Study of Changes in the Chemical Composition of Date Palm Fruits (*Phoenix dactylifera* L.) Derived from Tissue Culture Under the Influence of Different Pollen Treatments

Study of Changes in the Chemical Composition of Date Palm Fruits (*Phoenix dactylifera* L.) Derived from Tissue Culture Under the Influence of Different Pollen Treatments

Firas Mahdi Al-Hamoud[1], Muntaha Abd Al-Zahra Ati[2] and Abdul-Kareem Mohammad Abd[3]

[1]College of Agriculture, University of Basrah, Basrah, Iraq.
[2] Date Palm Research Center, Basrah, Iraq.
[3]College of Education for Pure Sciences, University of Basrah, Basrah, Iraq.

[1]E-mail: firas.abbas@uobasrah.edu.iq

Abstract. The current study was conducted on growing date palm trees in Al-Siba area - Basra Governorate in order to identify the chemical composition of the fruits under the influence of different pollen treatments. The study was conducted using three main factors. pollen) and the second factor is the pollen variety (Al-ghanami red and Al-ghanami + normal Al-Khukri and Al-ghanami + Alkanari) and the third factor is the age of the male pollination (early, medium and late). The fruit content of amino acids and total soluble protein in the interstitial stage and the percentage of total soluble solids in the wet stage were studied. And the percentage of knots, falling, and chips, in the khalal stage, and the results showed that there are differences in the chemical composition of the fruits under the influence of these treatments. Sequentially, the lowest value for total soluble protein and total soluble solids and the lowest percentage of precipitation and shea was 341.4 mg. L^{-1}, 47.08, 37.1, and 11.3%, respectively. As for the effect of the cultivar, the two cultivars Al-ghanami red + Alkanari and Al-ghanami red + Al Khukri normal were significantly superior in the fruit content of amino acids and total soluble protein, as it recorded (39.5, 33.6) mg.L^{-1} and (387.7, 397.5) mg.L^{-1} for both. the two categories sequentially. While the cultivar did not significantly affect the fruit content in the percentage of total dissolved solids and the percentage of precipitation, while Al-ghanami red cultivar recorded the highest percentage of knots and the lowest percentage of hook, which amounted to 55.4 and 4.5%, respectively. Significant differences were recorded between the ages of the male pollens in the fruit content of amino acids, total soluble protein and the percentage of total soluble solids. The medium-mature male pollen gave the highest concentration of free amino acids at an average of (38.7) mg.L^{-1} and the lowest concentration of total soluble protein and total soluble solids. At a rate of (347.6) mg.L^{-1} and (45.63)%, respectively. As for the bilateral and triple interactions, it showed a significant superiority in some of the study interventions.

Keywords. Chemical composition, Date palm, Fruits, Male cultivar, Pollination.

1. Introduction

The Date Palm, *Phoenix dactylifera* L., is one of the semi-tropical fruit trees, and it occupies a distinguished position from a historical and economic point of view for the population of Iraq. In

addition, its fruits have a high nutritional value. Developing the insemination technique that leads to an acceptable level of contraction [1]. The pollen varieties vary in their genetic and physiological characteristics, and it is known that the variation between these varieties can affect the quality and quantity of the fruits produced. The results of the research showed that the pollen variety affects the physical, chemical and physiological characteristics of palm fruits. And that the first effect of the pollen variety on the characteristics of palm fruits is called the term Metaxenia, and this phenomenon has been studied for years by[2-4]. on some cultivars. [5].was the first to indicate that the phenomenon of metazinia is due to endogenous hormones by pollen affecting either directly or indirect [6]. supported this suggestion in their study of several cultivars of date palm pollen.

During these stages, changes occur that have physiological and biochemical importance, as they determine the appearance, color, taste, smell and components of the fruits, and thus their nutritional value. Several studies have been paid attention to the changes in some date palm varieties, and among these changes is the content of the fruits of proteins that decompose into amino acids Which are its basic building units, and the composition and size of the protein depends on the quality and number of amino acids involved in building the protein[7]. Fruits in general are poor in their protein content, but they are considered a rich source of amino acids, as they contain date palm fruits The percentages of protein ranged between 2.3-5.6% depending on the growth stage, and most of the proteins found in palm fruits are soluble[8,9]. Dates are not a good source of protein, but they are of great importance because of the effect of protein on the physiological processes that occur during the stages of growth and development of the plant. Several studies have been conducted on changes in protein content in date palms, including the study of [10], in which the concentrations of soluble protein were shown. In three date palm cultivars, namely, Deglet Nour, Wasil and Daki, during the Khalal, Al-Rutab and Tamr stages, it was found that the percentage of soluble protein decreased gradually from the Khalal stage until the date stage for the three varieties, and it reached (5.45, 4.84, and 3.35) g/100g in the Deglet Nour class. Aseel cultivar (5.74, 4.18, and 3.09) g/100 g, while the Daki cultivar recorded (5.62, 4.01, and 3.23) g/100 g for successive growth stages. [11] showed in her study some of the changes associated with the pollination and setting of date palm fruits of two cultivars Al-Halawi and Al-Sayer, where significant differences were recorded between the two cultivars Al-Halawi and Al-Sayer. The Al-Halawi variety excelled in the second date (2 days of flower opening) in giving the highest concentration of free amino acids at a rate of 3.269 $mg.g.^{-1}$ and the highest percentage of fruit set at a rate of 79.61 and 84.04% for both seasons, respectively. While the fourth pollination date recorded the highest concentration of soluble protein at a rate of 1.856 $mg.gm^{-1}$, while the second pollination date recorded a significant superiority over the rest of the dates in the percentage of fruit set at a rate of 86.32 and 89.15% for both seasons, respectively. As for the sampling date, the third date was recorded. (5 days of inoculation) the highest values of amino acids and soluble protein compared to Al-Sayer cultivar. [12] also indicated the effect of two pollen varieties on some chemical characteristics during the wet phase of the textile Barhi cultivar, as the Al-ghanami Al-Akhdar variety recorded the highest percentage of total dissolved solids at a rate of (37.70)%. As well as the study of [13] that In it, he indicated the effect of local and external pollinators on some chemical and physiological characteristics of date palm, Khalas cultivar, cultivated in the Kingdom of Saudi Arabia. Pollinizer 1 gave the highest percentage of total dissolved solids and the lowest percentage of precipitation and chipping, which amounted to 71.60, 15.63, and 6.47%, respectively. The current study aims to understand the changes in the chemical composition under different treatments of pollen to improve the quality of the fruits and their nutritional properties and determine the time period required to receive pollen and the appropriate pollen variety and its impact on the chemical content of the fruits.

2. Materials and Methods

This study was conducted in one of the private orchards belonging to Al-Siba sub-district in Abi Al-Khasib District - Basra Governorate on the banks of the Shatt Al-Arab between latitude 30 and longitude 48 and at a distance of 60 km from the center of Basra Governorate during the growing season 2021-2022. As 54 tissue palms of the fruitful Barhi cultivar were selected, they were chosen on the basis of similarity in the strength of vegetative growth and the absence of pathological infections,

all of which are of similar ages ranging between 6-7 years. The palm trees are irrigated by drip irrigation. The orchard was prepared, and the date palm trees used in the experiment were identified in February by placing digital signs on them, according to the treatment and frequency. A number of pollinated male cultivars were also selected, with three varieties with their overlaps, which are the red sheep, the ordinary and the canary. Also, the type of male pollination was chosen in terms of age, which is early, medium and late in maturity. The pollination process was carried out by cotton balls dipped in pollen, after which the female pollen is bagged Immediately after the pollination process, to ensure that the pollen of other transactions is not transferred between palm trees, and to provide environmental conditions of temperature and humidity that help in the contracting process. Fruit samples were taken when they entered the khalal stage, while the leaves were taken before the fruits entered the ember stage from the third line after the developing top, which is at the peak of its physiological activity.

2.1. Estimation of Chemical Properties

2.1.1. Estimation of Total Soluble Proteins

The soluble protein in the leaves was estimated according to the method described by [14] taking 0.2 g of the soft sample and crushed with 10 ml of distilled water in a ceramic mortar, then placed in a water bath at a temperature of 50 °C for half an hour, after which it was centrifuged for 15 minutes, 1 ml of the resulting filtrate was taken of samples, as well as 1 ml of each standard protein dilution, to which 5 ml of Reagent A was added, which was prepared by adding 1 ml of the mixture (1% anhydrous copper sulfate with 2% Rochelle salt in a ratio of 1:1) with 50 ml of a 2% calcium carbonate solution. And the mixture was prepared just before use, mixing well and leaving the solution for ten minutes, then adding 0.5 ml of reagent B) prepared from a commercial solution of Follin Ciocaltu, where it was diluted immediately before use in a ratio of 1:2 with distilled water) to each From standard protein solutions as well as sample solutions with good mixing, then the resulting solutions were left for 30 minutes, after which they were measured with a spectrophotometer at a wavelength of 600 nm. Several concentrations of the standard protein solution were prepared by making dilutions of the original solution, which are: - Zero, 100, 200, 300 and 400 mg. Litre-^{1} .

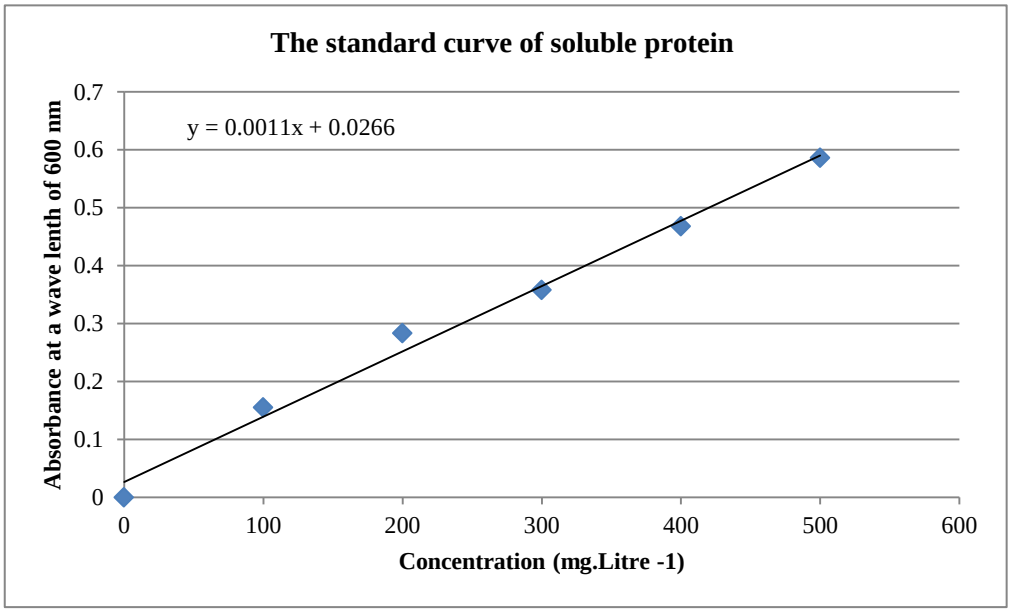

Figure 1. Standard curve of soluble protein.

2.1.2. Estimation of Free Amino Acids

The extraction method was used according to what was stated in[15] when determining the free amino acids in fruits during the khalal stage, according to the following steps:

- Crush 0.2 g of the dry sample with 95% ethanol in a ceramic mortar, then put the extract in the centrifuge at 6000 revolutions for 15 minutes.
- The clear part that evaporated until completely dry was taken, then 2 ml of distilled water was added to it and a centrifugation was performed.
- 1 ml of the resulting clear part was taken after the centrifugation process and 1 ml of Ninhydrin reagent was added to it, then placed in a water bath at 70 °C for 20 minutes, after which the samples were cooled.
- 5 ml of distilled water was added to the samples after cooling them, then the absorbance was measured at a wavelength of 570 nm. The absorbance of the amino acid Leucine was also measured with several dilutions, which are (0, 50, 100, 150, 200) $mg.L^{-1}$ at the same wavelength for the purpose of making the standard curve.

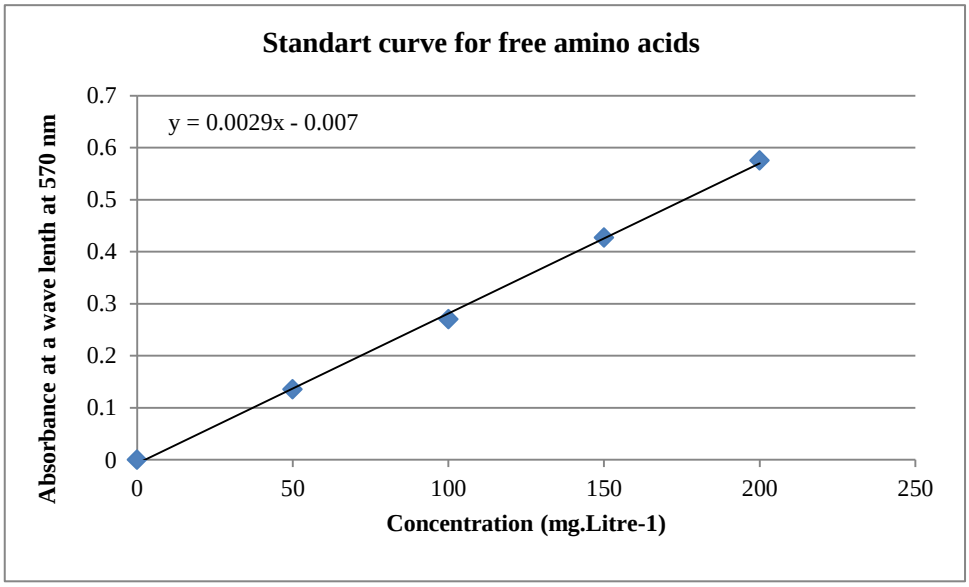

Figure 2. Standard curve of free amino acids.

2.1.3. Total Soluble Solids in the Fruit

5 gm of the flesh of the fruits that were harvested in the wet stage were weighed, 15 ml of distilled water was added to it, and it was mashed well using a ceramic mortar, then filtered and the percentage of total dissolved solids was estimated using the hand refract meter by taking a drop of juice and placing it on the prism of the device. The results were adjusted on the basis of the optimum temperature (20 °C), measured according to [16] method.

2.1.4. Percentage of Fruit Set (%)

Depending on the method [17] the settling ratio was determined as the number of set fruits and the number of empty scars were calculated on five random saplings from each stem and using the following equation:

% to hold the fruits= [(The number of knotty fruits)/(The number of knotty fruits + the number of empty scars)] × 100

2.1.5. Percentage of Fruit Drop (%)

The precipitation percentage is calculated from the following law:

% of fruit drop = [(The number of knotty fruits - the number of fruits remaining when harvesting)/ (The number of knotty fruits)] ×100

2.1.6. Percentage of Non-Setting Fruits (%)
The percentage of non-set fruits is calculated by the following law:

Non-setting (%) = [(The total number of fruits)/ (Number of non-setting fruits)]×100

2.2. Statistical Analysis
The experiment was designed according to the Randomized Complete Block Design as a factorial experiment with three factors: the first factor, the vaccination date, the second factor, the vaccine class, and the third factor, the age of the pollen, with three replications (2 * 3 * 3 * 3) using the least significant difference of 0.05, depending on [18].

3. Results and Discussion
The chemical characteristics are among the important indicators related to the ripeness of the fruits and have a direct relationship with the quality characteristics of the fruits and represent their content of amino acids, proteins, total soluble solids and others.

3.1. The Soluble Protein of the Fruits in the Khalal Stage
The results showed that there were differences in the chemical composition of date palm fruits under different varieties of pollen, and it was found that the concentration of total soluble proteins was higher in the fruits of dates pollinated with one variety compared to other varieties. Table No. (1) indicated that there were significant differences between the two dates in the content of The fruits of the Khalal stage of the Barhi histological variety of soluble protein, the first date (immediately after the pollen opens) recorded the highest value of soluble protein amounted to (404.7) $mg.L^{-1}$ compared to the second date (three days after the pollen opens) which recorded the lowest value at a rate of (341.4) $mg.L^{-1}$.
Table (1) shows the effect of cultivar and age of pollination on the content of soluble protein in date palm fruits. The cultivar Al-ghanami red + Al-Kukri Al-Khuri gave the highest value for soluble protein at an average of (397.5) $mg.L^{-1}$ compared to the cultivar Al-ghanami red (333.9) $mg.L^{-1}$.
The age of the pollen significantly affected the fruit content of soluble protein, as the age of the early and late male pollen significantly outperformed the medium male pollen at a rate of (398.6 and 373.0) $mg.L^{-1}$, respectively, while the average male pollen recorded the lowest rate for the same trait (347.6) $mg.L^{-1}$.
The binary interactions between date and variety, date and age, and cultivar and age showed a significant effect on the soluble protein content of fruits. L^{-1}, while the second date (three days after the pollen opens) with Al-ghanami red cultivar gave the lowest value at a rate of (314.7) $mg.L^{-1}$. The first date (immediately after the pollen opens) with the early male pollen gave the highest concentration at a rate of (431.8) $mg.L^{-1}$. As for the second appointment (three days after the pollen opening) with the late male pollen, it recorded the lowest concentration of soluble protein at a rate of (316.5) $mg.L^{-1}$. The Late Al-ghanami red + Late Normal Al-Khukri cultivar gave the highest value at a rate of (418.1) $mg.L^{-1}$, while the Late Al-ghanami red cultivar recorded the lowest value at a rate of (297.9) $mg.L^{-1}$.
In the three-way interactions, it was observed that the first date (immediately after the pollen opens) was superior to the late red sheep variety + the late ripening Alkanari variety, giving it the highest percentage of soluble protein at a rate of (590.6) mg.l-1, while the second date (three days after the pollen blooming) was recorded with The late Al-ghanami red variety has the lowest value, with an average of (249.5) $mg.l^{-1}$.

Table 1. Effect of cultivar, pollen age, and pollen reception date on fruits content of total soluble protein ($mg.L^{-1}$) in date palm cultivar Al-Barhi.

The date	cultivar	The age of the			Appointment rate	Cultivar rate		Age rate	
		early	Medium age	belated					
immediately after blooming	Al-ghnami red	328.1	385.0	346.3	404.7	Al-ghnami red	333.9	Early	398.6
	Al-ghnami normal+ا red Al-khukri	491.3	368.6	351.8					
	Al-ghnami +ا red Alkanari	476.1	304.7	590.6		Al-ghnami normal+ا red Al-khukri	397.5	Medium	347.6
After 3 days blooming	Al-ghnami red	394.0	300.6	249.5	341.4				
	Al-ghnami normal+ا red Al-khukri	343.4	345.6	484.5		Al-ghnami +ا red Alkanari	387.7	Belated	373.0
	Al-ghnami +ا red Alkanari	358.4	380.9	215.4					

cultivar * The date

immediately after blooming	Al-ghnami red	353.1	
	Al-ghnami normal+ا red Al-khukri	403.9	
	Al-ghnami +ا red Alkanari	457.2	
After 3 days blooming	Al-ghnami red	314.7	
	Al-ghnami normal+ا red Al-khukri	391.2	
	Al-ghnami +ا red Alkanari	318.2	

Age* The date

immediately after blooming	early	431.8
	Medium age	352.8
	belated	429.6
After 3 days blooming	early	365.3
	Medium age	342.4
	belated	316.5

Age*cultivar

	early	Medium age	belated
Al-ghnami red	361.1	342.8	297.9
Al-ghnami normal+ا red Al-khukri	417.3	357.1	418.1
Al-ghnami +ا red Alkanari	417.2	342.8	403.0

LSD values

The date	cultivar	Age	The * date cultivar	Age * The date	Age *cultivar	* The date Age *Cultivar
30.31	37.12	37.12	52.49	52.49	64.29	90.92

3.2. Amino Acids in the Fruits at the Khalal Stage

The results shown in Table No. (2) showed the effect of the date, the effect of the cultivar, and the age of the pollen on the content of date palm fruits, cultivar Al-Barhi histologically, in the Khalal stage of free amino acids. There were no significant differences between the two dates. The second date (three days after the pollen opened) was higher. The concentration of free amino acids reached (34.2) mg.L^{-1}, while the first date (immediately after pollen opening) recorded the lowest rate for the required trait (33.9) mg.L^{-1}. The same table indicated that there were significant differences for the effect of the male variety and the age of the pollen on The fruit content of amino acids in the Khalal stage, as the Al-ghanami red + Alkanari cultivar and the Al-ghanami + AlKhukri normal cultivar were significantly superior to the Al-ghanami red cultivar by recording the highest average concentration of free amino acids (39.5 and 33.6) mg.L^{-1}, respectively, compared to the Al-ghanami red cultivar, which recorded The lowest rate for the trait was (29.0) mg.L^{-1}. At the same time, the average male pollination recorded the highest average concentration of free amino acids, which amounted to (38.7) mg. L^{-1} and thus it has been significantly superior to the male late ejaculation.

The binary interaction between date and cultivar had a significant effect, with the superiority of Al-ghanami red + Alkanari cultivar with the second date (three days after the pollen opened) over the rest of the interactions at a rate of (39.9) mg.L^{-1}, while Al-ghanami red cultivar with the second date (after three days of pollen blooming) the lowest rate of free amino acids with an average of (28.5) mg.L-1. The overlap between date and age of pollen was significant, outperforming the second date (three days after pollen blooming) with the early male pollen and the first date (immediately after pollen blooming) with the average male pollen on the rest of the interactions in the fruit content of free amino acids at a rate of (40.1 and 40.1) mg.L^{-1}, respectively. The lowest value was recorded on the second date (three days after the pollen bloomed) with the late male pollen (25.3) mg. lt^{-1}.

As for the other two-way interaction between the cultivar and the age of the pollen, the medium red sheep + medium canary was significantly superior to the rest of the interactions, at a rate of (49.5) mg. L^{-1}.While the three-way interactions between the study factors gave significant differences with the superiority of the second date (three days after the pollen opens) with the medium red sheep + medium canary giving it the highest values with an average of (50.7) mg.L^{-1}. While the first date was recorded. (Immediately after the pollen blooming) with the Late Al-ghanami red cultivar, the lowest rate for the trait was (20.6) mg.L^{-1}.

Table 2. Effect of cultivar, pollination age, and pollen reception date on fruit content of amino acids (mg.L^{-1}) in date palm, Al-Barhi cultivar.

The date	Cultivar	The age of the			Appointment rate	Cultivar rate		Age rate	
		Early	Medium age	belated					
immediately after blooming	Al-ghnami red	26.6	41.6	20.6	33.9	Al-ghnami red	29.0	Early	35.7
	Al-ghnami normal+ıred Al-khukri	27.1	30.5	41.4					
	Al-ghnami +ıred Alkanari	476.1	304.7	590.6		Al-ghnami normal+ıred Al-khukri	397.5	Medium	347.6
After 3 days blooming	Al-ghnami red	394.0	300.6	249.5	341.4				
	Al-ghnami normal+ıred Al-khukri	343.4	345.6	484.5		Al-ghnami +ıred Alkanari	387.7	Belated	373.0
	Al-ghnami +ıred Alkanari	358.4	380.9	215.4					
cultivar * The date					Age* The date				
immediately after	Al-ghnami	353.1			early		431.8		

The date	Cultivar	The age of the			Appointment rate	Cultivar rate	Age rate
		Early	Medium age	belated			
y after blooming	red Al-ghnami normal+ lred Al-khukri	403.9			Medium age	352.8	
	Al-ghnami + lred Alkanari	457.2			belated	429.6	
After 3 days blooming	Al-ghnami red	314.7		After 3 days blooming	early	365.3	
	Al-ghnami normal+ lred Al-khukri	391.2			Medium age	342.4	
	Al-ghnami + lred Alkanari	318.2			Belated	316.5	

Age*cultivar			
	early	Medium age	belated
Al-ghnami red	361.1	342.8	297.9
Al-ghnami normal+ lred Al-khukri	417.3	357.1	418.1
Al-ghnami + lred Alkanari	417.2	342.8	403.0

LSD values						
The date	cultivar	Age	The * date cultivar	Age * The date	Age *cultivar	* The date Age *Cultivar
30.31	37.12	37.12	52.49	52.49	64.29	90.92

3.3. Total Dissolved Solids in the Wet Phase

Table No. (3) shows the effect of pollination dates, cultivar, pollen age and their interactions on the percentage of total dissolved solids in the wet stage. 48.91%, compared to the second date (three days after the pollen opened), which recorded the lowest rate for the aforementioned trait, amounting to 47.08%. As for the cultivar, it is noted from the same table also that there is no significant effect between the cultivars on the percentage of total dissolved solids, as the Al-ghanami red + Al-Kanari cultivar gave the highest values in the percentage of total dissolved solids, at a rate of 48.56% in the good record of the Al-ghanami red+ Al-Khukari cultivar. The values for the same trait amounted to 47.63%.

The age of the male ejaculation had a significant effect on the percentage of total dissolved solids, as the late male ejaculation was significantly superior in giving the highest percentage of total dissolved solids, amounting to 49.30% over the average male ejaculation, which recorded the lowest percentage of total dissolved solids, amounting to 45.63%.

As for the bilateral interactions between the date and the cultivar, the first date with the Al-ghanami red + Alkanari cultivar was significantly superior in giving the highest percentage of total dissolved solids, amounting to 49.89% over the second date (three days after the pollen opened) with the Al-ghanami red cultivar, which recorded the lowest percentage of solids The total solubility was 46.13%. The first date (immediately after the pollen opens) with the early male pollen was significantly superior in giving the highest percentage of total dissolved solids, amounting to 49.89%, compared to

the second date (three days after the pollen opening) and the medium male pollen, which gave the lowest percentage of total dissolved solids, by 43.80. %. Also, the Late Red Ghanami + Late Canary variety was significantly superior in giving the highest percentage of total dissolved solids, which amounted to 51.06%, while the Medium Al-ghanami red + Medium Medium Khukri recorded the lowest percentage of total dissolved solids, amounting to 43.92%. It is clear from Table (3) the triple interactions between date, variety and age that the first date (immediately after the pollen opens) was superior to the late Al-ghanami + late kanari variety in the percentage of total dissolved solids, as it gave the highest rate for the trait amounted to 53.56%, while the second date recorded (Three days after the pollen opens) with Al-Ghanami Al-Ahmar Al-Med + Al-Kukri Al-Khuri Al-Medium, the lowest percentage of total dissolved solids, at a rate of 42.56%.

Table 3. Effect of cultivar, age of pollination, and date of pollen reception on fruit content of total dissolved solids (%) in date palm cultivar Al-Barhi.

The date	Cultivar	The age of the			Appointment rate	Cultivar rate		Age rate	
		Early	Medium age	belated					
immediately after blooming	Al-ghnami red	51.56	50.56	46.28	33.9	Al-ghnami red	47.80	Early	49.06
	Al-ghnami normal+ˈred Al-khukri	48.56	45.28	48.28					
	Al-ghnami +ˈred Alkanari	49.56	46.56	53.56		Al-ghnami normal+ˈred Al-khukri	47.63	Medium	45.63
After 3 days blooming	Al-ghnami red	44.56	43.28	50.56	341.4				
	Al-ghnami normal+ˈred Al-khukri	52.56	42.56	48.56		Al-ghnami +ˈred Alkanari	48.56	Belated	49.30
	Al-ghnami +ˈred Alkanari	47.56	45.56	48.56					

cultivar * The date

immediately after blooming	Al-ghnami red	49.47
	Al-ghnami normal+ˈred Al-khukri	47.37
	Al-ghnami +ˈred Alkanari	49.89
After 3 days blooming	Al-ghnami red	46.13
	Al-ghnami normal+ˈred Al-khukri	47.89
	Al-ghnami +ˈred Alkanari	47.23

Age* The date

immediately after blooming	early	49.89
	Medium age	47.47
	belated	49.37
After 3 days blooming	early	48.23
	Medium age	43.80
	belated	49.23

Age*cultivar

	early	Medium age	belated
Al-ghnami red	48.06	46.92	48.42
Al-ghnami	50.56	43.92	48.42

The date	Cultivar	The age of the			Appointment rate	Cultivar rate	Age rate
		Early	Medium age	belated			
normal+ا red Al-khukri Al-ghnami +ا red Alkanari	48.56	46.06	51.06				
				LSD values			
The date	cultivar	Age	The * date cultivar	Age * The date		Age *cultivar	* The date Age *Cultivar
N.S	N.S	2.268	3.208	3.208		3.929	5.557

The current research showed that the increase in the percentage of free amino acids at the time of pollination, three days after the opening of the female pollen. An increase in the percentage of fruit set as in Table No. (4), meaning that the fruit needs more functional processes, and therefore the amino acids remain free to carry out metabolic processes. Through the results of the current study, an increase in the levels of amino acids was accompanied by a decrease in the fruit content of soluble protein, as in the two tables (1 and 2) for the same date as there is an inverse relationship, the more amino acids the lower the levels of soluble protein [19]. The current study showed the superiority of the Al-ghanami red + Alkanari variety in increasing the fruit content of free amino acids. The Al-ghanami red + Alkanari pollen variety contained high levels of free amino acids, which directly affected the increase in the fruit content of those acids, which are important components that are a basic building block for proteins and play a role in A role in enhancing the nutritional value, taste and flavor of the fruits. As for the age of the average male spawn, it had a significant effect, as it agrees with what [20] mentioned because of the nutritional status of the male spawn and its vitality ratio. And that this difference between pollen varieties in affecting the chemical content of fruits may be due to the difference in their content of carbohydrates, acids, proteins, phenols, and other compounds[21,22].
Table No. (1) shows that the date of pollination immediately after the pollen opens for the histolytic Barhi cultivar led to obtaining a good percentage of total soluble solids, as the date of pollination directly after the opening of the female pollen led to obtaining the highest percentage of total soluble solids, amounting to 48.91 % with no statistically significant differences between the date of insemination three days after the opening of the female pollen. Therefore, the date of vaccination is not of decisive importance, because the time period between the two dates is close, which led to the absence of significant differences. The results of the current study are consistent with that of [23]. The results of the current study showed that the cultivar does not affect the percentage of total dissolved solids, perhaps its reasons are due to a difference in the water content of those fruits, and that this difference affects differentially on the dilution of the cellular juice inside the fruits, and therefore the fruits with a low water content contain the total dissolved solids. high and vice versa [24]. Or perhaps the reason is that there are no significant differences in the fruit content of total sugars and sucrose in this study, where it was noted that the percentage of total soluble solids was not affected significantly by the effect of the male cultivar and is consistent with the study of [25] who did not notice any significant differences in the percentage of soluble solids. The male pollen was inoculated with three male cultivars, namely, Al-ghanami red, Al-ghanami Al-Akhdar, and Al-Khuri Al-Khurri. As for the age of the male pollen, it had a significant effect on the trait. The late and early male pollen were significantly superior in the percentage of total dissolved solids, in contrast to what [20] mentioned that the late male pollen And early pollen vitality is significantly lower than the average male pollen.

3.4. Percentage of Fruit Set %

The results in Table (4) showed that some of the male cultivars were characterized by a high ability to pollinate and increase the productivity of the tissue date palm under the influence of the experiment treatments. Significantly, with the first appointment (immediately after the pollen opens), as the percentage of contract reached 48.1%. As for the effect of the cultivar, it is noted in the same table that

there are significant differences between the two cultivars in the percentage of fruit set, the red ghanami cultivar recorded the highest value in the set percentage amounting to 55.4%, while the red ghanami + Alkanari variety gave the lowest value in the set percentage amounting to 39.2%. The age of the male pollen did not have a significant effect on increasing the percentage of fruit set, as the early male pollen gave the highest percentage of fruit set at 51.4%, while the middle male pollen gave the lowest rate of fruit set at 48.8%.

As for the bilateral interactions between the date and the cultivar, they were not significant in increasing the percentage of fruit setting for most of the study interactions. The results showed a gradual increase in the percentage of setting. The cultivar Al-ghanami red + Al-Khukri normal with the first date (immediately after the pollen opens) was significantly superior in increasing the percentage of setting, reaching 56.0%. Compared with the Al- ghanami rede + Alkanari cultivar with the first date (immediately after the pollen blooming), which gave the lowest value for the mentioned trait amounted to 32.2%. While no significant differences appeared with the Al-ghanami red variety and the first date (immediately after the pollen opens) and between the Al-ghanami red variety and the second date (three days after the pollen opens) and between the Al-ghanami red cultivar + the normal khukri and the second date three days after the pollen opens) and between the red ghanami cultivar + the canary and the second date three days after the pollen opens) in the percentage of fruit setting 55.9, 54.8, 53.6, and 46 .2% sequentially. The results also showed that the binary interaction between the date and the age of the flight did not have a significant effect with all the study interventions. As there was a non-significant increase in the percentage of fruit set, it was highest for the second date (three days after the pollen opens) with the early male pollen, then the second date (three days after the pollen opens) with the late male pollen, then the first date (immediately after the pollen opens) with The medium male pollen, then the first date (immediately after the pollen opens) with the early male pollen, then the second date (three days after the pollen opens) with the medium male pollen, and finally the first date (immediately after the pollen opens) with the late male pollen in the percentage of fruit setting 55.0 And 52.9, 50.9, 47.9, 46.8, and 45.4%, respectively.

Regarding the effect of the overlap between the cultivar and the age of the pollen, it was noted in Table (4) the superiority of the early red ghanami variety + the normal early ghunami, the medium red ghanami variety, the late red ghanami variety, the red early ghanami variety, the medium red ghanami variety + the average normal khukri, and the late red ghanami variety + late normal khukri. The late red ghanami + late canary significantly increased the contract percentage, reaching 59.9, 59.7, 53.4, 53.0, 52.6, 52.1, and 42.1%, respectively, over the early red ghanami + early canary and the medium red ghanami + medium canary, which recorded the lowest percentage. For fruit set, they amounted to 41.3 and 34.2%, respectively. The nature of the triple interaction between the study factors had an increase in the percentage of fruit set, but it was not significant in most of the study interventions. Significantly different with most of the study interventions. While the second date was given with the medium red ghanami + medium canary variety, the first date and the early red ghanami variety + early canary, the first date (immediately after the pollen opens) and the late red ghanami variety + the late canary, and the first date (immediately after the pollen opens) and the ghanami variety Medium red + medium canary in the percentage of fruit set, the lowest values were 37.9, 35.4, 30.7, and 30.5%, respectively.

Table 4. Effect of cultivar, pollination age, and pollen reception date on the percentage of fruit set in date palm Cv. Al-Barhi (%).

The date	Cultivar	The age of the			Appointment rate	Cultivar rate		Age rate	
		Early	Medium age	Belated					
immediately after blooming	Al-ghnami red	53.8	60.0	53.9	48.1	Al-ghnami red	55.4	Early	51.4
	Al-ghnami normal +ا red Al-khukri	54.4	62.0	51.7					
	Al-ghnami +ا red	35.4	30.5	30.7		Al-ghnami normal +ا red	54.8	Medium	48.8

The date	Cultivar	The age of the			Appointment rate	Cultivar rate		Age rate	
		Early	Medium age	Belated					
After 3 days blooming	Alkanari Al-ghnami red	52.2	59.3	52.9	51.6	Al-khukri Al-ghnami +ا red Alkanari	39.2	Belated	49.2
	Al-ghnami normal +ا red Al-khukri	65.4	43.1	52.4					
	Al-ghnami +ا red Alkanari	47.2	37.9	53.6					

cultivar * The date			Age* The date		
immediately after blooming	Al-ghnami red	55.9	immediately after blooming	early	47.9
	Al-ghnami normal +ا red Al-khukri	56.0		Medium age	50.9
	Al-ghnami +ا red Alkanari	32.2		belated	45.4
After 3 days blooming	Al-ghnami red	54.8	After 3 days blooming	early	55.0
	Al-ghnami normal +ا red Al-khukri	53.6		Medium age	46.8
	Al-ghnami +ا red Alkanari	46.2		belated	52.9

Age*cultivar	early	Medium age	belated
Al-ghnami red	53.0	59.7	53.4
Al-ghnami normal +ا red Al-khukri	59.9	52.6	52.1
Al-ghnami +ا red Alkanari	41.3	34.2	42.1

LSD values

The date	cultivar	Age	The * date cultivar	Age * The date	Age *cultivar	* The date Age *Cultivar
N.S	10.61	N.S	15.01	N.S	18.39	26.00

3.5. Percentage of Fruit Drop

The results in Table (5) show that the first date (immediately after the pollen opens) and the Red Ghanami cultivar and the medium male pollen give the highest percentage of fruit drop, which amounted to 37.9, 40.1, and 42.5%, respectively, with no significant differences compared to the second date (after three days of pollen opening) and the red sheep + canary cultivar and the age of the late male pollen gave the lowest values for the aforementioned trait, reaching 37.1, 34.4, and 34.4%, respectively.

Due to the nature of the binary and triple overlaps, the results in the same table showed that all the binary and triple overlaps in the study were not significant. It was noted that the highest percentage of fruit drop in the overlap between the first date (immediately after the pollen opens) and the Red Ghanami cultivar amounted to 34.3%, while the overlap between the first date gave (34.3%). Immediately after the pollen opens) and the red ghanami + canary cultivar had the lowest values for the mentioned trait, which amounted to 34.2%. The results also showed that the overlap between the second date (three days after the pollen opens) and the medium male pollen gave the highest percentage of fruit drop, amounting to 44.8%, compared to the second date (three days after the pollen opened) with the late male pollen that gave the lowest mentioned values of 30.1%. As for the interaction between the cultivar and the age of the pollen, the two cultivars, Al-Ghanami Al-Ahmar Early and Al-Ghanami Al-Ahmar Medium + Al-Kukri Normal Medium, excelled in giving the highest precipitation percentage of 45.8 and 45.8%, respectively, but it was not significant compared to the rest of the study interactions. Early, the lowest values for precipitation were 30.0%.
The results also indicate the triple overlaps, where the overlap between the second date (three days after the pollen opens) and the early red ghanami cultivar gave the highest precipitation rate of 47.8%, but it was not significant with all the study overlaps. The first date (immediately after the pollen blooms) with the Late Red Sheep + Late Canary cultivar gave the lowest values for the mentioned trait, which amounted to 22.0%.

Table 5. Effect of cultivar, age of pollination, and date of pollen reception on the percentage of fruit drop in date palm cultivar Al-Barhi (%).

The date	Cultivar	The age of the			Appointment rate	Cultivar rate		Age rate	
		Early	Medium age	belated					
immediately after blooming	Al-ghnami red	43.8	40.0	46.1	48.1	Al-ghnami red	40.1	Early	35.5
	Al-ghnami normal +ا red Al-khukri	25.4	34.6	48.3					
	Al-ghnami +ا red Alkanari	34.6	46.1	22.0		Al-ghnami normal +ا red Al-khukri	37.9	Medium	42.5
After 3 days blooming	Al-ghnami red	47.8	40.7	22.3	51.6				
	Al-ghnami normal +ا red Al-khukri	34.6	56.9	27.6		Al-ghnami +ا red Alkanari	34.4	Belated	34.4
	Al-ghnami +ا red Alkanari	26.7	36.8	40.2					

cultivar * The date			Age* The date		
immediately after blooming	Al-ghnami red	43.3	immediately after blooming	early	34.6
	Al-ghnami normal +ا red Al-khukri	36.1		Medium age	40.2
	Al-ghnami +ا red Alkanari	34.2		belated	38.8
After 3 days blooming	Al-ghnami red	36.9	After 3 days blooming	early	36.3
	Al-ghnami normal +ا red Al-khukri	39.7		Medium age	44.8
	Al-ghnami	34.6		belated	30.1

The date	Cultivar	The age of the			Appointment rate	Cultivar rate	Age rate
		Early	Medium age	belated			
	+ا red Alkanari						
	Age*cultivar						
	early	Medium age	belated				
Al-ghnami red	45.8	40.3	34.2				
Al-ghnami normal +ا red Al-khukri	30.0	45.8	37.9				
Al-ghnami +ا red Alkanari	30.6	41.5	31.1				
				LSD values			
The date	cultivar	Age	The * date cultivar	Age * The date		Age *cultivar	* The date Age *Cultivar
N.S	N.S	N.S	N.S	N.S		N.S	N.S

3.6. Percentage of Non-Setting Fruits

Table (6) indicates the effect of the date, cultivar and age of the pollen on the percentage of chipotle in the fruits of date palm cultivar Al-Barhi Al-Najsi. It is noted that both the first and second dates are not significant, as the first date (immediately after the pollen opens) gave the highest percentage of chipotle of 14.0% compared to the date. The second (three days after the pollen opens), which gave the lowest values for the required trait, 11.3%. As for the effect of cultivar, the Al-ghanami red + Al-Kanari cultivar was significantly superior in increasing the percentage of hookah, which amounted to 26.4%, compared to the two cultivars Al-ghanami red + Al-Khukri Al-Ordinary and Al-ghanami red, which gave the lowest percentage of hookah, which amounted to 7.3 and 4.5%, respectively. As for the age of the outgrowths, it did not significantly affect the percentage of the chicks, as the late male outgrowth gave the highest rate of 16.4% for the aforementioned trait, compared to the middle male outgrowth, which gave the lowest rate of 8.7%. As for the effect of the overlap between the date and the variety, the results showed in Table (6) that the first date (immediately after the pollen blooming) with the Al-ghanami + Alkanari cultivar and the second date (three days after the pollen blooming) with the Al-ghanamy red + Alkanari variety also had a significant superiority In giving the highest significant increase in the percentage of hookah to fruits by 33.6 and 19.2%, respectively, with a significant difference with most of the study interventions. It is also noted that there are no significant differences between the second date (three days after the pollen opens) and the red ghanami cultivar and between the first date (immediately after the pollen opens) and the red ghanami + normal khukri cultivar and between the second date (three days after the pollen blooming) and the Al-ghanami cultivar + Al-Khukri normal and between the first date (immediately after the pollen opens) and Al-ghanami red cultivar 8.3, 7.9, 6.7, and 0.8%, respectively.

The same applies to the binary overlap between the date and the age of the flight. The results showed that there were no significant differences in the percentage of the chisel in all study interventions. The first date (immediately after the pollen opens) with the early male pollen gave the highest percentage of chisel amounted to 17.5% compared to the second date (three days after the pollen opens) and the average male pollen that gave the lowest values for the desired trait amounted to 8.4%. As for the effect of the overlap between the cultivar and the age of the pollen, from the results of the same table, the superiority of the early Al-ghanami red + early ripening Alkanari, the late Al-ghanami + late ripening Alkanari, the medium Al-ghanami + the medium ripening Alkanari, the late Al-ghanami red variety and the early Al-ghanami red + the normal early ripening Al-khukri The late Al-ghunami red cultivar + the medium late ripening Al-ghanami cultivar gave the highest percentage of fruit slices

28.1, 26.8, 24.3, 12.4, 10.1, and 10.0%, respectively, compared to the medium Al-ghanami cultivar + the medium medium ripening regular Al-ghanami, the early ripening red ghunami cultivar, and the medium red ghunami cultivar. Maturity, where they gave the lowest values for the mentioned trait, 1.6, 1.2, and 0.0%, respectively.

The triple interaction between the factors of the study had a significant effect in increasing the percentage of chipotle, as the results of the statistical analysis according to Table (6) indicated the superiority of the first date (immediately after the pollen opens) with the late red sheep + late canary variety significantly in giving the highest percentage of chipotle fruits amounted to 47.3 % with a significant difference compared to other interventions. The results also show that there are no significant differences between the first date (immediately after the pollen blooming) and the early red sheep + early canary variety and between the second date (three days after the pollen opens) and the early red sheep + early canary variety and between the second date (three days after The pollen opens) and the medium red grouse variety + the medium canary is between the second date (three days after the pollen opens) and the late ripening red grouse variety is between the first date (immediately after the pollen blooming) and the medium red grouse variety + the medium canary is between the first date (immediately after the pollen opens) and the early Al-ghannami red cultivar + the normal early khukri between the second date (three days after the pollen blooming) and the late Al-ghanami red cultivar + the late normal khukri 30.0, 26.1, 25.3, 24.8, 23.4, 20.2, and 20.0%, respectively. while the overlap between The first date (immediately after the pollen blooming) and the early red Al-ghanami cultivar had the lowest percentage of fruit, reaching 2.4%.

Table 6. Effect of cultivar, pollen age, and pollen reception date on the percentage of pericarp of fruits in date palm (Al-Barhi cultivar) (%).

The date	Cultivar	The age of the			Appointment rate	Cultivar rate		Age rate	
		Early	Medium age	belated					
immediately after blooming	Al-ghnami red	2.4	0.0	0.0	48.1	Al-ghnami red	4.5	Early	13.1
	Al-ghnami normal +ا red Al-khukri	20.2	3.4	0.0					
	Al-ghnami +ا red Alkanari	30.0	23.4	47.3		Al-ghnami normal +ا red Al-khukri	7.3	Medium	8.7
After 3 days blooming	Al-ghnami red	0.0	0.0	24.8	51.6				
	Al-ghnami normal +ا red Al-khukri	0.0	0.0	20.0					
	Al-ghnami +ا red Alkanari	26.1	25.3	6.2		Al-ghnami +ا red Alkanari	26.4	Belated	16.4
cultivar * The date					Age* The date				
immediately after blooming	Al-ghnami red	0.8		immediately after blooming	early	17.5			
	Al-ghnami normal +ا red Al-khukri	7.9			Medium age	8.9			
	Al-ghnami +ا red Alkanari	33.6			belated	15.8			
After 3 days blooming	Al-ghnami red	8.3		After 3 days blooming	early	8.7			
	Al-ghnami normal +ا red	6.7			Medium age	8.4			

The date	Cultivar	The age of the			Appointment rate	Cultivar rate	Age rate
		Early	Medium age	belated			
	Al-khukri Al-ghnami +lred Alkanari	19.2			Belated	17.0	

Age*cultivar

	early	Medium age	belated
Al-ghnami red	1.2	0.0	12.4
Al-ghnami normal +lred Al-khukri	10.1	1.6	10.0
Al-ghnami +lred Alkanari	28.1	24.3	26.8

LSD values

The date	cultivar	Age	The * date cultivar	Age * The date	Age *cultivar	* The date Age *Cultivar
N.S	14.95	N.S	21.14	N.S	25.89	36.61

With regard to the physiological characteristics, the current study showed that the timing of pollen reception depends on the growth stage of the flower. The increase in the percentage of settling in the second date (three days after the pollen opens) (Table 4) is due to the fact that the flower is in the appropriate stage to receive pollen grains and to achieve the highest success rate in pollination. Formation of fruits, and in the event that the seasons are delayed in receiving pollen grains, or the timing is not appropriate, this may lead to the fruits not being formed correctly or the formation of an insufficient knot. Therefore, the effect of the pollen reception period translates into a direct effect on the increase in fruit setting of date palms when pollen is received. Pollen at the right time and in the right way. And that this difference in the effect of the pollen variety on the rate of falling in the fruits is due to several factors, including compatibility with a certain type of pollen over the other, or the genetic factor that plays a major role in the effect. Or it is a result of increasing levels of plant hormones in female flowers at the second date (after Three days from the blooming of the pollen) [26]. This difference between pollen varieties in affecting the percentage of chives in the fruits may be due to the difference in their content of plant hormones, and this was confirmed by most of the research [27].

Conclusion

The two cultivars Al-ghanami red + Alkanari and Al-ghanami red + Al Khukri normal had significantly higher fruit content of amino acids and total soluble protein, respectively, at 39.5, 33.6) and (387.7, 397.5) mg.L-1. While the cultivar did not significantly alter fruit content in total dissolved solids or precipitation, Al-ghanami red had the highest knot percentage (55.4%) and lowest hook percentage (4.5%). The amino acid, total soluble protein, and total soluble solids content of male pollens varied significantly with age. Medium-mature male pollen had the highest free amino acid concentration (38.7) mg.L-1 and the lowest total soluble protein and solids. At (347.6) mg.L-1 and (45.63)%. In several study interventions, bilateral and triple interactions were significantly better.

References

[1] Al-Jubouri, H. J. (2002). The importance of date palm trees *Phoenix dactylifera* L. in the State of Qatar. Facts and events of the training course on the applications of plant tissue culture in improving agricultural production. Publications of the Organization for Agricultural Development (21-27) January 2002. Doha - Qatar.

[2] Salomon-Torres, R., Ortiz-Uribe, N., Sol-Uribe, J. A., Villa-Angulo, C., Villa-Angulo, R., Valdez-Salas, B., Garcia-Gonzalez, C., Iniguez Monroy, C. G., & Norzagaray-Plasencia, S. (2018). Influence of different sources of pollen on the chemical composition of date (Phoenix dactylifera L.) cultivar Medjool in Mexico. Australian Journal of Crop Science, 12(6), 1008–1015. https://search.informit.org/doi/10.3316/informit.894431276877176.

[3] OUTGHOULIAST, H., MESSAOUDI, Z., TOUHAMI, A. O., DOUIRA, A., & HADDOU, L. A. (2020). EFFECT OF POLLEN SOURCE ON YIELD AND FRUITS QUALITY OF DATE PALM (Phoenix dactylifera L.) CV. 'MEJHOUL' IN MOROCCAN OASES. *PLANT CELL BIOTECHNOLOGY AND MOLECULAR BIOLOGY*, *21*(9-10), 60–69. Retrieved from https://ikppress.org/index.php/PCBMB/article/view/5016

[4] Shahsavar, A.R., Shahhosseini, A.(2022). The metaxenia effects of different pollen grains on secondary metabolites enzymes and sugars of 'Piarom' date palm fruit. *Sci Rep* 12, 10058 .(2022)https://doi.org/10.1038/s41598-022-14373-w.

[5] Swingle, W. T. (1928). Metaxenia in the date palm: possibly a hormone action by the embryo or endosperm. Journal of Heredity, 19(6), 257-268. https://doi.org/10.1093/oxfordjournals.jhered.a102996.

[6] Osman, A. M. A., Reuther, W., & Erickson, L. C. (1974). Xenia and metaxenia studies in the date palm Phoenix dactylifera L. *Report*. https://scholar.google.com/scholar?cluster=17685516655933425282&hl=ar&as_sdt=0,5

[7] Kang, T. S., & Kini, R. M. (2009). Structural determinants of protein folding. *Cellular and molecular life sciences*, *66*, 2341-2361. (2009). https://doi.org/10.1007/s00018-

[8] Al-Orf, S. M; Ahmed, M. H; Al-Atwai, N; Al-Zaidi, H; Dehwah, A & Dehwah, S. (2012). Review: Nutritional properties and benefits of the date fruits (Phoenix dactylifera L.). *Bulletin of the National Nutrition Institute of the Arab Republic of Egypt*, *39*, 98-129. https://pesquisa.bvsalud.org/portal/resource/pt/emr-193319

[9] Ahmed, I. S. A., Al-Gharibi, K. N., Daar, A. S., & Kabir, S. (1995). The composition and properties of date proteins. *Food chemistry*, *53*(4), 441-446. https://doi.org/10.1016/0308-8146(95)99840-V.

[10] Haider, M. S., Khan, I. A., Naqvi, S. A., Jaskani, M. J., & Shahid, M. (2014). Flesh and fiber characterization at three different edible stages of date fruit development. *International Journal of Food and Nutritional Sciences*, *3*(4), 16. https://www.academia.edu/8895677/FLESH_AND_FIBER_CHARACTERIZATION_AT_THREE_DIFFERENT_EDIBLE_STAGES_OF_DATE_FRUIT_DEVELOPMENT.

[11] Al-Bresam,W.F.F.A. (2016). A study of certain changes associated with pollination and fruit set of date palm *Phoenix dactylifera* L. CV. Halawi and Sayer. PhD thesis, College of Agriculture - Basra University - Iraq.

[12] Abeed, N. A. A., Taain, D. A., & Hamza, H. A. (2020, November). Influence of pollen source in some qualitative characteristics of date palm fruits propagated by offshoots and tissue culture techniques. In *Journal of Physics: Conference Series* (Vol. 1660, No. 1, p. 012002). IOP Publishing. DOI 10.1088/1742-6596/1660/1/012002.

[13] Munir, M., Alhajhoj, M. R., Sallam, A. A., Ghazzawy, H. S., & Al-Bahigan, A. M. (2020). Fruit yield and quality response of date palm cultivar Khalas to female inflorescence receptivity varied by pollination days. *Plant Arch*, *20*(2), 4007-4014. e-ISSN:2581-6063 (online), ISSN:0972-5210. http://plantarchives.org/20-2/4007-4014%20(6486).pdf

[14] Herbert, D., Phipps, P. J., & Strange, R. E. (1971). Chapter III chemical analysis of microbial cells. In *Methods in microbiology* (Vol. 5, pp. 209-344). Academic press. https://doi.org/10.1016/S0580-9517(08)70641-X.

[15] Moore,S. &Stein,W.H.(1954).In:Colowick ,M.s. and Kaplan,N.O.(ed)Methods in Enzymology.Vol./T/.Academic Preos ,New York. https://www.semanticscholar.org/paper/Methods-in-enzymology-Colowick-Kaplan/46acc239322f6447797a6a9dc0fde4748a126510#citing-papers.

[16] Horwitz, W. (1975). Official methods of analysis (Vol. 222). Washington, DC: Association of Official Analytical Chemists. http://sutlib2.sut.ac.th/sut_contents/H125800.pdf.

[17] Ream, C. L., & Furr, J. R. (1970). Fruit set of dates as affected by pollen viability and dust or water on stigmas. *Report. 47th annu. Date Grs' Inst.*, *47*. https://www.cabdirect.org/cabdirect/abstract/19710309815
[18] AL-Rawi, K. M. and A. M. Khalaf-Allah.(2000). Design and Analysis of Agricultural Experiments. Foundation of Dar AL-Ktob, University of Mosul, Ministry of Higher Education and Science Research, Iraq, pp. 488.
[19] Ravindran, C. P., & Nandakumar, S. (2015). Distribution pattern of amino acid content in different tissues of Solanum mammosum L. fruits. *The International Journal of Science and Technoledge*, *3*(6), 161-165.
[20] Ibrahim, Abdel Basset Odeh (2008). Date palm tree of life. Arab Center for the Studies of Arid Zones and Dry Lands. Damascus - Syria, 390 pages.
[21] Bacha, M. A., Ali, M. A., & Farahat, F. A. (1997). Chemical composition of pollen grains of some date palm males grown in Riyadh, Saudi Arabia. Arab Gulf Journal of Scientific Research, 15, 783-803. http://WOS:000072776800015.
[22] Al-Samarai, A. H.1 , Al-Salihi, F.G.2 , Al-Samarai, R.R(2016) Phytochemical constituents and nutrient evaluation of date palm (*Phoenix dactylifera*, L.) pollen grains . Tikrit Journal of Pure Science 21 (1): 56-62. https://www.iasj.net/iasj/download/4b00fe7659edf803.
[23] Mohammadi, N., Rastgoo, S., & Izadi, M. (2017). The strong effect of pollen source and pollination time on fruit set and the yield of tissue culture-derived date palm (Phoenix dactylifera L.) trees cv. Barhee. *Scientia Horticulturae, 224*, 343-350. https://doi.org/10.1016/j.scienta.2017.06.031.
[24] Abbas, K. I. (1995). Physiological study of metazinia in the date palm, cultivar El-Halawi. Phoenix dactylifera L.. Master thesis, College of Agriculture, University of Basra: 77 p.
[25] Ghaleb, Hossam Hassan Ali, Asaad Khaled Othman, and Ali Jawad Kazem Al-Eidani (1990). The effect of pollen cultivar on some physical and chemical characteristics of the fruits of the sweet palm cultivar during the Khalal and Al-Rutab stages. Basra Journal of Agricultural Sciences 3, (1 and 2): 75-81.
[26] Ali-Dinar, H., Mohammed, M., & Munir, M. (2021). Effects of Pollination Interventions, Plant Age and Source on Hormonal Patterns and Fruit Set of Date Palm (Phoenix dactylifera L.). *Horticulturae*, *7*(11), 427. https://doi.org/10.3390/horticulturae7110427
[27] Maryam, J.; Muhammad, J.; Naqvi, S.A. (2017). Storage and Viability Assessment of Date Palm Pollen. In Date Palm Biotechnology Protocols; Al-Khayri, J.M., Jain, S.M., Johnson, D.V., Eds.; Springer: New York, NY, USA, Volume II, pp. 3–13. [Google Scholar].