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Geometrical Properties of Local Sesame Seeds (Sesamum indicum L.) Grown in Kurdistan Region

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Abstract. In order to determine which sesame seed variety exhibited the optimal combination of geometrical features, this study compared three distinct varieties: one from sharzoor in Sulaymaniyah (S), another from Akre in Duhok (A), and a third from Mala Omar in Hawler (MO). The first portion of each sample was preserved in its original mixed form, while the subsequent portion was strained through a sieve using three distinct mesh sizes: 1.50, 1.35, and 1 mm. Less than an inch in diameter, medium in size, and tiny in diameter are the three resulting sesame seed sizes. The sesame seeds were measured in all three dimensions using a digital dial caliper. The volume (V, mm^3), sphericity (S%), arithmetic diameter (Da, mm), geometric diameter (Dg, mm), apparent density (ρd, kg/m^3), transverse surface area (At, mm^2), and flat surface area (Af, mm^2) were all measured for sesame seeds according to their geometrical features. The approximate weight of 100 seeds was also provided in grams. The results demonstrated that the sieved fraction was better than the mixed portion for each size category (mixed, big, medium, tiny). The geometrical parameters of Akre's sesame seeds were 3.33, 1.74, 0.89 mm, 3.31, 1.74, 0.91 mm, 3.08, 1.43, 0.88 mm, and 2.94, 1.24, 0.73 mm.

Keywords. Sesame seeds, Geometrical characteristics, Mesh size, Digital dial caliper.

1. Introduction

The upright annual plant sesame is also known as benniseed, sesamum, and simsim. It belongs to the family Pedaliaceae. Being one of the most traditional oilseed crops, it is widely valued for its high-quality seed oil [1]. In addition to its various culinary and medicinal benefits, the protein-rich sesame seed also yields exceptionally stable oil and flour and is a popular ingredient in sweets. [2]. In addition to being the most significant commercial material for oil production on the world, sesame seed contains extra nutrients including protein, calcium, and phosphorus. Due to its importance in export and industry, this seed is fundamental to normal providence. Sesame oil is often produced by growing sesame seeds in proximity to other crops. About 704,26 fedans of sesame seed were gathered in Egypt each year [3].

Sesame seeds' geometrical features are relevant to several issues, including but not limited to: sieve unit design and development, a specific machine, handling, cleaning, and storage. In addition to its culinary applications, the oil derived from sesame seeds is an ingredient in several common home items, including paints, butter, and varnishes. Its nutritional content is on par with soy beans, and its protein is very nutritious [4].

The geometrical properties of a material, including its shape, length, quantity, and size distribution, are crucial to many machine design and development issues, product behavior analysis when handling materials, electrolytic seed isolation, lamp refraction, color evaluation, and many more. [5]. When designing a system to transport solids via water or air, material shape is crucial [6].
The time of sieving, the geometry of the cell, and the speed of oscillation were the most important factors affecting separation efficiency. Maximizing efficiency was achieved by increasing the sieving duration and the rpm of the oscillation. This study set out to identify the geometrical properties of sesame seeds—findings are in line with previous research [7]—and how these traits influence the creation of tools for precise planting, cleaning, separation handling, storage, and threshing [8].

2. Materials and Methods

2.1. Preparation of Sample

Sesame seeds used in the study came from two different farms in Iraq: one in Sharzoor, Sulaymaniyah (S), and another in Akre, Duhok (A). Removing any dirt, stones, or cracked sesame seeds required a great deal of manual labor.

2.2. Sesame Seeds Used in Studies

For each of the three samples of sesame seeds (S, A, and MO), 400 seeds were selected at random. We acquired three distinct volume subdivisions or pats of sesame seed samples from this process: 100 seeds for the mix component and 300 seeds after sieving in three different mesh sizes (1.5, 1.35, and 1 mesh) based on their pore volume from largest to smallest.

- 1.5 mesh is the large part (L)
- 1.35 mesh medium part (M)
- mesh for small (Sm) part

2.3. Instrumentation

The length, width, and thickness of the sesame seed samples were measured using a Toolzone 150 mm Electronic Digital Vernier Caliper TC- 000899, X0005RMBUD. This caliper has a reading range of up to 150 mm and an accuracy of 150 mm. An electronic balance made in Switzerland by METTLER TOLEDO (SNR 1118151898, TDNR 26215122) was used to weigh the sesame seed samples.

2.4. Geometrical Properties Determination of Sesame Seeds

We measured the measurements of the sesame seeds (L, mm), weight (W, mm), and thickness (T, mm). Then, we calculated the geometrical parameters of the seeds (v, mm^3), (D_a, mm), (D_g, mm), (S, %), (ρ_d, kg/m^3) ,(A_t,mm^2), (A_f, mm^2) and we weighed 100 seeds for each sample.
The following relationships are used to calculate the geometrical parameters for samples of sesame seeds [9]

$$D_g = (L\times W\times T)^{1/3} \tag{1}$$

$$D_a = \frac{(L+W+T)}{3} \tag{2}$$

$$S= \frac{(L\times W\times T)1/3}{L} \times 100 \tag{3}$$

$$V= \frac{\pi}{6}(L\times W\times T) \tag{4}$$

the (A_t) and (A_f), is calculated in mm^2 [6].

$$A_t = \frac{\pi}{4}(W\times T) \tag{5}$$

$$A_f = \frac{\pi}{4}(L\times W) \tag{6}$$

Density of seed (ρ_d):

$$\rho_b = \frac{Wb}{Vb} \tag{7}$$

Where:-
the apparent density of the seeds in kilograms per cubic meter, the weight of the sesame seed sample in kilograms, and the volume of the seeds in cubic meters.
Through the use of an electronic balance, one hundred seeds were weighed.

3. Results and Discussion

The findings and measurements of the L, W, T, weight of 100 seeds, V, Da, Dg, S, ρ_d, At, Af, for S, A, and H sesame seed samples that were sorted into big, medium, and tiny by sieving are shown in tables 1, 2, and 3.
The study of product behavior during handling and sieving operations, as well as the creation or fabrication of equipment and their activities, might benefit from these geometrical features.
According to Table 1, 2, 3, and Figure 1, the length of A sesame seeds for the mix and medium samples was 3.08 mm, while those for the big and small samples were 3.33 mm and 2.98 mm, respectively. This difference in length was attributed to the different cultivation times and soil types.

Table 1. SPSS-determined geometrical properties of the Sharazoor sesame seeds sample for the Mix, L, Med, and Sm sizes.

Seed parameter of 100 seeds	Mean ± S.D			
	A	A_1	A_2	A_3
L, mm	2.98 ± 0.07759^{a}	2.96 ± 0.07228^{b}	2.853 ± 0.0645^{b}	2.70 ± 0.0667^{bc}
W, mm	1.62 ± 0.03936^{a}	1.60 ± 0.02337^{b}	1.43 ± 0.0117^{c}	1.27 ± 0.0194^{d}
T, mm	0.90 ± 0.02335^{a}	0.91 ± 0.04725^{a}	0.70 ± 0.01789^{b}	0.69 ± 0.0459^{b}
D_g, mm	1.63 ± 0.0214^{a}	1.62 ± 0.0267^{a}	1.42 ± 0.0174^{b}	1.33 ± 0.03320^{c}
D_a, mm	1.76 ± 0.0529^{b}	1.81 ± 0.0254^{a}	1.66 ± 0.0235^{c}	1.55 ± 0.0276^{d}
S, %	52.68 ± 1.8021^{b}	54.92 ± 1.1484^{a}	50.86 ± 1.1694^{c}	49.42 ± 1.4012^{c}
V, **mm³**	2.27 ± 0.0858^{a}	2.24 ± 0.1190^{a}	1.49 ± 0.0569^{b}	1.24 ± 0.0977^{c}
A_t, **mm²**	1.14 ± 0.0401^{a}	1.135 ± 0.052^{a}	0.78 ± 0.0184^{b}	0.69 ± 0.0499^{b}
A_f, **mm²**	3.80 ± 0.1351^{a}	3.707 ± 0.1056^{a}	3.19 ± 0.0715^{b}	2.68 ± 0.0661^{c}
ρ_b, kg/m³	0.72 ± 0.02293^{b}	0.73 ± 0.0341^{b}	0.96 ± 0.0347^{a}	1.06 ± 0.0666^{a}
mass of 100- seeds, g	0.280^{a}	0.282^{a}	0.200^{a}	0.130^{b}

*Values of three replicates

Table 2. SPSS-determined geometrical properties of the Akre sesame seeds sample for the Mix, L, Med, and Sm sizes.

Seed parameter of 100 seeds	Mean ± S.D			
	B	B_1	B_2	B_3
L, mm	3.33 ± 0.0792^{a}	3.31 ± 0.0536^{b}	3.08 ± 0.0777^{c}	2.94 ± 0.0769^{d}
W, mm	1.74 ± 0.0490^{a}	1.74 ± 0.0344^{a}	1.43 ± 0.0344^{b}	1.24 ± 0.0284^{c}
T, mm	0.89 ± 0.0261^{b}	0.91 ± 0.0294^{a}	0.88 ± 0.0294^{b}	0.73 ± 0.0435^{c}
D_g, mm	1.73 ± 0.0332^{a}	1.73 ± 0.0308^{a}	1.56 ± 0.0308^{b}	1.38 ± 0.0384^{c}
D_a, mm	1.99 ± 0.0361^{a}	1.99 ± 0.0311^{a}	1.80 ± 0.0311^{b}	1.64 ± 0.0378^{c}
S, %	52.02 ± 1.0358^{a}	52.42 ± 0.4754^{a}	50.89 ± 0.4754^{b}	46.78 ± 0.811^{c}
V, **mm³**	2.72 ± 0.1482^{b}	2.76 ± 0.1410^{a}	2.04 ± 0.66^{c}	1.40 ± 0.1170^{d}
A_t, **mm²**	1.22 ± 0.0551^{b}	1.25 ± 0.0489^{a}	0.99 ± 0.077^{c}	0.71 ± 0.0457^{d}
A_f, **mm²**	4.54 ± 0.1683^{a}	4.53 ± 0.1279^{a}	4.46 ± 1.1253^{b}	2.87 ± 0.096^{c}
ρ_b, kg/m³	0.65 ± 0.0301^{c}	0.64 ± 0.0300^{c}	0.75 ± 0.065^{b}	0.94 ± 0.0756^{a}
mass of 100- seeds, g	0.312^{a}	0.331^{a}	0.201^{b}	0.128^{c}

*Values of three replicates

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Table 3. SPSS-determined geometrical properties of the Mala Omar sesame seeds sample for the Mix, L, Med, and Sm sizes.

Seed parameter of 100 seeds	Mean ± S.D			
	C	C_1	C_2	C_3
L, mm	3.16 ± 0.0816[b]	3.33 ± 0.0629[a]	3.03 ± 0.0536[c]	2.98 ± 0.0513[c]
W, mm	1.75 ± 0.0370[b]	1.86 ± 0.0359[a]	1.43 ± 0.0154[c]	1.27 ± 0.0175[d]
T, mm	0.84± 0.0303[a]	0.84 ± 0.0325[a]	0.78 ± 0.0386[b]	0.71 ± 0.0532[b]
D_g, mm	1.66 ± 0.0390[a]	1.73 ± 0.0308[a]	1.49 ± 0.0299[b]	1.38 ± 0.0392[c]
D_a, mm	1.91 ± 0.0438[a]	1.99 ± 0.0337[a]	1.74 ± 0.0267[b]	1.65 ± 0.0315[c]
S, %	52.65 ± 1.6660[a]	52.29 ± 0.7780[a]	49.32 ± 0.8094[b]	46.52 ± 1.0161[c]
V, $\mathbf{mm^3}$	2.44 ± 0.1632[b]	2.71 ± 0.1507[a]	1.76 ± 0.1023[c]	1.42 ± 0.1202[d]
A_t, $\mathbf{mm^2}$	1.15 ± 0.0557[a]	1.23 ± 0.0563[a]	0.87 ± 0.0429[b]	0.71 ± 0.0540[c]
A_f, $\mathbf{mm^2}$	4.34 ± 0.1946[b]	4. 81 ± 0.1601[a]	3.39 ± 0.0831[b]	2.97 ± 0.0790[c]
ρ_b, kg/m^3	0.74 ± 0.0460[c]	0.70 ± 0.0362[c]	0.84 ± 0.0540[b]	0.95 ± 0.0757[a]
mass of 100- seeds, g	0.309[a]	0.317[a]	0.202[b]	0.119[c]

*Values of three replicates

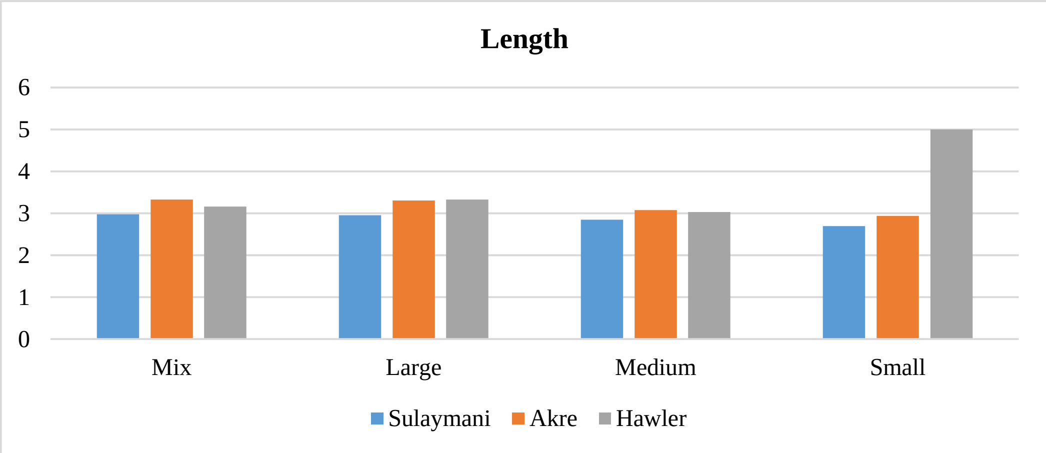

Figure 1. Sharazoor, Akre, and Mala Omar sesame seed samples broken down by length: mix, large, medium, and small.

Figure 2 shows that the MO sample width was 1.75 mm for the whole mix, 1.86 mm for the medium part, 1.43 mm for the small part, and 1.27 mm for the large part. When looking at the width geometrical properties, we can see that the large sieved sesame size has a higher measurement, which is normal given that all 100 seeds were larger than 1.5 mm.

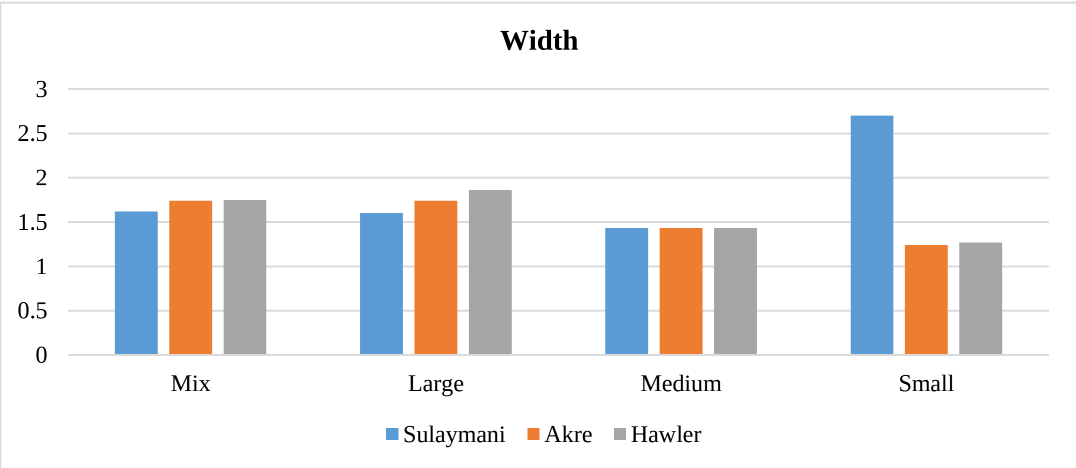

Figure 2. Sesame seed samples from Sharazoor, Akre, and Mala Omar, broken down by width.

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Figure 3 shows that the results are consistent with [10], and tables 1, 2, and 3 show that the mix and large parts thickness of S had higher measurements of 1.63 mm and 1.62 mm, respectively. Samples MO and A were almost identical, but the medium and small group of A had thicknesses of 0.88 mm and 0.73 mm, which were higher than the other samples.

Figure 3. Sesame seed samples from Sharazoor, Akre, and Mala Omar, broken down by thickness.

Since the A sample contains the best sesame seed compared to the S and MO samples, it is not surprising that its geometrical diameter is larger for the mix, big, medium, and small groups: 1.73 mm, 1.73 mm, 1.56 mm, and 1.38 mm.

Based on the results of the mathematical diameter calculation, it was found that the mix, large, and medium parts of sample A had greater measurements (1.99 mm, 1.99 mm, and 1.80 mm, respectively) than the MO and S samples. On the other hand, the tiny portion of the MO sample seed had a higher measurement (1.65 mm) than both A and S.

The results showed that Sharazoor had a higher S% than Akre and Mala Omar, with 54.92% in the big section and 52.68 in the mix. Group A had lower reporting rates for small and medium (50.89 vs. 46.78 percent).

Sesame seed volume for mix, big, and medium was found to be 2.72 mm, 2.76 mm, and 2.04 mm, with a greater value for MO sesame seed volume for tiny portion being 1.42 mm, due to the larger ratio of length, breadth, and thickness.

However, the high values for mix, big, medium, and tiny parts were found for A sample 1.22, 1.25 mm, 0.99 mm, and 0.71 mm, respectively, based on the transverse surface area, which is a great indicator that the result is accurate.

The results revealed that the flat surface area of A sesame seeds had a greater value as 4.54 mm for the mix and 4.46 mm for the medium part, compared to 4.81 mm for the big portion and 2.97±0.0790 mm for the small part. In contrast, the MO sesame seeds had a larger value than the other samples, both S and A.

While the MO sample has a greater apparent density for the mix at 0.74 mm, the S sample has a higher apparent density for sesame seed at 0.73 mm, 0.96 mm, and 1.066 mm, respectively, which is in accordance with [10].

Conclusion

Based on the research's findings, the big sieve component has superior geometrical qualities compared to the mix, thanks to its high ratio of length, breadth, and thickness. The study also found that the medium and small sieve components form a distinct group.

After sample 100 sesame seeds from each of Sharazoor, Akre, and Mala Omar, we found that the geometrical properties of the Akre seeds were generally better than those of the Sharazoor and Mala

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Omar seeds, including length, width, thickness, volume, sphericity, apparent density, geometric diameter, arithmetic diameter, weight, and transverse and flat surface areas.

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