

A Comparative Study of the Morphological Characteristics and Essential Oil Content of the Male and Female Spathe of the Date Palm (*Phoenix dactylifera* L.)

 Wasen F.F. Alpresem

Aromatic and Medical Plants Unit, College of Agriculture, University of Basrah, Basrah, Iraq.

Wasen.fadel@uobasrah.edu.iq

I. Abstract

This study was conducted in the Medicinal and Aromatic Plants Unit of the College of Agriculture University of Basra on the spathe covers of date palm inflorescences. Three male cultivars (Green Ghannami, Al-Khikri, and Al-Dairi) and three female cultivars (Barhi, Sayir, and Hallawi) were selected to determine the essential oil content of their spathe covers. Mature inflorescences were harvested from all study cultivars before their spathes cracked. A study of the morphological characteristics specific to the spathes (covers) was conducted. The inflorescences were then opened, and the flower clusters were removed to obtain the spathes (covers). These spathes were dried and ground for the purpose of analyzing their essential oil properties.

Color and size of spathes Differentiation of the spathe covers The phenotypic observation of the spathe covers under investigation showed a variation in color of the spathes among the studied cultivars, white for the Green Ghannami cv, yellowish-brown for Al-Khikri, bluish-green for Al-Dairi, light brown for the Barhi and Hallawi cultivars and brown for Sayir. Moreover, the internal color of spathe (jiff) differed according to the cultivars that were examined. Yellow for Al-Ghannami Al-Akhdar, dark yellow for Al-Khikri, greenish-yellow for Al-Dairi, orange for Al-Hallawi, light orange for Al-Sayir and Al-Barhi. The results also revealed a pronounced superiority of the female cv Sayir for the spathe length characteristic with a value of 88.55 cm, on the other hand, the male cv Al-Khikri obtained the minimum mean of 49.55 cm. The highest average spath width observed in the male cultivar Al-Dairi with 14.12 cm, but the lowest were scored by the female cultivar Hallawi and the male cultivar Al-Khikri with an average of 10.35 cm. As for the density of spathe cover (jiff), the highest average thickness of 3.11 mm was recorded by the male cultivar Al-Dairi while the lowest average thickness of 2. 11 mm was attained by the male cultivar Al-Khikri.

Results of the study on essential oil properties revealed that in date palm spathe covers, chemical properties of the essential oil showed differences among all examined cultivars. The male cultivar Green Ghannami had the maximum mean for the content of oil and densities of oil and essential oil in the spathe covers at 0.041%, 0.920, and 0.940 mg\muL⁻¹, respectively, with a significant difference between it and the other cultivars. In contrast, the female cultivar Hallawi displayed the minimum mean for these factors to be 0.027%, 0.820, 0.810 mg\muL⁻¹, respectively. Moreover, the male cultivar of Green Ghannami achieved also the upper limits of the mean refractive index for the oil and the mean pH for the essential oil and saponification value in the spathe covers at 1.587, 5.94 and 178.76, respectively, with

difference from the other interactions. In contrast, the lowest mean for these traits was recorded by the female cultivar Hallawi at 1.480, 5.81, and 165.34, respectively.

Keywords: Morphological characteristics, Essential oils, Spathe covers, Date palm

II. Introduction

The date palm, *Phoenix dactylifera* L., is a highly important plant species. It belongs to the Arecaceae (palm family), which encompasses over 200 genera and 2,500 species. This family is widely regarded as the most beneficial plant family to humans, second only to the grass family (Gramineae). The order Arecales, to which the date palm belongs, is one of the most important known plant orders, as many palm species are classified under it. The date palm belongs to the type species of the Phoenix genus, *P. dactylifera*. The date palm (*Phoenix dactylifera* L.) is a dioecious and unisexual plant; this means that male and female flowers are carried on separate trees. Consequently, pollen plays an essential and critical role in successful fruit setting and formation (Hadrami and Hadrami, 2011; Jain and Al-Khayri, 2011).

The active chemical components of medicinal plants are considered products of processes that occur either directly after photosynthesis, such as stable glycosides, or indirectly, such as alkaloids, volatile oils (essential oils), and others. Due to their therapeutic efficacy for many diseases, their rapid healing power, and their ability to alleviate symptoms, these products are referred to as Active Ingredients (de Sousa *et al.*, 2016)

Interest in studying date palm spathes (inflorescences) has increased not only because they are a direct cause of fruit set in date palm trees but also because they contain beneficial chemical compounds for humans, making them a complete food source. Chemical properties of the male spathe is considered a key indicator for determining the fertility of male date palms, as well as the female spathe and the total number of spathes, the time of flowering, the weight of the spathe, and the number of spikelets present in a single spathe (Liu, Huang and Li, 2013; Aly, 2018; Abdolrazaq *et al.*, 2017).

Date palm pollen plays an important role in supplying the ovaries with the necessary hormones for their growth and in encouraging the ovaries themselves to produce hormones that activate the conversion of tryptophan into auxin. It acts as an activating factor for pre-existing auxin. Furthermore, the male cultivar increases the yield of essential oil within the pollen grains, as well as influencing the essential oil's refractive index. Pollen grains from different date palm cultivars also exhibit variation in the specific gravity of their essential oil, the average pH level, and the saponification value (Farouk *et al.*, 2015).

The floral characteristics, which include spathe traits, can be used to distinguish between different date palm cultivars, such as the length and weight of the spathe, its chemical components like essential oils, the length of the spikelet, and the number of flowers on the spikelet (Jaradat and Zaid,2004). There are significant differences among the floral spathe characteristics of the male and female inflorescences of certain date palm cultivars. El-Kosary *et al.*, (2023) indicated that there are significant differences between date palm cultivars regarding floral spathe characteristics, especially their chemical content, spikelet length, and spikelet count.

III. Materials and Methods

This study was conducted in the Medicinal and Aromatic Plants Unit of the College of Agriculture, University of Basrah on date palm spathes. Three male cultivars(Green Ghannami, Al-Khikri, and Al-Dairi and three female cultivars Barhi, Sayir, and Hallawi were selected to determine the essential oil content of their spathe covers.

Mature spathes of all study cultivars were collected prior to their covers cracking. A study of morphology specific to the spathes was performed. The spathes were then peeled back, and the flower clusters were taken off in order to get the covers. These coverings were air dried for four days, then ground and stored in clean, dry glass jars for study.

Essential Oil Extraction

Essential oil was extracted from the covers of the spathe using the aromatic organic solvent extraction method, employing the organic solvent petroleum ether(Nabi *et al.*, 2025).

Percentage of Essential Oil

The percentage of essential oil was calculated according to the following equation:

$$\text{Essential Oil Percentage \%} = \text{Weight of oil produced mg} / \text{Weight of sample taken mg} * 100$$

Specific Gravity of Oil

The specific gravity of each oil sample from every treatment was estimated by taking a100 μL volume of the oil using a precise volumetric pipette. Using a Mettler analytical balance precise to four decimal places, the volume's weight was measured. Specific gravity values were subsequently calculated at 20 C0 for three measurements from each sample. This was done by dividing the weight of oil by the weight of the same volume of distilled water according to the following equation:

Specific Gravity of Oil = Weight of 100 μL^{-1} of essential oil / Weight of 100 μL^{-1} of distilled water

Essential Oil Density (mg $\cdot\mu\text{L}^{-1}$)

Refractive Index of the Oil

The refractive index of the essential oil was measured at a temperature of 25 C⁰ using an Abbe refractometer.

Essential Oil pH

The pH of the essential oil measured using a pH meter at a temperature of 25 C⁰.

Saponification Value of the Oil

The measurement involved weigh of 0.025 g essential oil and combining it with 3 mL of 0.5 N alcoholic potassium hydroxide solution. The mixture was then heated in a boiling water bath for 30 minutes under an air condenser. After the flask cooled, five drops of phenolphthalein indicator were added. Finally, the solution's alkalinity was neutralized using 0.5 N hydrochloric acid. The first reading (A) was recorded.

Subsequently, the previous steps were performed without the oil, and the volume of hydrochloric acid required to neutralize the solution was measured. This was recorded as the second reading (B). The saponification value was then calculated according to

Saponification Value=(A-B) / Sample *100

Statistical Analysis

The study utilized a Complete Randomized Design (CRD) for a simple experiment with a single factor: the type of spathe (inflorescence cover). Three male cultivars and three female cultivars were selected, each with three replicates, resulting in a total of 27 experimental units. Statistical analysis was conducted using the GenStat software for analysis of variance (ANOVA). For comparison between means, the Least Significant Difference L.S.D test was used at a probability level of 0.05%.

IV. Results and Discussion

Phenotypic characteristics of the Spathe

The phenotypic study of the spathe covers (Table 1) of the accessions showed a variation in the spathe colors: green for the Green Ghannam cultivar, yellowish-brown for the 'Al-Khikri' cultivar, bluish-green for the 'Al-Dairi' cultivar, light brown for the 'Al-Barhi' and 'Al-Helawi' cultivars, and brown for the 'Al-Sayer' cultivar, according to the difference in the studied cultivars. Similarly, the color of the fiber sheath (Jiff) from the inside varied into several colors depending on the studied cultivars, and was: yellow for the Green Ghannam cultivar,



dark yellow for the Al-Khikri cultivar, greenish-yellow for the Al-Dairi cultivar, orange for the Helawi cultivar, and light orange for the Sayer and Barhi cultivars.

Table (2) also indicates the significant superiority of the female cultivar Sayer for the spathe length trait, which reached 88.55 cm, while the cultivar Al-Khikri recorded the lowest average of 49.55 cm. Meanwhile, the cultivar Al-Dairi recorded the highest average for spathe width, reaching 14.12 cm, while the female cultivar Helawi and the cultivar Al-Khikri reached the lowest average of 10.35 cm. As for the thickness of the fiber sheath (spathe cover), the male cultivar Al-Dairi recorded the highest average thickness of 3.11 mm, while the cultivar Al-Khikri reached the lowest average of 2.11 mm.

These findings, therefore, indicate a genetic proximity of the tested cultivars with each other in floral traits and it is possible that the genetic factors, which they carry may be the result of their derivation from a common ancestor already differentiated with regard to the site from an environmental point of view. The present study also suggested that spathe length was one of the strongest floral traits for classification. Moreover, the findings of the present study revealed that all phenotypic traits of accessions contributed to the discrimination of the date palm cultivars. This study is consistent with that of Ouarda *et al.*, (2012) which is on phenotypic variability of the five most relevant date palm cultivars in Tunisia for testing and distinguishing these cultivars based on floral phenotypic characters. The findings of that investigation showed the importance the spathe diameter and inflorescence thickness to differentiate all the date palm cultivars. It is also worth nothing in view of the results of the present study that floral traits hold a greater significance in botanical classification.

Table (1) Phenotypic Description of Male and Female Spathe Covers of Date Palm

| cultivars | Color of the outer sheath | Color of the inner sheath |
|---------------|---------------------------|---------------------------|
| Green Ghannam | Green | Yellow |
| Al-Khikri | Yellowish-brown | Dark yellow |
| Al-Dairi | Bluish-green | Greenish-yellow |
| Barhi | Light brown | Light orange |
| Helawi | Light brown | Orange |
| Sayer | Brown | Light orange |

Table (2) Length, Width, and Thickness of Male and Female Spathe Covers of Date Palm

| Cultivars | Spathe length (cm) | Spathe width (cm) | Spathe thickness (mm) |
|---------------|--------------------|-------------------|-----------------------|
| Green Ghannam | 85.55 | 10.57 | 2.41 |
| Al-Khikri | 49.55 | 13.35 | 2.11 |
| Al-Dairi | 58.55 | 14.12 | 3.11 |
| Barhi | 62.55 | 12.85 | 2.31 |

| | | | |
|--------------------|-------|-------|-------|
| Helawi | 70.55 | 10.35 | 2.19 |
| Sayer | 88.55 | 11.69 | 2.99 |
| L.S.D. \geq 0.05 | 1.121 | 0.251 | 0.132 |

Chemical Characteristics of the Essential Oil

The results of the study, illustrated in Table (3) showed variation among the studied date palm spathe cover accessions (cultivars) in the chemical characteristics of the essential oil.

The male cultivar Green Ghannam recorded the high percentage of oil, specific gravity of the essential oil, and oil density in the spathe covers, reaching 0.041%, 0.920, and 0.940 mg. μ L⁻¹, respectively, with a significant from the rest of the cultivars. Meanwhile, the female cultivar Helawi recorded the lowest average for the same characteristics, reaching 0.027%, 0.820, and 0.810, respectively.

Table (3) Some Chemical Characteristics of the Essential Oil in Male and Female Spathe Covers of Date Palm

| Cultivars | Percentage (%) | Specific Gravity | Oil Density mg. μ L ⁻¹ |
|--------------------|----------------|------------------|---------------------------------------|
| Green Ghannam | 0.041 | 0.920 | 0.940 |
| Al-Khikri | 0.039 | 0.900 | 0.915 |
| Al-Dairi | 0.035 | 0.870 | 0.885 |
| Barhi | 0.030 | 0.850 | 0.860 |
| Helawi | 0.027 | 0.820 | 0.810 |
| Sayer | 0.034 | 0.872 | 0.882 |
| L.S.D. \geq 0.05 | 0.0021 | 0.032 | 0.0452 |

The results illustrated in Table (4) showed variation among the studied date palm spathe cover accessions (cultivars) in the chemical characteristics of the essential oil. The male cultivar Green Ghannam recorded the highest average for the refractive index of the oil, the pH of the essential oil, and the saponification number in the spathe covers, reaching 1.587, 5.94, and 178.76, respectively, significantly distinct from all other interactions. Meanwhile, the female cultivar Helawi recorded the lowest average for the same characteristics, reaching 1.480, 5.81, and 165.34, respectively.

Table (4) Some Chemical Characteristics of the Essential Oil in Male and Female Spathe Covers of Date Palm

| Cultivars | Refractive Index | Oil pH | Saponification Number |
|--------------------|------------------|--------|-----------------------|
| Green Ghannam | 1.587 | 5.94 | 178.76 |
| Al-Khikri | 1.564 | 5.90 | 174.63 |
| Al-Dairi | 1.535 | 5.85 | 171.87 |
| Barhi | 1.515 | 5.81 | 168.98 |
| Helawi | 1.480 | 5.81 | 165.34 |
| Sayer | 1.536 | 5.862 | 171.916 |
| L.S.D. \geq 0.05 | 0.064 | 0.032 | 1.342 |

According to the study's findings, the essential oil requirements of the spathe of the male and female cultivars under consideration varied. This could be because these cultivars differ genetically (Abbas *et al.*, 1995). Plant hormones are responsible for the qualitative features of the essential oil in the spathe covers of the different cultivars. These hormones increase the elasticity of the cell walls, which causes them to expand, activate the cytoplasm, and improve metabolic processes. (Hopkins and Muner, 2008). The high degree of unsaturation of the bonds in the oil's aromatic components or an increase in high molecular weight fatty acids could be the cause of the oil's increased refractive index. The essential oil extracted from the Green Ghannami cultivar's spathe covers had a higher refractive index (Alpresem *et al.*, 2025). Genetic variations across the cultivars may also be responsible for the rise in essential oil density, as seen by the different amounts of solid compounds—especially oxygenated compounds—in the essential oil composition. (Pino *et al.*, 2006) Additionally, the cultivars' genetic diversity may have improved their metabolic processes' efficiency and increased their output, including the essential oil's constituents, which had a favorable impact on the essential oil's saponification number (Thabet *et al.*, 2014).

V. References

Abbas, M. F.; Jassim, A. M. and Ibrahim, A. O. (2000). Indole -3- acetic acid concentration during fruit development in date palm (*Phoenix dactylifera* L. cv. Hillawi). Fruits, Vol. 55: 115 -118.



- Abdolrazaq, K.A.; Y. Ali; S. Dehghani; and A. Vahid (2017). Effect of calcium nitrate and boric acid on pollen germination of some date palm male cultivars. *European Journal of Experimental Biology*. 4 (3): 10 – 14.
- Al-Najjar, Mohammed Abdul Amir Hassan (2014). An Evaluative and Taxonomic Study of Date Palm Male Pollinizers (*Phoenix dactylifera* L.) Growing in the Central and Southern Regions of Iraq. Ph.D. Thesis, College of Agriculture – University of Basra
- Alpresem, W. F., Al-Showily. N. S. and Alnajjar M.Abdulameer (2025). Detection of medicinally Effective Compounds in Two Genera of Ornamental Palm Leaves and Roots (*washingtonia filifera* and *Phoenix* sp.) IOP Conf. Series: Earth and Environmental Science 1487 (2025) 012047. doi:10.1088/1755-1315/1487/1/012047.
- Aly, H. (2018) ‘Evaluation of pollen grains germination, viability and chemical composition of some date palm males’, *Middle East Journal of Agriculture Research*, 7(2), pp. 235–247.
- de Sousa Araújo, T.A., de Melo, J.G., Júnior, W.S.F., Albuquerque, U.P. (2016). Medicinal Plants. In: Albuquerque, U., Nóbrega Alves, R. (eds) *Introduction to Ethnobiology*. Springer, Cham. https://doi.org/10.1007/978-3-319-28155-1_22.
- El-Kosary, S. *et al.* (2023) ‘Morphological, Physicochemical, and Molecular Evaluation of Twenty-Three Date Palm Males Growing in Aswan Governorate’, *Basrah Journal of Agricultural Sciences*, 36(1), pp. 90–106. Available at: <https://doi.org/10.37077/25200860.2023.36.1.08>.
- Farouk, A., Metwaly, A. and Mohsen, M. (2015) ‘Chemical composition and antioxidant activity of date palm pollen grains (*Phoenix dactylifera* L . *Palmae*) essential oil for Siwe cultivar cultivated in Egypt’, *Middle East Journal of Applied Sciences*, 5(4), pp. 945–949.
- Hadrami, A. El, Daayf, F. and Hadrami, I. El (2011) ‘Date Palm Biotechnology’, *Date Palm Biotechnology*, pp. 237–252. Available at: <https://doi.org/10.1007/978-94-007-1318-5>.
- Hopkins, W. G. and Muner, N. P. (2008). *Introduction to plant physiology*. 4th Edition, J. Wiley and Sons, U. S. A. 526 pp.
- Jaradat, A.A. and Zaid, A. (2004). Quality traits of date palm fruits in a center of origin and center of diversity. *Food, Agriculture & Environment*, 2(1):208-217.
- Jain, S.M. and Al-Khayri, J.M. (2011) *Date Palm Biotechnology*. Available at: <https://doi.org/DOI 10.1007/978-94-007-1318-5>.
- Liu, L., Huang, L. and Li, Y. (2013) ‘Influence of Boric Acid and Sucrose on the



Germination and Growth of Areca Pollen', *American Journal of Plant Sciences*, 4, pp. 1669–1674. Available at: <https://doi.org/http://dx.doi.org/10.4236/ajps.2013.48202>.

Nabi, M.H. Bin *et al.* (2025) 'Essential oils: Advances in extraction techniques, chemical composition, bioactivities, and emerging applications Md.', *Food Chemistry Advances*, 8(101048). Available at: <https://doi.org/https://doi.org/10.1016/j.focha.2025.101048>.

Ouarda, E.F.; David, J.W. and Mohamed, L.K. (2012). Phenotypic and nuclear variation in Tunisian cultivars of date palm (*Phoenix dactylifera* L.) . *African Journal of Biotechnology* .11(22):6034-6042.

Pino, J.; M. Sanchez; R. Sanchez; and E. Roncal (2006). Chemical composition of orange oil concentrates. *Nahrung Food*. 36(6):539 – 542.

