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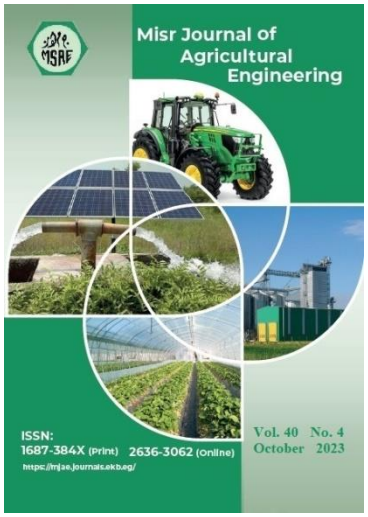
SOME PHYSICAL PROPERTIES AFFECTING DATES CLASSIFICATION

Dalia Abo Bakr [1&]*, W. K. ElHelew [2], Sahar Zayan [3], M. A. Mayhoub [4]

[1] MSc. stud., Ag. Eng. Dept., Fac. of Ag., Ain Shams U., Cairo, Egypt.
[2] Assoc. Prof., Ag. Eng. Dept., Fac. of Ag., Ain Shams U., Cairo, Egypt.
[3] Head of research at the Plant Pathology Research Institute., Ag. Res. Center (A. R. C)., Giza, Egypt.
[4] Assist. Prof., Ag. Eng. Dept., Fac. of Ag., Ain Shams U., Cairo, Egypt.
* E-mail: Dalia_abobbakr@agr.asu.edu.eg orcid 0009-0009-4584-8041



Keywords:
Date fruit; Physical properties; Handling process; Classification.

ABSTRACT

This research was inducted to investigate the differences between the physical properties for accepted and rejected dates for Mejdool and Saeidi varieties, to enhance the final products quality depending on their dimensional attributes. Dates' physical properties are crucial for minimizing losses during fruit handling. They also help to determine the quality of the fruit. The results showed that the difference appears between the physical properties of the accepted and rejected date fruits. In the Mejdool variety there was a difference between the mean for the properties of length, average width, mass, and volume. According to the study sample, it was shown that the accepted fruits of dates are more than (26 mm, 22 gm and 19 cm^3) for the physical properties (average width, mass, and volume), respectively. Generally, as a result of the existence of an overlap in the range between the physical properties under study of the accepted and rejected date fruits, which reduces reliance on them in the classification processes. The classification processes for date fruits need other methods such as deep learning, image analysis, etc., to achieve a final good quality product.

1. INTRODUCTION

Egypt is the largest date producing country in the world with a production quantity 1.7 million tons. Only 0.03 million tons were exported, with 1.9% rate from the production quantity in 2021, based on reports by the Food and Agriculture Organization (FAO, 2022). The date fruit comes in more than two hundred distinct types worldwide. It's interesting to note that every kind has certain unique characteristics that set it apart from the others. During the growth and ripening process and harvesting stage dates, some of the product is damaged by pests, insects, mites, and mechanical equipment and these defects cause significant economic losses to the storage and exportation of date fruit (Sarraf et al., 2021). There were different methods to detect the rejected fruits and vegetables such as: traditional methods (by sight, or at the labors), Imaging Techniques (Hyperspectral Imaging Systems, X-ray Imaging, Magnetic Resonance Imaging (MRI), and Thermal Imaging) (Adedeji et al., 2020; Nturambirwe and Opara, 2020). This study used dates at Tamr stage for the Mejdool, and Saeidi varieties for each of the accepted and rejected dates.

Dates physical qualities, such as color, shape, size, and texture, are often used to assess their quality, while their chemical composition and sensory qualities, such as flavor, are used to measure their nutritional value. The color of the date fruit varies greatly depending on the maturation stage and date variety. Similar to how suppliers select and grade date fruit, physical evaluations are typically utilized to establish the criteria for the primary evaluation. Additionally, there were notable differences between the physical characteristics of dates, such as the diameter, length, and weight of the flesh and seeds. (Abdul-Hamid et al., 2020; Amorós et al., 2009)

There were some studies dealing with the date fruits' physical properties. Dairi dates physical properties were as the following: There was a range of 3.75 to 7.01 g and 3.75 to 7.36 cm^3 in mass and volume. The dimensions were 29.8 and 40.2 mm in length, 15.7 and 20.2 mm in breadth, and 15 and 19.7 mm in thickness. Additionally, the geometric mean diameter, sphericity, and surface area were between 19.54 and 25.03 mm, 0.58 and 0.69, and 1200.04 and 1968.26 mm^2, respectively (Jahromi et al., 2008). The Saeidi date fruits variety at the Tamr stage were analyzed for the quantity of 86 fruits /Kg, average fruit weight 11.62g and pit weight 1.48g, percentage of flesh 86.28%, total soluble solids 88.38%, and insect infestation percentage 3.48% (Ramadan, B. R. et al., 2016).

Some of the physical properties for Zahidi date variety including their dimensions, arithmetic and geometric mean diameters, sphericity, surface area, 1000-fruits mass, bulk density, true density, porosity, angle of repose, and coefficient of static friction, were determined in this study as a function of the amount of moisture in the fruit. Average date palm fruit dimensions were determined to be 33.65 and 33.12 mm, 22.12 and 22.03 mm, and 20.02 and 19.95 mm, respectively, at varied moisture contents of 69.5 and 61.56 percent (w.b.). Fresh date fruit had mean geometric and arithmetic diameters that varied from 23.51 to 25.96 mm and 24.29 to 26.59 mm, respectively. Sphericity values ranged from 0.73 to 0.737 for various moisture contents (Desai et al., 2019).

The physical properties of Dayri dates were about 80% of lengths fruits were between 33 mm and 37 mm, 78% of the widths between 17 mm and 19 mm, 88% of the thickness between 14 mm and 16 mm and the moisture contents were 3.39% for Dayri dates. This means that length was 33.26 mm, width was 18.89 mm and thickness was 15.07 mm and mass was 5.01 g for Dayri date (Jumaah, 2022). Thus, the main objective of our study is to investigate some physical properties and their effect on accepted dates under the study conditions, to value the sorting process for achieving a good quality final product.

2. MATERIALS AND METHODS

Date fruits collection:

The dates fruits (Mejdool and Saeidi cv.) were gathered from different regions around Egypt. Tamr maturity stage dates were utilized for each variety, with approximately moisture content less than 25% for the semi dry dates (Alam et al., 2023; Sarraf et al., 2021). The rejected dates samples were collected from the factory-rejected fruits according to CODEX STANDARD 143-1985. The international standard for dates, Codex STAN 143–1985, focuses on ripe/unripe and intact/damaged dates and pays no attention to cultivar-specific characteristics (Codex, 1985). All dates had been divided into two groups accepted and rejected for two

varieties. Each sample was given a label and placed in its own case. The number of samples for each variety was 100 samples for both the accepted and rejected dates for each variety.

Physical properties:

Some physical properties such as length, width, thickness, volume, and mass of the fruit were measured for each sample.

Dimensions of the date fruits:

Digital calipers with a precision of (+/- 0.01mm/0.0005) were used to measure the perpendicular dimensions of the fruits (length "L", width "W_1", and thickness "W_2").

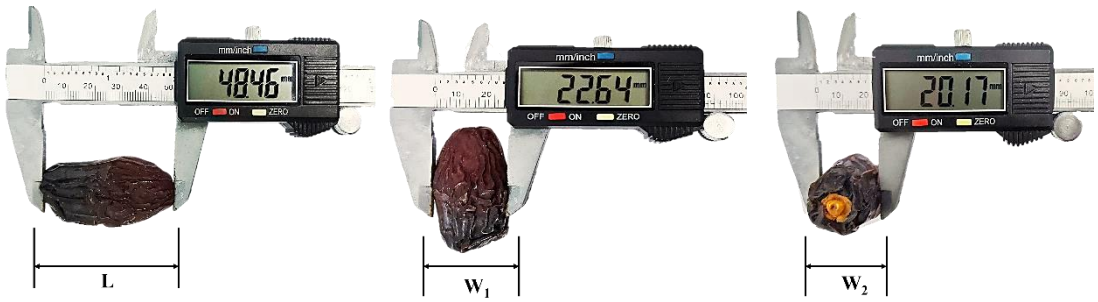


Fig. (1): Dimensions measurements for dates.

Mass of the date fruits "m":

An electronic balance with a sensitivity (0.1) and a range of 1 gm to 5 kg was used to calculate the mass of each fruit (salter digital balance model 1177 BKWHDR).

Actual volume "V":

The actual volume was measured by the water displacement method. Each fruit was coated with paraffin wax with a density 0.9 g/cm^3 to prevent fruit from absorbing water, then each fruit mass was calculated with and without wax and it was put in a water flax to measure the displaced water volume. Finally, to calculate the actual fruit volume the following equations were used:

$$V_{wax} = (m_{t\,air} + m_{d\,air}) / \rho_{wax} \quad \ldots\ldots \quad (1)$$

$$\rho_{date} = m_{d\,air} / (V_{water} - V_{wax}) \quad \ldots\ldots \quad (2)$$

$$V_{date} = m_{d\,air} / \rho_{date} \quad \ldots\ldots\ldots\ldots \quad (3)$$

where:

$m_{t\,air}$ is the total mass of the date fruit and wax in the air.

$m_{d\,air}$ is the mass of the date fruit in air.

V_{water} is the volume of displaced water from the date fruit with wax.

V_{date} is the actual volume of the date fruit without wax.

Arithmetic and geometric mean diameter

Date fruit dimensions of length, width, and thickness were utilized to calculate the arithmetic "D_a" and geometric "D_g" mean diameters. Using the following equation (Mohsenin, 1986).

$$D_a = (L+2W)/3 \quad \ldots\ldots\ldots \quad (4)$$

$$D_g = (L * W^2)^{1/3} \quad \ldots\ldots \quad (5)$$

where:

W is the average width $((W_1 + W_2)/2)$.

Sphericity "Φ" and aspect ratio "Ra":

Date fruit is regarded as a triaxial ellipsoid for purposes of determining its sphericity, with its length, width, and thickness acting as its relative intercepts. The following formula was used to determine the date fruit's sphericity (Mohsenin, 1986). And, to determine the fruit shape the aspect ratio was calculated from the fruit dimensions as the following:

$$\Phi = Dg / L \quad \text{.....} \quad (6)$$

$$Ra = W/L \quad \text{.....} \quad (7)$$

Surface area "S":

The following equation was used to estimate the date fruit's surface area by analogy with a sphere having a certain geometric mean diameter (Mohsenin, 1986).

$$S = \pi D_g^2 \quad \text{.....} \quad (8)$$

Statistical analysis:

A statistical analysis T- Test Two Paired Independent Samples at 0.05 of the data was carried out according to SPSS software using the following website ("T-Test Calculator for 2 Independent Means," 2023). The significance of the T-Test is judged if the p-value is less than the value of the level of significance 0.05.

3. RESULTS AND DISCUSSION

One of the post-harvest handling phases to obtain the final product suitable for markets is sorting and grading. The following results show the physical properties differences between the accepted and rejected dates for two varieties Mejdool, and Saeidi. The samples were approximately one hundred random samples for each category.

Date length and average width:

Figs. 2 and 3 showed the length and Average width frequency difference between Mejdool and Saeidi date varieties for comparing accepted and rejected samples. There were significant differences between accepted and rejected mean length and average width. However, there is a percentage of overlap between length and average width. The results showed that the overlapping in the Saeidi was more than in Mejdool. The mean and range of the two varieties under study can be compiled in the following **Table 1**.

Table 1: Length and width data analysis of Mejdool and Saeidi dates varieties according to health state:

Quality	Length (L) mm				Average width (W) mm			
	Min	Max	Mean	SD	Min	Max	Mean	SD
Mejdool Dates								
Accepted	42.73	57.95	50.07	2.97	23.03	29.43	25.49	1.22
Rejected	30.70	55.19	44.17	5.14	17.04	27.22	21.74	1.87
T-Test Value		9.92				16.74		
Saeidi Dates								
Accepted	30.10	42.33	35.65	2.40	17.81	24.23	21.09	1.15
Rejected	27.51	41.17	34.54	3.00	16.08	24.52	19.85	1.51
T-Test Value		2.89				6.54		

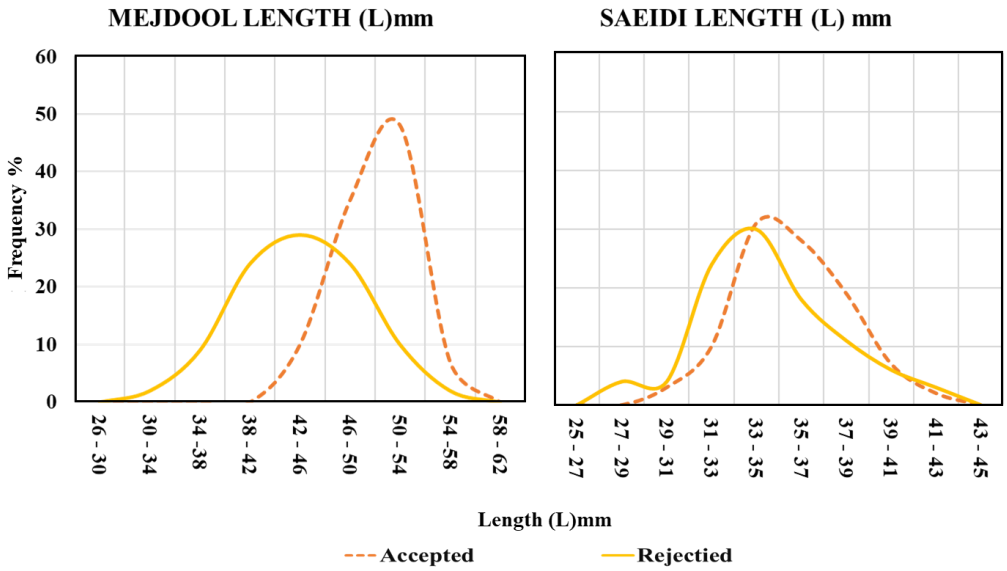


Fig. (2): Length difference between two date varieties for comparing accepted and rejected samples.

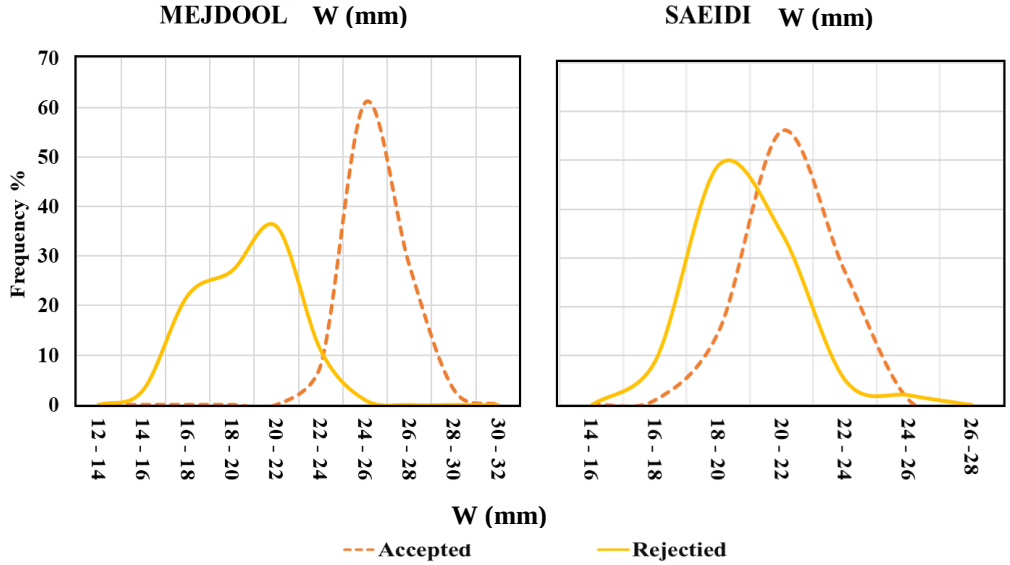


Fig. (3): Average width difference between two date varieties for comparing accepted and rejected samples.

Date mass and volume:

Figs. 4 and 5 showed the mass and volume frequency difference between Mejdool and Saeidi date varieties for comparing accepted and rejected samples. There were significant differences between accepted and rejected mean mass and volume. However, there was a percentage of overlap between mass and volume. The overlapping in the Saeidi is more than Mejdool. From the results of mass and volume, it was found that the Mejdool mean density was 1.23 g/cm^3 for accepted and 1.27 g/cm^3 for rejected value. Also, its values varied from 1.05 g/cm^3 to 1.46 g/cm^3 for accepted, and from 1.00 g/cm^3 to 1.64 g/cm^3 for rejected Mejdool. Additionally, Saeidi mean density was 1.15 g/cm^3 for accepted and 1.25 g/cm^3 for rejected value. Also, its values varied from 0.91 g/cm^3 to 1.84 g/cm^3 for accepted, and from 1.00 g/cm^3 to 2.06 g/cm^3 for rejected Saeidi under the study samples. The rejected fruits were classified according to CODEX STANDARD 143-1985 (Codex, 1985). The mean and range of the two varieties under study can be compiled in the following **Table 2**.

Table 2: Mass and volume data analysis of Mejdool and Saeidi dates varieties are accepted date fruits.

Quality	Mass (M) g				Volume (V) cm^3			
	Min	Max	Mean	SD	Min	Max	Mean	SD
Mejdool Dates								
Accepted	18.00	29.00	21.58	1.80	13.89	23.78	17.61	1.89
Rejected	8.00	30.00	14.79	3.83	4.89	21.78	11.65	3.01
T-Test Value	16.04				16.85			
Saeidi Dates								
Accepted	5.00	15.00	10.70	1.52	4.89	15.00	9.42	1.64
Rejected	8.00	17.00	9.68	1.93	3.89	12.00	7.83	1.92
T-Test Value	4.15				6.23			

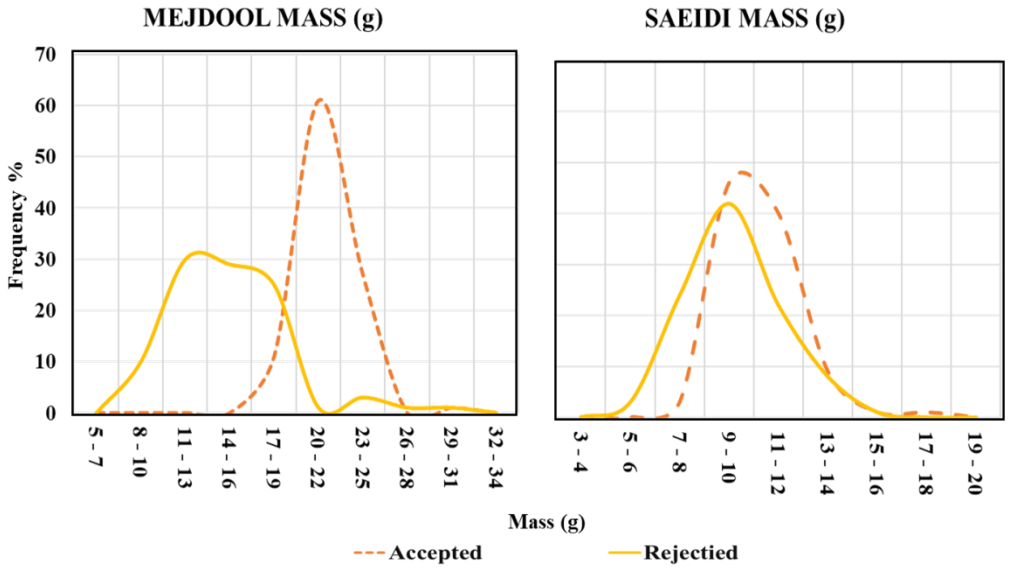


Fig. (4): Mass difference between three date varieties for comparing accepted and rejected samples.

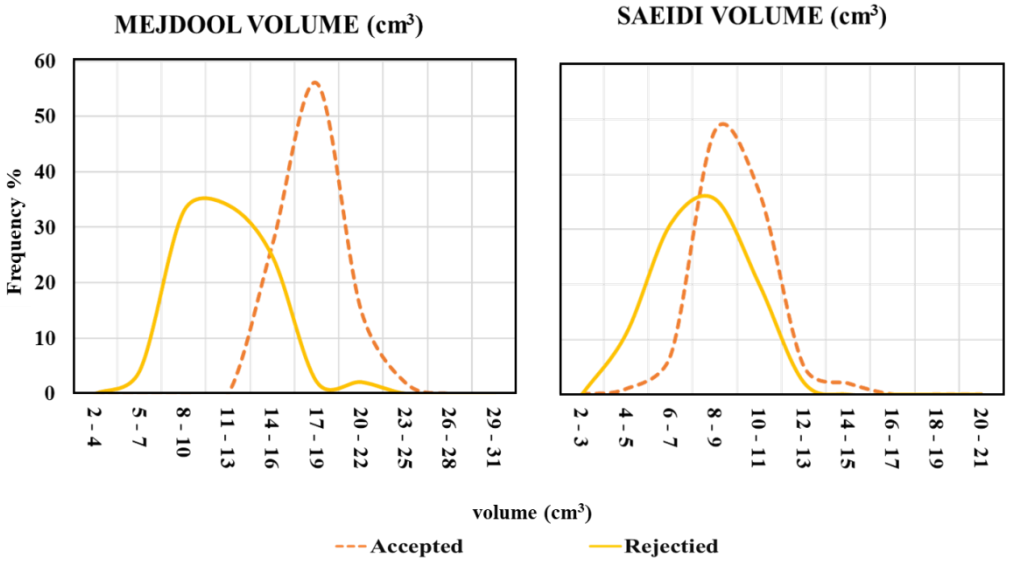


Fig. (5): Actual Volume difference between two date varieties for comparing accepted and rejected samples.

Date Arithmetic and Geometric Mean Diameter, Sphericity, Aspect Ratio, and Surface Area: There are many other physical properties used in handling and classification operations. Some of these properties can be collected in table 3, such as arithmetic and geometric mean diameter, sphericity, aspect ratio, and surface area for Mejdool and Saeidi dates varieties, to value the sorting process for achieving a good quality final product. These properties are important in designing separating, harvesting, sizing, and grinding machines.

Table 3 shows the comparison between accepted and rejected under the study samples. In Table 3, it is noted the difficulty to distinguish between accepted and rejected samples by using these properties. However, there were significant differences between accepted and rejected means. The mean and range of the two varieties under study can be compiled in the following **Table 3**.

Table 3: Arithmetic and geometric mean diameter, sphericity, aspect ratio, and surface area data analysis of accepted date fruits:

Attribute	Accepted				Rejected				
	Min	Max	Mean	SD	Min	Max	Mean	SD	T-Test Value
Mejdool Dates									
D_a, mm	31.12	37.08	33.68	1.13	21.59	35.69	29.22	2.55	16.00
D_g, mm	29.49	34.74	31.89	1.07	20.73	33.91	27.50	2.29	17.41
Φ	0.559	0.756	0.639	0.036	0.528	0.754	0.627	0.047	2.08
Ra	0.417	0.657	0.511	0.044	0.383	0.655	0.497	0.056	2.00
S, cm^2	27.30	37.89	31.98	2.16	13.50	36.10	23.91	3.95	17.92
Saeidi Dates									
D_a, mm	22.88	29.24	25.94	1.30	20.92	30.04	24.75	1.63	5.75
D_g, mm	22.05	28.08	25.11	1.24	19.93	29.12	23.85	1.57	6.28
Φ	0.619	0.804	0.706	0.033	0.583	0.793	0.693	0.044	2.32
Ra	0.488	0.721	0.593	0.042	0.445	0.706	0.578	0.055	2.27
S, cm^2	15.27	24.75	19.84	1.96	12.47	26.63	17.94	2.40	6.15

4. SUMMARY & CONCLUSION

Through studying some of the physical properties of this study samples, the following were shown:

- Some difference appears between the physical properties of the accepted and rejected dates. In the Mejdool variety, there is a significant difference between the mean for the properties of length, average width, mass, and volume. According to the study sample, it was shown that the fruits of dates are more than (26 mm, 22 gm and 19 cm^3) for the physical properties (average width, mass, and size), respectively.
- Generally, as a result of the existence of an overlap in the range between the physical properties under study of the accepted and rejected date fruits, which reduces reliance on them in the classification processes.
- From the above, classification processes for date fruits need other methods such as deep learning, image analysis, etc., to achieve a final good quality product.

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بعض الخصائص الفيزيائية التي تؤثر على تصنيف التمور

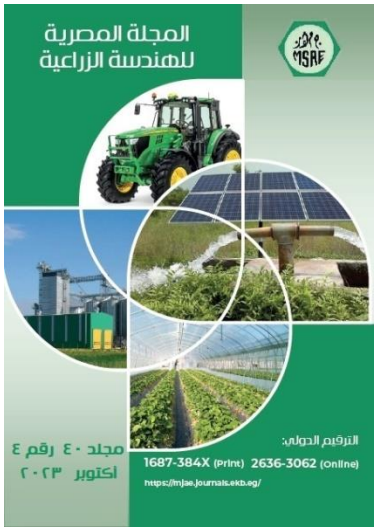
داليا أبو بكر[١&*]، وليد كامل محمد سالم الحلو[٢]، سحر عبده زيان[٣]، محمد احمد ميهوب[٤]

[١] طالبة ماجستير - قسم الهندسة الزراعية - كلية الزراعة - جامعة عين شمس - القاهرة - مصر.

[٢] أستاذ مساعد - قسم الهندسة الزراعية - كلية الزراعة - جامعة عين شمس - القاهرة - مصر.

[٣] رئيس بحوث بمعهد بحوث امراض النبات - مركز البحوث الزراعية - الجيزة - مصر.

[٤] مدرس - قسم الهندسة الزراعية - كلية الزراعة - جامعة عين شمس - القاهرة - مصر.



الكلمات المفتاحية:
التمور؛ الخصائص الفيزيائية؛ عملية التداول؛ التصنيف.

الملخص العربي

تعد مصر أكبر دولة منتجة للتمور في العالم بإنتاج ١,٧ مليون طنًا. تصدر منهم ٠,٠٣ مليون طنًا بنسبة ١,٩% من الانتاج في عام ٢٠٢١، بناءً على تقارير منظمة الأغذية والزراعة (FAO, 2022). وبسبب الفجوة بين الإنتاج والتصدير تهدف الدراسة إلى رفع كفاءة فرز ثمار التمور من خلال دراسة تأثير بعض الخواص الطبيعية عليها، ومن ثم رفع جودة المنتج النهائي المُعد للتصدير.

تم إجراء هذا البحث لدراسة الفروق بين الخصائص الفيزيائية للتمور المقبولة والمرفوضة لأصناف المجدول والصعيدي. وجُمعت عينات ثمار التمور المرفوضة من عينات المصنع المرفوضة وفقًا لمعيار CODEX STANDARD 143-1985. اعتمادًا على سماتها البعدية مثل الطول، والعرض، والسمك، وبعض الخصائص الأخرى مثل الكتلة والحجم. أظهرت نتائج البحث أن هناك اختلافات تُظهرها بعض الخواص الطبيعية لثمار التمور المقبولة والمرفوضة. ففي صنف مجدول كان هناك فرق بين متوسطات الطول، والعرض، والكتلة، والحجم. فقد تبين أن ثمار التمر التي تزيد عن ٢٦ مم عرض أو ٢٢ جرام كتلة أو ١٩ سم^3 حجم يمكن أن تكون جيدة حسب العينة تحت الدراسة. وعموما على الرغم من أن التصنيف المبني على أساس المتوسطات يعطي نتائج جيدة للتفرقة بين الثمار المقبولة والمرفوضة إلا أنه نتيجة وجود نسبة من التداخل بين مدى هذه الخواص يقلل أو يمنع من الاعتماد عليها. لذلك لابد من وجود بعض الوسائل الأخرى التي يعتمد عليها في التصنيف مثل الشبكات العصبية وتحليل الصور وغيرها من الوسائل لتحقيق منتج نهائي ذو جودة عالية.