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A Comparative Study of the Lipid Content in the Leaves and Roots of Two Palm Family Genera: Washingtonia and Phoenix.

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I. Abstract

This study was conducted at the Medicinal and Aromatic Plants Unit of the College of Agriculture, University of Basrah. The research focused on the leaves and roots of two palm genera,*Washingtonia* and two species from the genus *Phoenix* specifically, *Camarines* and *Pusilla* to investigate the lipid content of the leaves and roots. The results showed a significant impact of both the palm type and the specific plant part on the characteristics of the extracted lipids. The different palm types varied in all lipid characteristics. The *Washingtonia* palm recorded the highest average values for the iodine number, acidity, and saponification value of the lipids (63.30, 41.95, and 257.49 mg KOH g^{-1}) respectively. The *Pusilla* palm, in contrast, showed the highest average values for melting point, refractive index, and specific gravity (181 C^0, 1.523, and 1.1846 g Ml^{-1}) respectively.

Furthermore, the study's findings indicated that the lipids from the roots of all species had superior qualitative characteristics compared to the lipids from the leaves. The high saponification values suggest a high proportion of short-chain fatty acids. Additionally, a high iodine number is associated with a high molecular weight of the lipids. The extremely high melting point of the extracted lipids in this study (181 C^0) makes them unsuitable for food purposes according to international standards, which require a maximum melting point of 40 $C^0$for edible oils.

Keywords: Lipid Content, Roots, Leaves, Palm Family, Washingtonia, Phoenix

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II. Introduction

Palm trees are widely used in landscaping and for decorating the interiors of buildings, facilities, and homes. The Washingtonia palm, also known as the California palm, is a hybrid of two species: W. robusta (the Mexican fan palm) and Washingtonia x filabusta. Belonging to the Arecaceae family, it is a very common ornamental palm grown around the world and in Iraq for its beautiful appearance in public streets(Zona, 2008; Star *et al*., 2003).
The Canary Island palm (Camarines'), Pusilla, Roebelenii, and Humilis are all members of the Arecaceae family and the genus Phoenix. They are widely cultivated in hot and subtropical regions around the world(Basu *et al*., 2014).
Some studies have shown that palms have distinct and useful properties, with each part of the tree being used differently. For example, they are used in paper production, the absorption of heavy and toxic elements, energy production, and as fertilizer for soil(Jonoobi *et al*.,2019).
A medicinal plant contains medically active chemical compounds found in specific organs or various parts of the plant. These compounds are byproducts of secondary metabolic processes, including lipids. Due to their effectiveness in treating many diseases, speeding up recovery, and alleviating symptoms, these products are known as active ingredients. They also serve as a defense mechanism against predatory animals and microorganisms, leading to changes in the secretions of the roots and leaves(Liu *et al*., 2020; de Sousa Araújo *et al*., 2016).
Most previous research has focused on the nutritional value of dates, with very little attention given to other parts of the palm tree. Additionally, some studies have focused on the chemical components of the tree itself (Muhsin,2019).

In a study conducted on the roots and leaves of the ornamental palm *Washingtonia filifera* and four species of ornamental palms belonging to the genus *Phoenix* (specifically Canariensis, Pusilla, Roebelenii, and humilis), qualitative analysis of chemical compounds in the leaves was performed using GC-MS technology.The results showed that Washingtonia filifera had a high concentration of medicinally active compounds (alkaloids, saponins, tannins, glycosides, resins, and coumarins) in its leaves, while the roots contained these compounds in much smaller quantities. Lipids have garnered increasing attention recently

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due to their physiological and chemical importance as essential components of all animal and plant tissues. Some are linked to nutritional requirements, such as linoleic acid, and others are integral to the composition of cell membranes(Alpresem *et al*.,2025). A study was also conducted to estimate and compare the lipid content of the roots of some date palm varieties, examine their properties, and identify the fatty acids present in these lipids(Bhatla & Lal.,2023).

The lipid content in date palm seeds is estimated to be about 10.36% of the dry weight of the seeds. A study on Canary palm seeds found that their oil content is also 10.36%. In addition to oil, date seeds contain other components including(Ash,1.18%,Protein,5.67%,Carbohydrates, 72.59%,Moisture, 10.20%)The percentage of lipids in date seeds varies depending on the date variety, but this figure represents a general average(Merle *et al*.,2002).

Due to the scarcity of studies on the presence of fatty substances in the leaves and roots of palm family genera, this current study was conducted

III. Materials and Methods

This study was conducted at the Medicinal and Aromatic Plants Unit of the College of Agriculture, University of Basra. The research focused on the leaves and roots of two palm genera, Washingtonia and two species from the genus Phoenix: Canariensis and Pusilla. The purpose was to study the lipid content of the leaves and roots. Leaf samples (from the middle) and root samples (from a depth of 30 cm) were collected from the trees. They were then washed and dried in an oven at 45 C^0 until completely dry. The dried parts were ground using an electric mill. The ground samples were stored in tightly sealed glass containers at a laboratory temperature of 20-22 C^0 until they were used.

Lipid extraction

Lipid extraction was performed using solvents as described by (Sandi,2019), a mixture of chloroform and methanol (1:2), twenty times for each sample. The extract was then dried using a rotary evaporator at 40 C0. The samples were stored in a nitrogen-saturated

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environment at -20 C0 to prevent oxidation and were purified before use. Fatty acid esters were prepared according to (mention the source here) and separated by gas-liquid chromatography with a flame ionization detector (Pye Unicam Series 304 Chromatograph). Some physical properties of the lipids were estimated(Iodine value,Specific gravity,Saponification value, Acid value, Refractive index (measured using an Abbe Refractometer) and Melting point (measured using a Melting Point Apparatus)(Al-Najjar *et al*.,2021).

Statistical Analysis

A Randomized Complete Block Design (RCBD) was used for a two-factor factorial experiment. The two factors were(Factor (1) Palm type and Factor (2) Plant part The experiment had three replicates, totaling 18 experimental units. The statistical analysis was performed using the GenStat software for analysis of variance (ANOVA). For comparing the means, the Least Significant Difference (L.S.D.) at a 0.05 probability level was applied(Tuba,2008).

IV. Results and Discussion

Iodine value of Lipids

The influence of palm type on the iodine value of fats is presented in Table 1. Washingtonia palms did much better than the other species, achieving the highest average of 63.30. Canary palm's Iodine value was found to be the lowest with an average value of 58.61 and Pusilla palm's Iodine value was found to be 60.44. There was also a significant effect of the plant part on the iodine value. Roots gave the highest (61.68) value different significantly from the other parts of the plant whose average was 59.89. The interaction between palm type and plant part Roots of Washingtonia gave the highest value (64.26) significantly different from the rest of the interactions. Canary leaf had the least average (57.87. The iodine value of the fats in the Canary and Pusilla palm-root was, respectively, 59.35 and 61.43. While, C×W leaves were predominant over C×W roots, Washingtonia leaves were superior and recorded significantly higher mean value (62.34).

Table (1) The Iodine value for Lipids Extracted from the Roots and Leaves of Two Genera of the Palm

Palm Type	plant part	Average effect of

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	Leaves	Roots	type
Washingtonia	62.34	64.26	63.30
Canary	57.87	59.35	58.61
Pusilla	59.45	61.43	60.44
Average effect of plant part	59.89	61.68	Interaction =1.676
L.S.D.	Palm Type= 1.222	plant part =0.934	

Acidity values of lipids

As can be seen from Table 2, the influence of the type of palm on the acidity values of the lipids was highly significant. The Washingtonia palm also showed the higher average, 41.95, compared to other species. The lowest average was recorded by the Pusilla palm of 38.93 and 40.45 average for the Canary palm. The plant part affected substantially the acidity of the lipid. Roots presented higher saponifier acid value with average of 40.60, which differed significantly from leaves that presented an average of 40.09. In terms of the interaction between the palm species and plant part, Washingtonia palm roots exhibited the highest LA value (42.23). This was in sharp contrast to all other pairs. The minimum in average was recorded among palm leaves of Pusilla (38.74). The acidity scores of the roots of Canary and Pusilla palms were 40.45 and 39.11, respectively

Table (2) Acidity of Lipids Extracted from the Roots and Leaves of Two Genera of the Palm Family.

Palm Type	plant part		Average effect of type
	Leaves	Roots	
Washingtonia	41.67	42.23	41.95
Canary	39.85	40.45	40.15
Pusilla	38.74	39.11	38.93

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Average effect of plant part	40.09	40.60	Interaction =1.341
L.S.D.	Palm Type= 0.845	plant part =0.543	

Saponification Values of Lipids (mg g^{-1} KOH)

Table 3 also indicates the influence of palm type and plant part on the saponification values of the fats. The Washingtonia palm was also better than the others, with yield of 257.49 mg g-1 was recorded. The Pusilla palm had the lowest saponification average of 225.87 mg g-1 and the Canary palm had an average of 238.99 mg g-1. The plant part was also found to have effect on saponification values. The highest value was recorded in the roots at an average of 245.78 mg g-1, and this was significantly different from the leaves with an average of 235.78 mg g-1. For the interaction of palm type with plant part the largest lipid saponification value was found in the roots of Washingtonia (261.65 mg g-1) which was significantly different from the rest of the combinations. On the other hand, average Al accumulation in the leaves of the Pusilla palm was the lowest measured, being 221.37 mg g-1. The saponification value of the lipids in the roots of the Canary palm and Pusilla were 245.32 and 230.36 mg g-1, respectively. The Washingtonia palm leaves also were far better than both the Canary and Pusilla palm roots, with a mean of 253.33 mg g-1.

Table (3) Saponification of Lipids Extracted from the Roots and Leaves of Two Genera of the Palms

Palm Type	plant part		Average effect of type
	Leaves	**Roots**	
Washingtonia	253.33	261.65	257.49
Canary	232.65	245.32	238.99
Pusilla	221.37	230.36	225.87
Average effect of plant part	235.78	245.78	Interaction =8.45
L.S.D.	Palm Type= 6.37	plant part =4.44	

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Melting Point of Lipids (C^0)

The melting point of the lipids was also significantly influenced by palm type and plant part, as evidenced in Table 4. The average melting point of the Pusilla was observed to be significantly highest (181.00 C) but lowest in the Washingtonia (179.85 C) and the melting point in the case of the Canary was 180.56 C A significant effect of the plant part was likewise noted. The roots were superior, with a mean of 181.20 C, significantly different from the leaves, with an average of 179.73 C For the palm type and plant part interaction, the roots of the Pusilla palm showed the highest lipid melting point rate, 182.00 C, significantly different from all other interactions. The melting point of lipids from roots of the Washingtonia palm was (180.50 C average), while the lipids from the roots of the Canary palm melted at 181.11 C The melting point of the lipids of the Washingtonia palm and the Canary palm leaves averaged (179.2 and 180.29) C, respectively.

Table (4) Melting Point of Lipids(C^0) Extracted from the Roots and Leaves of Two Genera of the Palms

Palm Type	plant part		Average effect of type
	Leaves	**Roots**	
Washingtonia	179.20	180.50	179.85
Canary	180.00	181.11	180.56
Pusilla	180.00	182.00	181.00
Average effect of plant part	179.73	181.20	Interaction =0.634
L.S.D.	Palm Type= 0.421	plant part =0.256	

Refractive index of lipids

The effects of palm type and plant part on the refractive index of the lipids are presented in Table 5. The average refractive index value of the Pusilla palm is the highest with 1.523, and

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the minimun value is for the Washingtonia palm is 1.514. The refractive index of the glaucomapine stem was 1.515 at 589 nm. The average refractive index of the roots of the palms, 1.522 exceeded the leaves 1.513. The Pusilla palm roots displayed the highest refractive index which was 1.530. On the other hand, the lowest average was recorded for Canary palm leaves (1.510).

Table (5) Refractive Index of Lipids Extracted from the Roots and Leaves of Two Genera of the Palms

Palm Type	plant part		Average effect of type
	Leaves	**Roots**	
Washingtonia	1.512	1.515	1.514
Canary	1.510	1.520	1.515
Pusilla	1.516	1.530	1.523
Average effect of plant part	1.513	1.522	Interaction =0.0431
L.S.D.	Palm Type= 0.0333	plant part =0.0231	

Specific gravity of lipids

The results of the statistical analysis in Table 6 showed that both palm type and plant part had a significant effect on the specific gravity of the lipids. The Canary palm was superior to the other types, recording the highest average at 1.3058 g mL^{-1} The Washingtonia palm had the lowest average at 1.1460 g mL^{-1}, while the Pusilla palm's lipid specific gravity was 1.1864 g mL^{-1}. The plant part also had a significant impact on the specific gravity of the lipids. The roots recorded a higher value of 1.2261 g mL^{-1}, a significant difference from the leaves, which had an average of 1.1993 g mL^{-1}.

Regarding the interaction between palm type and plant part, the roots of the *Canary* palm recorded the highest value at 1.3243 g mL^{-1}, which was a significant difference from all other interactions. In contrast, the leaves of the *Washingtonia* palm had the lowest average at 1.1356 g mL^{-1}. The specific gravity values for the lipids in the roots of the *Washingtonia* and

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Pusilla palms were 1.1564 g mL^{-1} and 1.1976 g mL^{-1}, respectively. The leaves of the *Canary* palm also had a significantly higher average (1.2872 g mL^{-1}) than the roots of both the *Washingtonia* and *Pusilla* palms.

Table (6) Specific Gravity of Lipids (g mL^{-1}) Extracted from the Roots and Leaves of Two Genera of the Palms

<table>
<tr><td rowspan="2">Palm Type</td><td colspan="2">plant part</td><td rowspan="2">Average effect of type</td></tr>
<tr><td>Leaves</td><td>Roots</td></tr>
<tr><td>Washingtonia</td><td>1.1356</td><td>1.1564</td><td>1.1460</td></tr>
<tr><td>Canary</td><td>1.2872</td><td>1.3243</td><td>1.3058</td></tr>
<tr><td>Pusilla</td><td>1.1752</td><td>1.1976</td><td>1.1864</td></tr>
<tr><td>Average effect of plant part</td><td>1.1993</td><td>1.2261</td><td rowspan="2">Interaction =0.0876</td></tr>
<tr><td>L.S.D.</td><td>Palm Type= 0.0568</td><td>plant part =0.0345</td></tr>
</table>

The study showed that the characteristics of the lipids vary based on the palm type, which can be attributed to the genetic differences among the species studied. The properties also differed depending on the plant part, as the lipids from the roots of all species were superior in all their qualitative characteristics to the lipids from the leaves. The high saponification values of the extracted lipids suggest a high proportion of short-chain fatty acids. Additionally, a high iodine value is associated with a high molecular weight of the lipids. The melting point of the extracted lipids in this study was extremely high, making them unsuitable for food purposes. According to international standards, the maximum melting point for edible oils is 40C0(Rehman *et al*.,2019; EL-Hossary,2000) .

The high refractive index values of the lipids extracted from the roots and leaves of these varieties reflect the presence of unsaturated fatty acids, indicating a high proportion of them. The importance of lipids to the plant lies in their role as an energy source used in vital metabolic processes. They also have medicinal and therapeutic benefits and are a key

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component of the chloroplast and mitochondrial membranes in leaves(Amira,2001;Gonzalez *et al*.,2003).

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