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Research Paper

Effect of Solvent Extraction on the Distribution of Phenolic Compounds in Arbutus pavarii and Pistacialentiscus Plants: A Case Study from Al-Ghabal Al-Akhder Region, Libya.

HAMAD.M.ADRESS.HASAN
Salma S.Abdalla Mohammed
Salma A Taher mohamed
NajahEselini
SALIMAH ABOULQASSIM MUSTAFA

Abstract:
This study examined how solvents affected Arbutus pavarii and Pistacialentiscus phenolic component extraction. Samples were prepared and extracted using ethanol, methanol, chloroform, and ethyl acetate. The extracts showed that solvent choice considerably affects phenolic content, with ethanol, methanol, and chloroform outperforming ethyl acetate. These data show that solvent characteristics affect phenolic extraction efficiency.
Key words: *Phenolic Compound Extraction, Arbutus pavarii, Pistacialentiscus, Solvent Influence, Ethanol, Methanol, Chloroform, Ethyl Acetate, Extraction Efficiency, Solvent Properties, Phytochemical Analysis*

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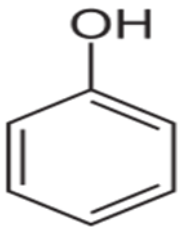
I. Introduction:

1.1Phenolic Compounds:

Plant secondary metabolites, phenolic chemicals, are essential for medical use. A large range of plant bioactives have hydroxyl groups connected to aromatic rings and are mostly produced from phenylalanine. As powerful antioxidants, they are crucial for plant development, defence, and stress response. This abbreviated portion summarises the original content by emphasising phenolic compounds' antioxidant properties without going into detail(Smith and March, 2007).

1.2Chemical Structure of Phenol:

Preventing chemical burns requires careful handling of phenol, a white, crystalline substance (C6H5OH) with volatile and acidic qualities (Weber et al., 2004). Industrially synthesised from petroleum, it is a precursor to plastics, polycarbonates, epoxies, nylon, detergents, herbicides, and medicines. The molecule has phenyl-hydroxyl bonds.



Sodium phenoxide, its sodium counterpart, is even more water-soluble than phenol, which forms homogenous solutions at certain ratios (Smith and March, 2007).

1.3. Reactions:

The electron-donating oxygen in phenol makes it very reactive in electrophilic substitution, allowing the addition of different groups to its ring. Its strong reactivity, closely following aniline, causes extensive replacement around the hydroxy group during bromination or chlorination. At normal temperature, dilute nitric acid converts phenol into 2- and 4-nitrophenol. Concentrated nitric acid nitrates the ring to 2,4,6-trinitrophenol or picric acid (Roscoe, 1981).

1.4. Acidity:

Phenol is a weak acid in aqueous solution, it is in equilibrium with the **phenolate** anion $C_6H_5O^-$ (also called **phenoxide**), (Mayer *et al*., and 2019).

$$C_6H_5OH \rightleftharpoons C_6H_5O^- + H^+$$

1.5 Uses:

Plastic precursors like bisphenol-A, needed for polycarbonates and epoxides, are made from phenol and acetone. For Bakelite and other industrial uses, it creates phenolic resins with formaldehyde. Hydrogenation produces nylon precursor cyclohexanone, while alkylation produces detergents such nonylphenol (Kaeding, 1964). Aspirin, pesticides, and other drugs are made from phenol. In molecular biology, phenol-chloroform extraction is essential for nucleic acid isolation, with pH controlling DNA or RNA isolation (Svobodova and Walterova, 2003).

1.6 Medical Applications:

Joseph Lister pioneered phenol as an antiseptic. It was commonly employed in carbolic soaps until the 1970s and in chemical matrixectomy for ingrown nails (Kazem, 2017). Otto Boll's 1945 approach is still used in podiatry. Phenol is a vaccine preservative and an active ingredient in sore throat sprays and oral analgesics including Chloraseptic, TCP, and Carmex for transient pharyngitis relief (Kazem, 2017).

1.7 Niche Applications:

Due to its cost, phenol is used in many modest applications. It is essential to aviation paint strippers that remove chemically resistant coatings like epoxy and polyurethane (Svobodova and Walterova, 2003). Additionally, phenol derivatives are used in sunscreens, hair dyes, and skin lighteners (Deselms, 2008). These compounds help cosmetic goods achieve their desired effects.

1.8 Effect of the solvent on phenolic compounds:

Water, ethanol, methanol, acetone, and their aqueous mixes are used to extract phenolics from plants. Although several extraction procedures exist, no standard has been developed (Cacace and Mazza, 2003; Bucić-Kojić et al., 2007). The chemical composition of phenolics, extraction methods, sample size, storage, and contaminants affect extraction efficiency (Naczk and Shahidi, 2004). For vegetable phenolic extraction, solid-liquid extraction with various solvents is common (Alothman et al., 2009; Cottica, 2011). Solvent polarity greatly impacts phenolic class extraction and solubility (Naczk and Shahidi, 2006).

1.9. Solvent classifications:

Polar and non-polar solvents exist. Besides mercury amalgams, several metal solutions are liquid at ambient temperature. Polarity is usually estimated by the solvent's dielectric constant (Abbott and Hanson, 2008) . Water's high dielectric constant of 88 (at 0 °C) indicates its strong polarity. Dielectric constants under 15 indicate non-polar solvents (Hansen, 2002) .

The solvent's dielectric constant assesses its tendency to partially cancel a charged particle's electric field. This reduction is compared to the charged particle's vacuum field strength. A solvent's dielectric constant reduces the solute's effective internal charge. A solvent's dielectric constant usually predicts its capacity to dissolve organic molecules (Kosower, 1969).

1.10. Other polarity scales:

Solubility and miscibility depend on solvent polarity, dipole moment, polarizability, and hydrogen bonding capacity, which must be measured accurately in chemical and biological applications (Gutmann, 1976). Polar solvents dissolve sugars and salts, while non-polar solvents dissolve oils and waxes because "like dissolves like".

Polarity has multiple contributions. Examples of Kamlet-Taft parameters are dipolarity/polarizability (π*), hydrogen-bonding acidity (α), and hydrogen-bonding basicity (β). Reichardt's dye, nitroaniline, and diethylnitroaniline wavelength shifts in the solvent can be used to compute these. Hansen's parameters divide cohesive energy density into dispersion, polar, and hydrogen bonding (Abbott and Hansen, 2008).

1.11. Polarprotic and polar aprotic:

Polar or polarizable solvents have a dielectric constant (relative static permittivity) larger than 15. They can be protic or aprotic. Anions are strongly solvated by hydrogen bonding in protic solvents. Protic solvent water. Aprotic solvents like acetone and dichloromethane have strong dipole moments and solvate positively charged species via their negative dipole. Polar protic solvents favour the SN1 reaction mechanism in chemical processes, while polar aprotic solvents favour SN2. Polar solvents dissolve in water by creating hydrogen bonds, but non-polar solvents cannot (Abbott and Hansen, 2008).

1.12 Objective of the Study

This article examines how ethyl acetate, ethanol, acetone, diethyl ether, methanol, and chloroform affect phenolic component distribution in Arbutus pavarii and Pistacialentiscus plants. The research will take place in Libya's Al-Ghabal Al-Akhder region. This study compares the extraction efficiency and solubility of phenolic components from seven plant species using different solvents. The study will reveal solvent-specific extraction capabilities and how solvent choice may affect phenolic component profile in Arbutus pavarii and Pistacialentiscus.

II. Materials and Methods

2.1. Sampling:

2.1.1. Selection the plants for this study:

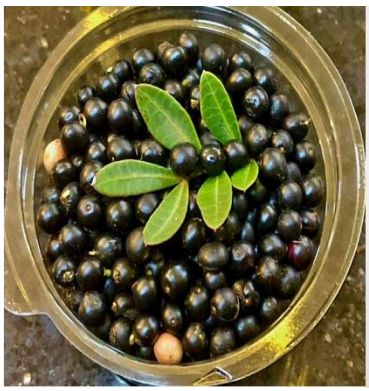
Due to the important many plants which used at AL-Gabal AL-Khder region, Libya, this study was designed to select two different endemic plants (***Arbutus pavarii*** and ***Pistacialentiscus***), which collected from Al-Gabel Al –Kadar region during spring 2019 season.

2.1.2. Samples preparation:

Leafs and fruits of every specie of the studied plants were separated and washed with distilled water several times, then dried in open air for fifteen days. The images of the studied plants are given in figures (1 – 4).

Fig(1): ***Arbutus pavarii*** fruits

Fig(2):***Arbutus pavarii*** leafs



Fig(3): ***Pistacialentiscus***fruits

Fig(4): ***Pistacialentiscus***leafs

2.2. Taxonomical investigation:

The samples were kindly identified by plant Taxonomy unit, and the samples kept inseliphiumherbarium, Faculty of Science, Omar Al Mokhtar University. The taxa of studied plants are shown in figures (5-6).

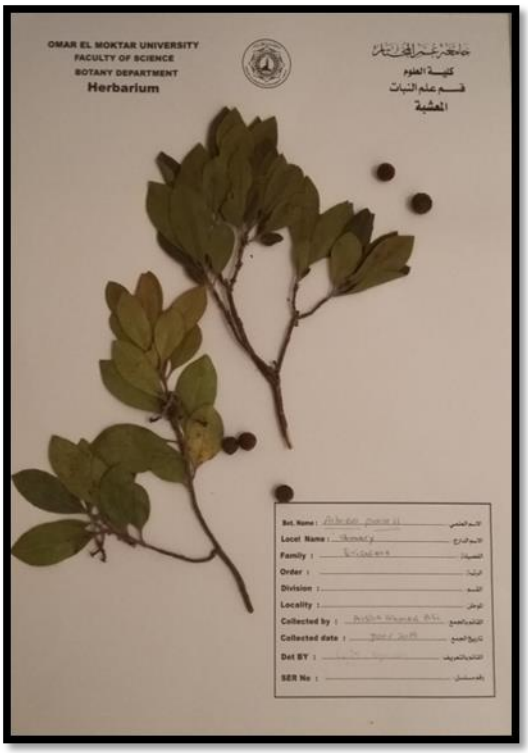


Figure (5): Herbarium sample of ***Arbutus pavarii***.

Figure (6): Herbarium sample of ***Pisticialentiscus***.

2.3. Phytochemical screening:

All the phytochemical screening tests were carried out according to standard methods and can be describing as follows:

2.3.1. Test for sterols and/or triterpines:

Libermann-Burchad's test:

Table 1: Libermann-Burchard Test for the Presence of Sterols and Triterpenes in Sample Extracts

Step	Description	Source
1	Add 1 ml of sample extract to a dry test tube.	El Hifnawy et al., 1992
2	Add 0.3 ml of acetic anhydride to the tube.	El Hifnawy et al., 1992
3	Apply a few drops of strong sulphuric acid to the tube.	El Hifnawy et al., 1992
4	Observe the color change at the junction of the two layers; a reddish-violet color indicates a positive reaction.	El Hifnawy et al., 1992
5	Note the color of the chloroformic solution; a green coloration signifies the presence of sterols and triterpenes.	El Hifnawy et al., 1992

2.3.2. Test for flavonoids:

The alcohol and aqueous extracts of the examined herbal plants were extracted with 1% hydrochloric acid. Each extract was made alkaline and coloured faint yellow if flavonoids were present (Balbaa et al., 1981).

2.3.3. Test for alkaloids:

The extracts of the tested herbal plants were further extracted with 20ml of dilute hydrochloric acid, cooled and rendered alkaline with dilute ammonium hydroxide solution, then extracted with chloroform. The chloroform extract is subjected to the following test:

Dragendorff's test:

Table 2: Dragendorff's Test Procedure for Alkaloid Detection

Step	Details	Reference
Solution a	0.85 g of basic bismuth nitrate dissolved in 10 ml acetic acid and 40 ml water	-
Solution b	8 g potassium iodide in 20 ml water	-
Stock solution	Mix equal volumes of solutions a and b	-
Application	Apply a few drops of chloroform extract to filter paper, dry, and spray with reagent; observe orange color for alkaloids	Stahl, 1964

2.3.4. Test for tannins:

Table 3: Procedure for Tannin Detection in Herbal Plant Extracts

Procedure Step	Description
Extraction	Herbal plant extracts (alcohol and aqueous) are further extracted with 50% ethanol.
Filtration	The mixture is filtered to obtain a clear hydro-alcoholic solution.
Testing	The clear hydro-alcoholic solutions are subjected to subsequent testing.

Ferric chloride test:

Table 4: Reagent Addition and Observation Procedure

Procedure Step	Description	Reference
Reagent Addition	1 ml of 1% FeCl3 reagent is added to the hydro-alcoholic solution.	Clauss, 1961; Egyptian Pharmacopoeia, 1984
Observation	Development of blue color indicates the presence of pyrogallol tannins.	Clauss, 1961; Egyptian Pharmacopoeia, 1984

2.3.5. Test for carbohydrates and /or glycosides:

Table 5: Testing Protocol for Carbohydrates and Glycosides in Herbal Plant Extracts

Procedure Step	Description	Reference
Aqueous Extraction	Extract tested herbal plants with water; obtain aqueous extract.	Clauss, 1961
Molisch Test Preparation	Mix 2 ml extract with 0.2 ml ethanolic α-naphthol (20%).	Clauss, 1961
Molisch Test Reaction	Add 2 ml concentrated sulphuric acid along the test tube side.	Clauss, 1961
Observation	A violet ring indicates the presence of carbohydrates/glycosides.	Clauss, 1961

2.3.6. Tests for cardiac glycosides:

a) Keller-Killiani test:

Table6: Keller-Killiani Test Procedure for the Detection of Deoxy-Sugars in Herbal Extracts

Procedure Step	Description	Observation
Reagent Preparation	Dissolve 1 ml of the herbal extract in glacial acetic acid with ferric chloride traces.	
Acid Layer Addition	Gently add concentrated sulphuric acid with ferric chloride to the bottom of the test tube with a pipette.	
Color Development	Observe for 2-5 minutes.	An intense blue color at the interface indicates deoxy-sugars.

b)Kedde's test :

Table 7: Kedde's Test Protocol for the Identification of Cardinolides in Herbal Extracts

Procedure Step	Description	Observation	Reference
Extract Preparation	Take 1 ml of the herbal extract.		Clauss, 1961
Kedd's Reagent	Add 0.5 ml of Kedd's reagent (3,5-dinitrobenzoic acid solution).		Clauss, 1961
Alkaline Addition	Follow with 1 ml of ethanolic solution of sodium hydroxide.		Clauss, 1961
Color Observation	Observe the reaction.	Formation of purple color indicates presence of cardinolides.	Clauss, 1961

2.3.7. Test for anthraquinones:

a) Bornträger's test:

Table8: Bornträger's Test for Detection of Anthraquinone Glycosides in Extracts

Procedure Step	Description	Observation	Reference
Extract Preparation	Take 1 ml of each extract.		
Alkaline Treatment	Add aqueous ammonia or caustic soda to the extract and shake.		
Color Observation	Observe the reaction in the aqueous layer.	Rose-red color indicates the presence of anthraquinone glycosides.	

b) Modified-Bornträger's test:

Table 9: Modified-Bornträger's Test Protocol for Anthraquinone Detection in Herbal Extracts

Procedure Step	Description	Observation	Reference
Extract Preparation	Take 1 ml of the herbal extract.		
Hydrolysis	Hydrolyze with alcoholic potassium hydroxide.		
Acidification	Acidify the hydrolyzed extract.		
Bornträger's Test	Continue with Bornträger's test on the acidified extract.		
Color Observation	Observe the reaction in the aqueous layer.	Rose-red color indicates the presence of anthraquinones.	Egyptian Pharmacopoeia, 1984

2.3.8. Test for saponins:

Froth test:

Table 10: Froth Test Procedure for Saponin Detection in Herbal Extracts

Procedure Step	Description	Observation	Reference
Water Addition	Add 5 ml of tap water to 1 ml of the herbal extract.		Clauss, 1961
Shaking	Shake the mixture vigorously for five minutes.		Clauss, 1961
Froth Observation	Observe the mixture after shaking.	A froth developing 1 cm high and persisting for 15 minutes indicates saponins.	Clauss, 1961

2.4. Estimate the phenolic compounds in the studied plants:
This investigation employed ethyl acetate, ethanol, acetone, diethyl ether, methanol, and chloroform. The following approach was used to determine phenolic component concentrations and types from solvent extracts:

2.5. Sample preparation and extraction:
The Velioglu et al. (1998) approach extracted phenolic chemicals. To prevent flesh browning, the samples were steamed at 100 °C for 15 min, chilled, and dried in a hot-air oven. Other three residual samples were chopped into small pieces and directly baked in a 60 °C hot-air oven until dry. A laboratory blender mashed the dry samples (Rumboa et al., 2009) .
Samples were steam blanched to inactivate derivative enzymes and reduce phenolic loss from leaching (Rumboa et al., 2009). Ethyl acetate, Ethanol, Acetone, Di ethyl ether, Methanol, and Chloroform were refluxed at 60 °C to extract 50 g of materials at 80% concentration. Many researchers have tested the solvents employed in this work to extract phenolic chemicals (Ignat et al. 2011). Buchner funnels lined with Whatman no.1 filter paper filtered the extracts .
The process was done twice for each extract and 100 ml deionized water was added. For solvent removal, samples were concentrated in a 40 °C rotary evaporator (Babbar et al., 2011). Gc–Ms was used to analyse the extracts at Alexandria University's Central lab of chemical analysis after refrigeration .

2.6. Antimicrobial activity:
2.6.1. Preparation of the samples:
Fresh plant portions were washed twice with tap water, shad-dried at room temperature, and ground with a mechanical grinder (Akinpelu*et al*., 2008; Alshammary and Ibrahim, 2014).
2.6.2. Preparation of the solvent extracts:
The Pavaria and pisticia plant powders were extracted with each of the solvents in this study by adding ten grammes of each plant powder to 100 ml of each crude extract, then evaporated at different temperatures according to the solvent in a rotary evaporator. The extracts were collected and stored at 40C until further use.(Akinpelu*et al*., 2008; Alshammary and Ibrahim, 2014).

3.1. The Results:
3.1.1. Preliminary Phytochemical screening:
The plant species under research showed the following in preliminary phytochemical screening:
The dried powdered plants were screened for carbohydrates, glycosides, tannins, flavonoids, sterols, triterpenes, saponins, and anthraquinone. Table (1) shows that all plants had sugars and/or glycosides, tannins, sterols and/or triterpenes, alkaloids, and cardiac glycosides but no saponins. Flavonoids are in all plants, anthraquinones are not.

Table (11): Phytochemical screening of the studied plants

chemical Test	A. pavarii Leafs Aq	A. pavarii Leafs Al	A. pavarii Fruits Aq	A. pavarii Fruits Al	Pistacia Leafs Aq	Pistacia Leafs Al	Pistacia Fruits Aq	Pistacia Fruits Al
Saponins	-	-	-	-	-	-	-	-
Tannines	+	+	+	+	+	+	+++	+++
Carbohydrate and/or Glycosides	+	+	+	+	++	++	++	+
Alkaloids	++	++	+	+	+	+	+	+++
Flavonoids	+	++	+	++	+	++	+	+++

chemical Test	A. pavarii Leafs Aq	A. pavarii Leafs Al	A. pavarii Fruits Aq	A. pavarii Fruits Al	Pistacia Leafs Aq	Pistacia Leafs Al	Pistacia Fruits Aq	Pistacia Fruits Al
Steroids and/or Triterpenoids	+	+	+	+	+	+	+	+++

In the context of the table above, the plus (+) and minus (-) signs are typically used to indicate the presence or absence of a specific chemical constituent within the extracts tested from various parts of the plants.

- A plus sign (+) indicates that the particular chemical compound or group (like saponins, tannins, carbohydrates/glycosides, alkaloids, flavonoids, or steroids/triterpenoids) is present in the extract.
- A double plus sign (++) may suggest a higher concentration or stronger presence of the compound compared to a single plus sign.
- A triple plus sign (+++) could indicate an even higher concentration or a very strong presence.
- A minus sign (-) indicates that the compound was not detected in the extract.

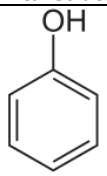
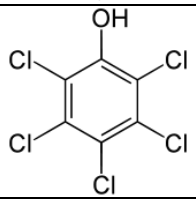
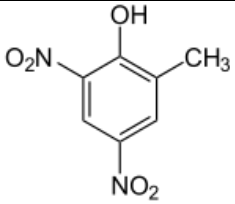
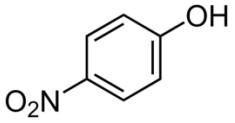
The number of plus signs can vary depending on the protocols of the specific study or the scales used by the researchers to quantify the presence of these compounds. It's a qualitative or semi-quantitative measure rather than a precise quantitative analysis. The actual meaning and whether it indeed reflects concentration or simply presence/absence would be defined by the methodology of the study.

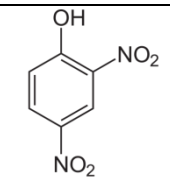
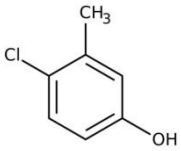
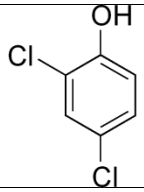
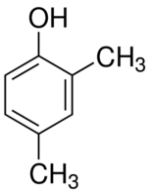
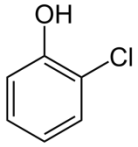
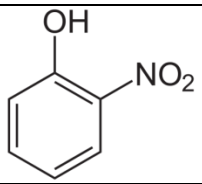
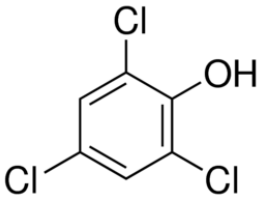
The phytochemical screening of Arbutus pavarii and Pistacia species indicated carbohydrates/glycosides, sterols/triterpenes, tannins, and flavonoids presence, with saponins and alkaloids absent in Pistacia but present in pavarii. Notably, tannins were more abundant in fruits, with overall higher levels of bioactive compounds in fruits than leaves, especially in Pistacia. These findings hint at the plants' potential medicinal value, warranting further investigation.

3.2. Types of phenolic compounds:

The phenolic compounds which detected by using Gc-ms showed presence the following compounds in the used different solvents (Ethyl acetate, Ethanol, Acetone, Di ethyl ether, Methanol and Chloroform). The phenolic compounds which detected including the following phenolic derivatives (Table 2):

Table (12): The detected phenolic compounds in the studied plants.

Compound	Chemical Structure
Phenol	
Pentachlorophenol	
2-Methyl-4,6-dinitrophenol	
4-Nitrophenol	

2,4-Dinitrophenol	
4-Chloro-3-methylphenol	
2,4-Dichloropheno	
2,4-Dimethylphenol	
2-Chlorophenol	
2-Nitrophenol	
2,4,7-Trichlorophenol	

Also the results showed variations in the contents of the detected phenolic compounds, where the contents were varied from solvent to solvent, the types and contents of the detected phenolic compounds in this study were given the Tables of

The main findings from your study can be summarized in the following table format:

Table 13: Summary of Phenolic Compound Distribution and Solvent Efficacy in Arbutus pavarii and Pistacialentiscus

Category	Arbutus pavarii	Pistacialentiscus
Compounds Detected	Carbohydrates/Glycosides	Carbohydrates/Glycosides
	Tannins	Tannins
	Sterols/Triterpenes	Sterols/Triterpenes
	Alkaloids	Alkaloids
	Cardiac Glycosides	Cardiac Glycosides
Absent Compounds	Saponins	Saponins
	Anthraquinones	Anthraquinones

Category	Arbutus pavarii	Pistacialentiscus
Solvents Used	Ethanol	Ethanol
	Methanol	Methanol
	Chloroform	Chloroform
	Ethyl acetate	Ethyl acetate
Effective Solvents for Phenol Extraction	Ethanol (Leaves)	Chloroform (Leaves)
	Chloroform (Fruits)	Methanol (Fruits)
Potential Applications	Antioxidants	Antioxidants
	Antimicrobial Agents	Antimicrobial Agents

The following table describes the main findings on Arbutus pavarii and Pistacialentiscus phenolic compound spectra. The columns compare phytochemical elements found and absent across species to assess solvent efficiency in phenolic entity extraction. The table also lists these chemicals' beneficial uses in pharmacology and nutraceuticals.

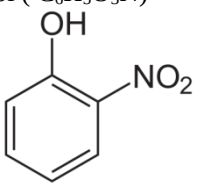
In practice, solvent polarity strongly affects extraction yields, with ethanol and chloroform working best for leaf matrices and methanol for fruit matrices. This synoptic form allows easy comparison between subject species, enhancing phytochemical relevance discourse.

This table can connect empirical data with analytical discourse when strategically placed at the end of the Results segment or at the start of the Discussion. Should the study's exposition be cluttered with tabular data, this reduced tabulation may be enough to summarize the key findings, streamlining the narrative and strengthening its scholarly value.

3.3. Discussion:

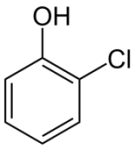
According the results which recorded in this study there is wide variations in the contents of some compounds by using different solvents i.e the contents of phenol compound (C_6H_5OH) showed high contents by using the solvents of ethanol in ***pavaria*** leafs, while the high content of phenol(C_6H_5OH) in the ***pavaria*** fruits was found in chloroform extract , whereas the same compound recorded high level in the chloroform extract of ***pastasia*** leafs comparing with the high level in ***pasatsia*** fruits which found in methanol extract comparing with the other used solvents which used in this study .Genaraly the high contents of phenol (C6H5OH) were found in Chlorofom***pasatasia*** extract following by the ethanol extract of ***pavaria*** leafs .

Also the contents of compound of 2-Nitrophenol ($C_6H_5O_3N$)



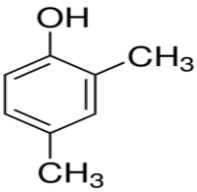
Showed wide variations in the extracts of the used solvents, where the high contents were detected in the extractof chloroform***pavaria*** fruits comparing with the extracts of the other solvents.

The contents of 2- Chlorophenol (C_6H_5OCl) showed wide variations in the studied extracts , where the higher values was found in



Methanolic extract of ***pastasia*** fruits followed by the chloroform extract of ***pastasia*** leafs and theethanolic extract of ***pavaria***leafs .

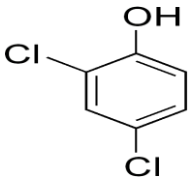
The contents of 2,4 –dichlorophenol showed small variations in the studied extracts of the selected solvents , except in Diethyl ether extract of ***Pastasia*** fruits :



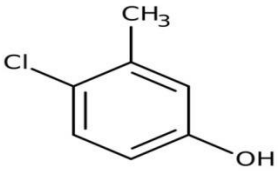
Generally the contents of 2,4-dichlorophenol are found in the following order :

Pasatasia leafs chloroform extract >***Pavaria*** leafs chloroform extract >***pavaria*** fruits chloroform extract .

Also the contents of 2,4dichlorophenol ($C_6H_4OCl_2$)showed small variations in the studied extraction of the plants , but the chloroform extracts showed high contents of 2,4 dichlorophenol comparing with the extracts of the studied samples.

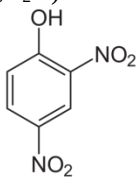


On the other side the contents of 4, Chloro-3, methyl phenol (C_7H_6OCl) :



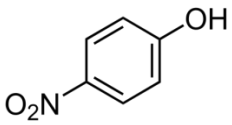
Showed variations in the studied solvents extractions , also no special solvent gave high values of 4, chloro – 3 methyl phenol in the studied plants , where the high content of ***pastasia*** fruits was recorded by used Ethyl acetate solvent (76.52 µg/g) , while in ***pasatsia*** leafs extract , the high content was found in Chloroform extract (190.54 µg/g) , on the hand the ***pavaria*** fruits extract recorded high content in butanol (952.34µg/g) , and the ***pavaria*** leafs of ethanol extract showed high value of 4, chloro – 3 methyl phenol .

The high contents of 2,4- Dinitro phenol ($C_6H_4O_5N_2$) :



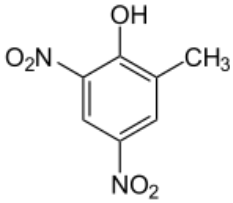
Recorded high levels in ethanolic extract of ***pastasia*** fruits (842.65 µg/g)followed by the extract of chloroform of pavaria leafs (650.06µg/g) , on contrast small amounts of 2,4 –Dinitro phenol were recorded in the extracts of ethyl acetate and di ethyl ether .

The results also recorded that the high contents of 4- Nitrophenol ($C_6H_5O_2N$)



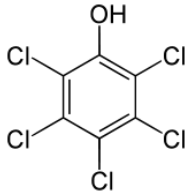
Were recorded in the Diethyl ether extract of ***pastasia*** leafs (21.09µg/g) followed by the chloroform extract of ***pastasia*** leafs (17.14µg/g), Also high levels of 4- Nitro phenol were recorded in ***pavaria*** leafs (16.22µg/g) comparing with ***pavaria*** fruits (6.13 µg/g), generally no wide variations were recorded for the 4-Nitrophenol compound in the used solvents for the studied plants .

The results showed that the contents of 2- methyl -4,6dinitro phenol ($C_6H_5O_5N_2$) :



in all the solvent extractions recorded the similar levels , relative increase were recorded in ethanoic extractions comparing with the other extracts , generally the contents of Also the contents of 2- methyl -4,6 dinitro phenol were ranged between (20.53 – 21.52 µg/g) .

The results showed small variations in the contents of phentachlorophenol ($C_6H\ OCl_5$) :



In the studied plants in all the used solvents : were the contents of ($C_6H\ OCl_5$) were fluctuated in the range of (13.32 - 22.87µg/g), the relative increase of phentachloro phenol content was recorded in ***pavaria*** fruits (22.87µg/g) .

Depending on the results which recorded in this study , the extraction of the detected phenolic compound contents was influence on the contents of the phenolic compounds , this mainly attributed to the polarity of the used solvents . Some of solvent extracts contained higher phenolic compounds compared with the extracts of some complexes.

In most extracts the ethanol , methanol and Chloroform exhibited high contents of the detected phenolic compounds , on the other side the solvents i.e ethyl acetate , Acetone and Diethyl ether gave low concentrations of the detected phenolic compounds .This mainly attributed to the type of solvents .

It was stated that the solvents are grouped into nonpolar, polar aprotic, and polar protic solvents, with each group ordered by increasing polarity. The properties of solvents which exceed those of water are bolded.

The solvents are classify to different categories (polar and non polar) and / or other classification (protic , non-protic and aprotic solvents) , in this study the solvents as (Chloroform , diethyl ether)are non polar solvents, while solvents as (Ethanol , Methanol, acetone and ethyl acetate) are classify as polar solvents (Abbott and Hansen, 2008). .

Also the polar aprotic solvents which used in this study including (ethyl acetate ,acetone ,) , while the solvents of (Ethanol and Methanol) are protic solvents .

It was reported that the solid–liquid extraction method of phenolic compounds with different solvents from plant sources are the most commonly used for isolating these compounds. Crude phenolic extracts contain complex mixtures of some classes of phenols, which are selectively soluble in thedifferent solvents. In this sense, solvent polarity plays a key role in increasing phenol solubility (Zhao et al., 2006) .

Also the polarity of extracting solvent and the solubility of chemical constituents in the extracting solvent might influence on the (phenolic compounds), (P.C) of the extracts. Therefore, in this study, the samples were extracted using four different solvents in order to determine the recovery of (P.C) using such solvents. The results revealed that ethanol ,methanol and butanol were better than the other two solvents in extraction of phenolic compounds . This could probably be because of their higher polarity and better solubility for phenolic components present in plant materials (Zhao et al., 2006).

Also it was declared that the extraction efficiency with methanol was highest for extracting phenolic compounds (Pryzbylski et al., (1998) reported that the phenolic compounds of extracts varied with polarity of the solvent with alcoholic extract showing relatively higher (P.C)ability. The diverse chemical structures of the phenolic compounds ranging from simple to polymerized forms might consequently change their solubility behaviors. Alcohols are often used for extraction of medium polar and polar phenolic compounds such as flavonoid glycosides and phenolic acids (Harborne , 1998).

During the primary investigation on studies which carried out on the same species of the selected plants in the this study no results were recorded before this study for the species especially in Libya, therefore these results for the species of phenolic compounds mainly the first results which showed the contents and types of phenolic compounds. The phenolic compounds are very useful for anti-oxidant and antimicrobial agents.

Please note that due to the extensive length of the chromatograms depicting the detected phenolic compounds in pavarii fruits, their inclusion in the article has been omitted.

III. Conclusion:

Based on the results recorded in this study, there were wide variations in the contents of different phenolic compounds extracted from various plant sources using different solvents. The polarity of the solvents played a significant role in the extraction efficiency and solubility of the phenolic compounds. The study used both polar and non-polar solvents, including ethanol, methanol, chloroform, diethyl ether, acetone, and ethyl acetate.

The results indicated that ethanol, methanol, and chloroform extracts generally exhibited higher contents of phenolic compounds compared to the other solvents. Ethanol, methanol, and butanol were found to be better solvents for extracting phenolic compounds due to their higher polarity and better solubility for these components in plant materials.

Specifically, the contents of phenol, 2-Nitrophenol, 2-Chlorophenol, 2,4-dichlorophenol, 2,4-dichlorophenol, 4-Chloro-3-methylphenol, 2,4-Dinitrophenol, and 4-Nitrophenol varied significantly among the solvents used for extraction. However, 2-methyl-4,6-dinitrophenol and pentachlorophenol showed relatively small variations in their contents across the solvents.

The study highlights that the choice of solvent for phenolic compound extraction is crucial, as it can significantly affect the composition and concentration of the extracted compounds. Solvents with higher polarity, such as ethanol and methanol, tend to yield higher amounts of phenolic compounds. Additionally, the solvents' polarity and solubility properties interact with the phenolic compounds' chemical structures, leading to differential extraction efficiencies.

It's worth noting that these results represent the first recorded data for the phenolic compound contents and types in the selected plant species, particularly in Libya. The phenolic compounds extracted from these plants are of great interest due to their potential as antioxidants and antimicrobial agents.

In conclusion, this study demonstrates that solvent selection is a critical factor in the extraction of phenolic compounds from plant sources. Ethanol, methanol, and chloroform were found to be effective solvents for extracting phenolic compounds in this study. The recorded variations in phenolic compound contents highlight the importance of considering solvent polarity and solubility when designing extraction methods for specific phenolic compounds of interest. These findings contribute to our understanding of phenolic compound extraction and provide valuable information for further research and applications in various fields, such as natural product chemistry, pharmacology, and food science.

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