11	-0.35	0.28	0.03	0.32	-0.01	1										
Fe	-0.29	-0.64*	-0.21	0.08	0.03	0.21	0.66*	1									
Mg	-0.30	-0.48	0.36	-0.08	0.34	0.01	0.88**	0.60*	1								
K	-0.31	-0.53	0.34	-0.11	0.28	0.05	0.87**	0.60*	0.98**	1							
Seed 1000	-0.14	-.53*	-0.13	-0.11	-0.01	0.25	0.74**	0.76**	0.60*	0.62*	1						
Length	-0.05	-0.36	0.10	0.03	-0.18	0.02	0.53	0.48	0.33	0.34	0.72**	1					
Breadth	-0.11	-0.27	-0.10	0.16	-0.08	0.01	0.58*	0.57*	0.39	0.46	0.79**	0.74**	1				
Thick-ness	-0.18	-0.52	-0.16	-0.01	-0.03	0.21	0.75**	0.79**	0.53	.56*	0.94**	0.75**	0.83**	1			
GMD	-0.12	-0.43	-0.06	0.05	-0.11	0.10	0.68**	0.66**	0.45	0.49	0.89**	0.92**	0.90**	0.94**	1		
DSP	-0.15	-0.10	-0.27	0.04	0.21	0.12	0.30	0.35	0.31	0.37	0.29	-0.36	0.31	0.28	0.04	1	
SA	-0.10	-0.43	-0.07	0.07	-0.11	0.08	0.67**	0.67**	0.44	0.48	0.89**	0.92**	0.90**	0.93**	0.99**	0.03	1

*Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)
MC Moisture content; CF Crude fibre; CHO Carbohydrate; Seed100 Weight of 1000 seeds; GMD Geometric mean diameter; DSP Degree of sphericity; SA Surface area.

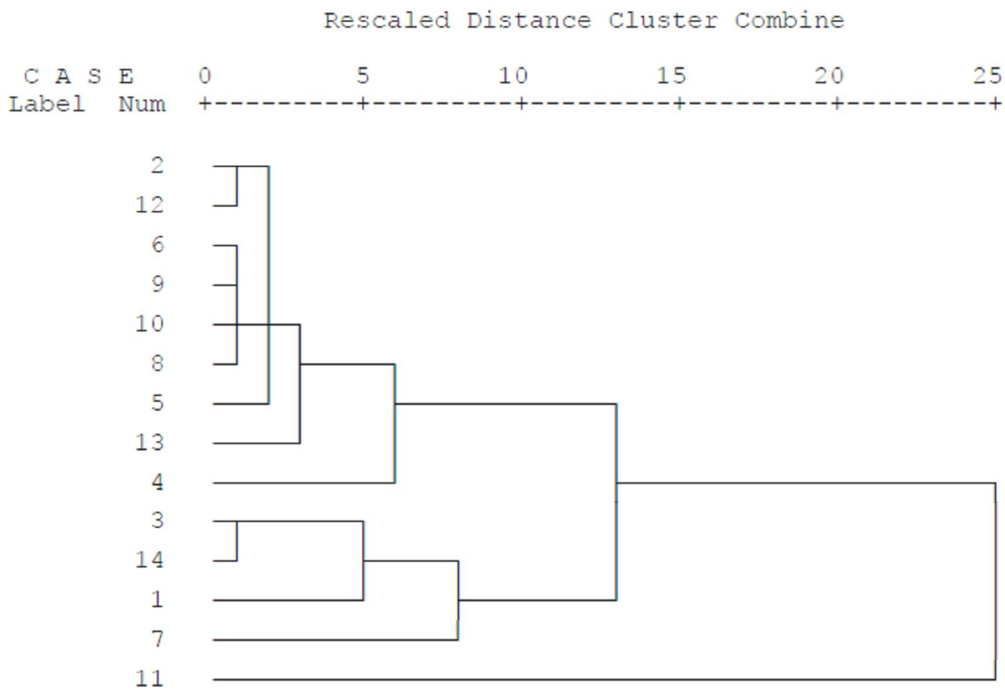

Fig. 1: Dendogram showing three hierarchical clusters of improved sesame varieties on physical properties and nutritional composition

Clustering method: complete linkage using Euclidean distance as measure of dissimilarity.
CLUSTER 1: NGB/04/026 (2), NG/SA/07/090 (5), NG/SA/07/095 (6), NG/SA/07/052 (8), NG/SA/07/137 (9), OM1 (10), OKENE MKT (12); CLUSTER 2: NCRI BEN 01M (1), NCRI BEN 03L (3), NG/SA/07/179 (4), NG/SA/07/106 (7), NCRI BEN 02M (13), KANO 05 (14); CLUSTER 3: YANDEF 55 (11).

CONCLUSION

The study concluded that there were significant varietal differences (P<0.05) in the physical properties, proximate and mineral composition of the improved sesame seeds. The improved varieties were classified in terms of their physical properties and nutritional composition into three distinct categories. Variety NCRI BEN OIM was the best in terms of most of the parameters determined while YANDEF 55 was the least. The physical properties of the improved sesame seeds were very close to values already reported for traditional varieties and this implied less requirement for major modifications in the existing processing equipment for the improved sesame seeds.

REFERENCES

Abou-Gharbia, H.A., Shahidi, F., Shehata, A.A.Y. & Youssef, M.M. 1997. Effect of processing on Oxidative stability of sesame oil extracted from intact and dehulled seed. *Journal of American Oil Chemists' Society:* 74: 215-221.

Abou-Gharbia, H.A., Shehata, A.A.Y., Shahidi, F. 2000. Effect of processing on oxidative stability and lipid classes of sesame oil. *Food Research International*, 33: 331-334.

Al-Mahasneh, M.A., Ababneh, H.A., Rababah, T. 2007. Some engineering and thermal properties of back cumin (*Nigella sativa* L.) seeds. *International Journal of Food Science and Technology,* 10: 1365-2621.

AOAC 1990**.** *Official methods of analysis*. Association of Official Analytical Chemists: Washington, DC.

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

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

Ganesh, S.K., Thangavelu, S. 1995. Genetic divergence in sesame (*Sesamum indicum* L.). *Madras Agricultural Journal,* 82: 263-265.

Gupta, R.K., Das, S.K. 1997. Physical Properties of Sunflower Seeds. *Journal of Agricultural Engineering Research,* 66: 1 – 8.

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

Kachru, R.P., Gupta, R.K., Alam, A. 1994. *Physio-chemical constituents and engineering properties of food crops*. Jodhpur, India, Scientific Publisher.

Kahyaoglu, T., Kaya, S. 2006. Modelling of moisture, colour and texture changes in sesame seeds during the conventional roasting. *Journal of Food Engineering,* 75: 167-177.

Kim, M.J., Jeong, M.K.., Chang, P.S., Lee, J. 2009. Radical scavenging activity and apoptotic effects in HT-29 human colon cancer cells of black sesame seed extract. *International Journal of Food Science and Technology*, 44: 2106-2112.

Lu, X., Schmitt, D., Chen, S. 2010. Effect of sesame protein isolate in partial replacement of milk protein on the rheological, textural and microstructural characteristics of fresh cheese. *International Journal of Food Science and Technology*, 45: 1368-1377.

Maduako, J.N., Faborode, M.O. 1990. Some physical properties of cocoa pods in relation to primary processing. *Ife Journal of Technology,* 2: 1-7.

Mohsenin, N.N. 1978. *Physical properties of plant and animal materials*. Gorden and Breach Science Publisher, New York.

Nzikou, J.M., Matos, L., Bouanga-Kalou, G., Ndangui, C.B., Pambou-Tobi, N.P.G., Kimbonguila, A., Linder, T.M., Desobry, S. 2009. Chemical composition of the Seeds and oil of sesame (*Sesamum indicum* L.) grown in Congo-Brazzaville. *Advance Journal of Food Science and Technology*, 1, 6-11.

Olowe, V.I.O. 2004. Production potential for sesame in the forest-savannah transition zone of south-west Nigeria. *MUARIK BULLETIN*, **7:** 20-29.

Olowe, V.I.O. 2007. Optimum planting date for sesame (*Sesamum indicum* L.) in the transition zone of south west Nigeria. Agriculture *Tropica et Subtropica,* 40: 156-163.

Patil, R.R., Sheriff, R.A. 1994. Genetic divergence in Sesame (*Sesamum indicum* L.). *Mysore Journal of Agricultural Science,* 28: 106-110.

Sahay, K.M. 1998. *Cleaning and grading of oil seed: equipment and approaches.* Central Institute of Agricultural Engineering, Bhopal, India, pp 61-64.

Simonyan, K.J., El-Okene, A.M., Yiljep, Y.D. 2007. Some Physical Properties of Samaru sorghum 17. *Agricultural Engineering International; the CIGR Ejournal* manuscript FPO7008, Volume IX.

Souza, E., Sorrels, M.E. 1991. Relationships among 70 North American oat germplasm: I. cluster analysis using quantitative characters. *Crop Science*, 31: 599-605.

Tokusoglu O., Onal, M.K., Alakr, I. 2004. Proximate, chemical composition, amino acid and fatty acid profile of sesame seed flour. *Journal of Food Science and Technology (Mysore),* 41: 409-412.

Tunde – Akintunde, T.Y., Akintunde, B.O. 2004. Some physical properties of sesame seed. *Biosystems Engineering,* 88: 127 – 129.

Tunde-Akintunde, T.Y., Akintunde, B.O. 2007. Effect of moisture content and variety on selected properties of beniseed". *Agricultural Engineering International; the CIGR*

Yoshida, H. 1994. Composition and quality characteristics of sesame seed (*Sesamumindicum*) oil roasted at different temperatures in an electric oven. *Journal of the Science of Food and Agriculture,* 65: 331-336.

Yoshida, H., Takagi, S. 1999. Antioxidant effects of sesamol and tocopherols at various concentrations in oils during microwave heating. *Journal of the Science of Food and Agriculture,* 79: 220-226.

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