Libyan Agriculture Research Center Journal International 1 (2): 103-107, 2010
ISSN 2219-4304

Varietal Differences in the Physical Properties and Proximate Composition of Elite Sesame Seeds

[1]*A.A. Adebowale*, [2] *S.A. Sanni and* [3]*O.A. Falore*

[1]Department of Food Science and Technology,
University of Agriculture, P.M.B. 2240, Abeokuta, Ogun state, Nigeria
[2]Department of Nutrition and Dietetics,
University of Agriculture, P.M.B. 2240, Abeokuta, Ogun state, Nigeria

Abstract: The study investigated varietal differences in the physical properties and proximate composition of improved sesame seeds. Fourteen varieties of sesame seeds obtained from National Centre for Genetic Resources and Biotechnology (NACGRAB), Moor Plantation, Ibadan, Oyo State and Plant Breeding and Seed Technology Department, University of Agriculture, Abeokuta, Ogun State were analyzed for their physical properties and proximate composition using standard methods. The result revealed that there were significant varietal differences (P<0.05) in all the physical properties determined. Variety NG/SA/07/095 had the highest value of 1000 seed weight (3.12g) and YANDEF 55, had the lowest (1.09g). The length of YANDEF 55 was the lowest (2.26mm) while that of NCRI BEN 01M was the highest (3.01mm). The breadth ranged from 1.55 - 1.86 mm; with KANO 05 having the least value and NG/SA/07/095 having the highest value. The thickness also ranged between 0.74 and 0.97mm. The Arithmetic Mean Diameter (AMD) and Geometric Mean Diameter (GMD) ranged from 1.51-1.91 mm and from 1.32-1.70 mm, respectively. The Degree of Sphericity ranged between 0.57 and 0.64, while aspect ratio ranged between 61.50 and 75.00%. Surface area (SA) ranged from 5.84 - 8.94 mm^2 with KANO 05 having the least and NG/SA/07/052 having the highest. The ash content of the seeds ranged from 4.00 - 7.00% with NG/SA/07/106 having the least value and YANDEF 55 having the highest value. NCRI BEN OIM had the highest fat content of 20.50% while YANDEF 55 had the least value of 11.50%. The crude protein content of NG/SA/07/106 was found to be the highest (23.03%) while NG/SA/07/179 had the lowest (12.69%). The crude fibre content ranged from 1.86 - 2.54%. Carbohydrate content of NCRI BEN OIM was the lowest (41.55%) while that of NCRI BEN 02M was the highest (58.20%). The study showed that there are significant varietal differences (P<0.05) in the physical properties and proximate composition of the improved sesame seeds except moisture content. The values obtained were in close agreement with the result obtained 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 physical dimensions were not far from the existing local varieties.

Key words: Variety % Sesame seeds % Physical % Proximate % Properties

INTRODUCTION

Sesame (*Sesamun spp*) is a flowering plant in the genus '*sesamin*'. It is believed to be the oldest spice being used over some years, even though the precise natural origin of the specie is unknown [1]. It is cultivated in some part of Benue, Plateau, Kwara and Niger states of Nigeria[1]. Two main varieties of sesame plants that are traditionally grown in Nigeria are: (1) *Sesamum radiatum* (black): its fruits have a terminal beak split in the seeds which usually have dark streaks; (2) *Sesamum indicum* (white): seeds are usually smooth and pale in colour.

Sesame is an excellent source of high quality oil and protein, 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 seeds are, primarily grown for its richness in oil which comes in a variety of colour and are primarily source of cooking oil in the Eastern part of Nigeria. The oil is excellent edible oil that has high

Correspondence Author: A.A. Adebowale, Department of Food Science and Technology, University of Agriculture, P.M.B. 2240, Abeokuta, Ogun state, Nigeria.

preservative qualities. 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 [2]. 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 physical properties of sesame seeds such as weight, diameter, surface area, bulk density are required and necessary in the design and optimal performance of the grain threshing unit. The size of grains represented by their equivalent diameter and sphericity is necessary to describe their shape [4]. The surface area is useful to calculate the rate of heat transfer and in the design of appropriate heating equipment. Material size is required for grading and packing [5] and in sieve separation and grinding operations [6]. In order to optimise some postharvest handling factors: threshing efficiency, pneumatic conveying and storage of sesame seed; the physical properties of seeds are essential [7].

The main objective of this study was to investigate the varietal differences in the physical Properties and proximate composition of improved sesame seeds.

MATERIALS AND METHOD

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

Methods

Physical Properties of Sesame Seeds

1000 Seed Weight: One thousand seed was randomly selected and the weight was measured using an electronic balance (Metler AE240S; Metler-Toledo, Greifensee, Switzerland) of 0.001g sensitivity.

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[8]:

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

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

Aspect Ratio (%R_a): This was obtained using the following relationship [9]:

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

Spericity (Φ): This was obtained using the formula given by Jain and Ball [10] as follows:

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

Surface Area: The Surface area (*S*, mm2) of seeds was calculated using equation (5) [10]:

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

Volume: Seed volume was calculated using equation (6) [10]:

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

Chemical Analysis

Proximate: Moisture, crude protein, fat, crude fibre and total ash was determined by the method of AOAC [11]. Carbohydrate was calculated by difference.

RESULTS AND DISCUSSION

Physical Properties of Improved Varieties of Sesame Seeds: Table 1 showed the varietal differences in the physical properties of improved sesame seeds. The result revealed that there were significant varietal differences ($P<0.05$) in all the physical properties measured. Variety NG/SA/07/095 had the highest value of 1000 seed weight (3.12g) and YANDEF 55, had the lowest (1.09g). The length of YANDEF 55 was the lowest (2.26mm) while that of NCRI BEN 01M was the highest (3.01mm). The breadth ranged from 1.55 - 1.86 mm, with KANO 05 having the least value and NG/SA/07/095 having the highest value. The thickness also ranged between 0.74 and 0.97mm.

Physical dimensions (length, breadth and thickness) are useful in determining aperture size in the design of grain handling machinery. Similar results were reported for black cumin seeds[12], millet and local varieties of sesame seeds [1, 13, 14]. Sesame seed can be cleaned based on properties of the desirable seed and contaminates.

Table 1: Varietal differences in the physical properties of improved varieties sesame seeds

Variety	1000 seed weight (g)	Length (mm)	Breadth (mm)	Thickness (mm)	Aspect Ratio (%)	Arithmetic Mean Diameter (mm)	Geometric Mean Diameter (mm)	Degre of Sphericity	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}	1.50^{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}	0.61b^{cde}	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^{fg}	1.54^{fg}
OM1	2.88^{i}	2.85^{def}	1.75^{bcd}	0.89de	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}	1.65^{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}	7.34^{de}	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}	0.74^{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)

According to Sahay [15] vibration screens separate products on the basis of differences in sizes of various constituents whereas air screen cleaners separate material on the basis of difference in size and weight. If any of these principles is to be applied in design, one of the important factors that must be considered 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 un-cleaned 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 also ranged from 1.51-1.91 mm and from 1.32-1.70 mm, respectively. The values were lower than that of millet and sorghum [13, 16]. 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 0.64 which is similar to values obtained by Tunde-Akintunde and Akintunde [14, 17] for local varieties of sesame as well as that of sunflower seeds but is lower than that of millet grains (0.78–0.83) and soybean seeds which is 0.81–0.82.

Hence, the shape of sesame seeds (round at bottom and tappers at top) is similar to that of sunflower seeds [18] while that of millet and soybean seeds are more spherical [13,19]. 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 mm2 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 and Akintunde [14] 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 far from the existing local varieties.

Proximate and Mineral Composition of Improved Varieties of Sesame Seeds: Table 2 showed the result of the proximate and mineral composition of improved sesame seeds. The result showed that the varietal differences in the moisture content of the improved sesame seed is not significant (P>0.05) while significant varietal differences existed in other proximate parameters as well as the mineral content (P<0.05). The moisture content ranged between 5.0 and 8.75%. 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 4.00-7.00% 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 the sesame varieties. NCRI BEN OIM had the highest fat content of

Table 2: Varietal differences in the proximate and mineral contents of improved varieties of sesame seeds

Variety	Moisturens	Ash	Fat	Protein	Crude fibre	Carbohydrate	Ca	Fe	Mg	K
NCRI BEN 01M	8.75	6.75^{de}	20.50^{d}	20.26^{gh}	2.20^{j}	41.55^{a}	19.27^{l}	1.44^{c}	6.62^{fg}	11.49^{j}
NGB/04/026	5.00	5.00^{abc}	15.50^{abc}	16.57^{bc}	2.16^{i}	55.78^{d}	17.64^{g}	1.12^{b}	6.95^{h}	12.6^{l}
NCRI BEN 03L	7.00	6.25^{cde}	16.00^{bc}	22.10^{f}	2.01^{e}	46.65^{abc}	16.21^{c}	1.87^{f}	5.67^{c}	9.62^{c}
NG/SA/07/179	6.00	4.25^{ab}	17.00^{cd}	12.69^{a}	1.86^{a}	58.20^{d}	13.15^{b}	1.85^{e}	5.89^{d}	1036^{e}
NG/SA/07/090	8.00	5.50^{bcd}	14.50^{abc}	16.25^{b}	1.96^{d}	53.80^{bcd}	19.93^{m}	2.03^{i}	5.96^{d}	9.90^{d}
NG/SA/07/095	6.25	4.25^{ab}	13.00^{abc}	19.38^{fg}	1.89^{b}	55.24^{cd}	16.45^{d}	2.36^{k}	6.72^{g}	11.18^{h}
NG/SA/07/106	7.50	4.00^{a}	12.50^{ab}	23.03^{i}	2.01^{h}	49.87^{abcd}	20.15^{n}	3.02^{m}	7.11^{i}	12.88^{n}
NG/SA/07/052	5.50	5.25^{abc}	14.00^{abc}	18.16^{de}	2.32^{l}	54.78^{cd}	19.13^{k}	2.99^{l}	6.61^{efg}	10.58^{f}
NG/SA/07/137	6.50	5.00^{abc}	13.00^{abc}	18.38^{ef}	1.94^{c}	55.19^{cd}	16.49^{e}	1.89^{g}	5.21^{b}	9.28^{b}
OM 1	7.00	4.25^{ab}	12.50^{ab}	17.50^{cde}	2.22^{k}	58.53^{d}	17.83^{i}	2.15^{j}	6.53^{ef}	11.14^{g}
YANDEF 55	8.25	7.00^{e}	11.50^{a}	20.13^{gh}	2.04^{f}	51.10^{bcd}	5.41^{a}	0.50^{a}	1.45^{a}	2.88^{a}
OKENE MKT	6.00	5.25^{abc}	14.50^{abc}	17.07^{bcd}	2.08^{g}	54.86^{cd}	17.50^{f}	2.14^{j}	7.35^{j}	12.47^{m}
NCRI BEN 02M	7.00	5.75^{cde}	14.50^{abc}	13.31^{a}	2.43^{m}	57.01^{d}	18.07^{j}	1.93^{h}	6.50^{e}	11.60^{k}
KANO 05	8.25	6.00^{cde}	16.50^{bcd}	20.79^{h}	2.54^{n}	45.93^{ab}	17.71^{h}	1.63^{d}	7.32^{j}	11.43^{i}

Values are means of three replicates Mean values having different superscript within column are significantly different (P<0.05)

ns not significantly different (P>0.05)

20.50% while YANDEF 55 had the least value of 11.50%. The fat content of the improved sesame seeds was lower than values reported by Yoshida [20] and Tokusoglu *et al*. [21] for local sesame seeds.

The seed could be further explored to develop a high crude oil yield variety that would be of immense nutritional and economic advantages. The crude protein content of NG/SA/07/106 was found to be the highest (23.03%) while NG/SA/07/179 had the lowest. The crude fibre content ranged from 1.86 - 2.54%. The crude fibre content is an indication of the roughages/bulkiness of the sample, the higher the crude fibre content, the more bulky the variety [20]. Carbohydrate content of NCRI BEN OIM was the lowest (41.55%) while that of NCRI BEN 02M was the highest (58.20%).The variation in the values could be a reflection of varieties and/or genetic makeup of the seeds [20].

The minerals compositions are also determined and all the mineral contents of the varieties are significantly different (P<0.05) from each other. YANDEF 55 had the lowest iron content (0.50%) while OM1 had the highest (2.15%). 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. Virtually all the sesame seed varieties had higher values of calcium content, (NG/SA/07/106 had the highest value of 20.15% while YANDEF 55 had the least value of 5.41%).

This implied that NG/SA/07/106 is a very rich in calcium and preferably good for strong bone and teeth compared to others. Magnesium content ranged from 1.45–6.62%, with YANDEF 55 having the least and NCRI BEN 01M had the highest. Potassium ranged from 2.88–12.88%. 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 are of important nutritional significance.

CONCLUSION

The study showed that there are significant varietal differences (P<0.05) in the physical properties, proximate and mineral composition of the improved sesame seeds except moisture content. 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 was very close to values reported for traditional varieties and this implied less requirement for major modifications in the existing processing technology for the improved sesame seeds. Since sesame seeds are mostly relished for their oil, there is the need to study the varietal differences in the oil content and quality of the improved sesame seeds.

REFERENCES

1. Sonntag N.O.V., 1981. Composition and characteristics of individual fats and oils: Bailey industrial oil and fat products, W. John and sons, New York, 4th ed, 1: 289-477.

2. Yoshida, H. and Kajimoto, 1994. Composition and quality characteristics of sesame seed (*Sesamum indicum*) oil roasted at different temperature in an electric oven. J. Food Sci., 65: 331-336.
3. Kachru, R.P., R.K. Gupta and A. Alam, 1994. Physio-chemical Constituents and Engineering Properties of Food Crops. Jodhpur, India, Scientific Publisher.
4. Asoegwu, S.N., S.O. Ohanyere., O.P. Kanu and C.N. Iwueke, 2006. Physical properties of African oil bean seed (*Pentaclethra macrophylla*) Agricultural Engineering International: the CIGR Ejournal Manuscript FP 05 006 Vol VIII.
5. Singh, K.K., B.S. Reddy., A.C. Varshney and S. Mangraj, 2004. Physical and functional properties of orange and sweet lemon. Applied Engineering in Agriculture, 26(6): 821-823.
6. Wilhelm, L.R., D.A. Suter and G.H. Brusewitz, 2004. Physical properties of food materials: Food and process Engineering Technol., pp: 23-52.
7. Milani, E., M. Seyed A. Razavi, A. Koocheki1, V. Nikzadeh, N. Vahedi1, M. Moein Fard and A. Gholamhossein Pour, 2007. Moisture dependent physical properties of cucurbit seeds. International Agrophysics, 21: 157-168.
8. Mohsenin, N.N., 1978. Physical properties of plant and animal materials, Gorden and Breach Science Publisher, New York, pp: 234.
9. Maduako, J.N. and M.O. Faborode, 1990. Some physical properties of cocoa pods in relation to primary processing, Ife journal of Technol., 2: 1-7.
10. Jain, R.K. and S. Bal, 1997. Physical properties of pearl millet. J. Agricultural Engineering Res., 66: 85-91.
11. AOAC, 1990. Official methods of analysis. Association of official analytical chemists. Arlington, Washington DC.
12. Al-Mahasneh, M.A., H.A. Ababneh and T. Rababah, 2007. Some engineering and thermal properties of back cumin (*Nigella sativa* L.) seeds. International J. Food Science and Technol., 10: 1365-2621.
13. Baryeh, E.A., 2002. Physical properties of millet. J. Agricultural Engineering Res., 51: 39-46.
14. Tunde-Akintunde, T.Y. and B.O. Akintunde, 2007. Effect of Moisture Content and Variety on Selected Properties of Beniseed". Agricultural Engineering International: the CIGR Ejournal. Manuscript FP 07 021. Vol. IX.
15. Sahay, K.M., 1998. Cleaning and grading of oilseed: equipment and approaches. Summer school on processing and storage of oilseeds and products for food uses. Central Institute of Agricultural Engineering, Bhopal, India, pp: 61-64.
16. Simonyan, K.J., A.M. El-Okene and Y.D. Yiljep, 2007. Some Physical Properties of Samaru sorghum 17. Agricultural Engineering International; the CIGR Ejournal manuscript FPO7008, volume ix.
17. Tunde-Akintunde, T.Y. and B.O. Akintunde, 2004. Some physical properties of sesame seed. Biosystem Engineering, 88: 127-129.
18. Gupta, R.K. and S.K. Das, 1997. Physical Properties of Sunflower Seeds. J. Agricultural Engineering Res., 66: 1-8.
19. Deshpade, S.D., S. Bal and T.P. Ojha, 1993. Physical properties of soybean. J. Agricultural Engineering Res., 56: 89-98.
20. Yoshida, H., 1994. Composition and quality characteristics of sesame seed (*Sesamum indicum*) oil roasted at different temperatures in an electric oven. J. the Science of Food and Agri., 65: 331-336.
21. Tokusoglu, O., M.K. Onal and I. Alakr, 2004. Proximate chemical composition, amino acid and fatty acid profile of sesame seed flour. Journal of food Science and Technology (Mysore), 41: 409-412.