



A Comparative Study of Anatomical and Chemical Characteristics of Some Local Grapevine Cultivars (*Vitis vinifera* L.) Grown in Northern Iraq

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Abstract

The current research conducted a comparative study of the anatomical and chemical characteristics of nine (9) local grapevine cultivars (*Vitis vinifera* L.) cultivated in northern Iraq, namely: Sarkoula, Shadda Bayda, Beidhawi, Muscat Sebi, Sloobi, Rashmio, Faleen Turki, Bakira Black, and Zah-r Bakira. The anatomical study included the characterization of the leaves in terms of the shape and dimensions of the upper and lower epidermal cells, surface covering, stomata, and the stomatal complex, which was of the anomocytic type. It was observed that stomata were present exclusively on the lower surface (hypostomatic). The venation system in the leaf was of the palmate-reticulate type across all studied cultivars. On the chemical side, phenolic and alkaloid compounds were identified using High-Performance Liquid Chromatography (HPLC) by extracting them from the leaves during the flowering period. Five (5) phenolic compounds were identified, namely: Apigenin, Kaempferol, Quercetin, 2,6-Dimethylphenol, and Gallic acid, in addition to one alkaloid compound, Caffeine. The quantitative and qualitative estimation of these compounds confirmed their significance as reliable chemotaxonomic markers in distinguishing and isolating the studied cultivars from one another.

Keywords: Anatomical and Chemical Characteristics

دراسة مقارنة للخصائص التشريحية والكيميائية لبعض أصناف العنب المحلية (*Vitis vinifera* L.) المزروعة في شمال العراق

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ملخص

أجرى البحث الحالي دراسة مقارنة للخصائص التشريحية والكيميائية لتسعة (9) أصناف محلية من العنب (*Vitis vinifera* L.) تُزرع في شمال العراق، وهي: سركولا، وشدا بيضاء، وبيضاوي، ومسقط سبي، وسلوبي، ورشميو، وفلين تركي، وباكيرة السوداء، وزهر باكيرة. شملت الدراسة التشريحية توصيف الأوراق من حيث شكل وأبعاد خلايا البشرة العلوية والسفلية، والغطاء السطحي، والثغور، ومركب الثغور الذي كان من النوع غير المنتظم. لوحظ أن الثغور موجودة حصرياً على السطح السفلي (السطح السفلي). كان

نظام التعرق في الورقة من النوع الكفي الشبكي في جميع الأصناف المدروسة. أما من الناحية الكيميائية، فقد تم تحديد المركبات الفينولية والقلويدية باستخدام كروماتوغرافيا السائل عالي الأداء (HPLC) عن طريق استخلاصها من الأوراق خلال فترة الإزهار. تم تحديد خمسة (5) مركبات فينولية، وهي: أبيجينين، وكايمفيرول، وكيرسيتين، و6،2-ثنائي ميثيل فينول، وحمض الغاليك، بالإضافة إلى مركب قلوي واحد هو الكافيين. وقد أكد التقدير الكمي والنوعي لهذه المركبات أهميتها كعلامات تصنيفية كيميائية موثوقة في تمييز وعزل الأصناف المدروسة عن بعضها البعض.

الكلمات المفتاحية: الخصائص التشريحية والكيميائية

1. Introduction

The diversity and variations among living organisms, particularly plants, have necessitated efforts to uncover, describe, and interpret these differences. Morphological, anatomical, and phytochemical characteristics are considered vital aspects that facilitate the identification and classification of wild and cultivated species, especially those of economic importance that constitute a significant part of a nation's natural wealth [2].

The grapevine, *Vitis vinifera* L., is a fruit species of high nutritional and economic value. It exhibits a wide geographical distribution across temperate and semi-arid regions, particularly in tropical and subtropical zones throughout Asia, Africa, and the Americas. This species encompasses more than 950 cultivars [2]. Its fruits are rich in sugars, vitamins, proteins, lipids, and organic acids [3].

Cultivars are classified into four major groups based on production objectives these are

1- Table Grapes: Including *Bahrezi*, *Abbasi*, *Kamali*, *Halwani*, *Deis Al-Anz*, *Beidh Al-Hamam*, *Taifi*, *Mirani*, and others. 2- Raisin Grapes: Including seeded varieties such as *Hiyah*, *Sakaat Al-Askaniya*, *Trarash*, and *Razqi*; and seedless varieties such as *Kishmishi*, *Korinth*, *Perlette*, and others. 3- Wine Grapes: Such as *Furmint*, *Semillon*, and *Pinot Gris*. and 4- Sweet Juice Grapes: Such as *Zark*, *Warka*, *Sloobi*, and others [4].

Data and evidence derived from anatomical studies provide an additional foundation for taxonomy, often supporting morphological, cytological, phytochemical, and ecological traits. Most anatomical features are regarded as Diagnostic Features, utilized in delimiting taxonomic ranks at the genus, species, and variety levels [5]. These include the leaf anatomy, upper epidermal cell structure, internal leaf configuration, and the xylem anatomy of both vegetative and reproductive organs. Furthermore, anatomical traits frequently bolster morphological descriptions and hold significant weight in modern taxonomic studies [6].

The importance of leaf anatomy—specifically stomatal distribution, stomatal index, and the thickness of the upper and lower epidermis—in distinguishing

between two grapevine cultivars, *Grenache Noir* and *Syrah*, where distinct morphological and anatomical variations were observed [7].

Chemical constituents in plants play an effective role in nature by determining the flavor and palatability of the tissues in which they occur. In many instances, species and varieties can be distinguished by their taste, independent of other characteristics. That phenolic compounds are among the most well-known and widely utilized chemical substances in taxonomy due to their ubiquitous presence in leaves, flowers, fruits, seeds, wood, and bark [6, 8].

Chemical properties serve as indicators of the relationships between various taxonomic ranks and show high correlation with morphological and anatomical traits. They are crucial in delineating broad relationships between taxa, though they should not be relied upon as taxonomic evidence in isolation from other criteria [9]. Among the chemical compounds that have garnered significant attention from taxonomists are phenols, including flavonoids and alkaloids, being products of secondary metabolism. Due to their high concentrations in plants, structural diversity, ease of extraction, and their medical and economic importance [10], these compounds—found in leaves, flowers, fruits, and seeds—are essential for evaluating evolutionary relationships [11, 12].

Recent phytochemical studies on phenolic compounds [13], have identified numerous phenolic constituents in the seeds and leaves of various grapevine cultivars.

The objective of this study is to compare anatomical and Chemical characteristics between the Local cultivars of the grapevine (*Vitis vinifera* L.) grown in Northern of Iraq.

2. Materials and Methods

2.1. Sample Collection

Samples were collected from nine local grapevine cultivars: (*Sarkoula*, *Shadda Beidha*, *Beidhawi*, *Sloobi*, *Rashmio*, *Faleen Turki*, *Bakira Black*, and *Zah-r Bakira*). These cultivars are widely cultivated in northern Iraq. The samples were obtained from the nursery of the Department of Horticulture and Landscape Design, College of Agriculture and Forestry, University of Mosul, for the purpose of investigating their anatomical and phytochemical characteristics.

2.2. Anatomical Study

2.2.1. Epidermal Preparation

The study utilized fresh leaf samples to examine epidermal cells, including their dimensions, trichomes, stomata, and stomatal index, following the method described by [14]. Due to the thinness of the leaves and the difficulty of traditional peeling, the Replica Method was employed. Clear nail polish was applied to both

the adaxial (upper) and abaxial (lower) surfaces. After a drying period of (1–3) minutes, clear adhesive tape was applied over the film and then peeled off, carrying a precise impression of the epidermis. The tape was mounted onto glass slides and examined under a compound light microscope. Images were captured using a high-resolution mobile camera. Measurements for epidermal cells and stomatal dimensions were recorded using a (7x) ocular lens and a (40x) objective lens. The Stomatal Index (SI) was calculated according to [15] using the following formula:

$$SI = \left(\frac{S}{S + E} \right) \times 100$$

Where:

- **S:** Number of stomata per unit area.
- **E:** Number of epidermal cells in the same area.

2.2.2. Leaf Clearing

Leaf samples were placed in Petri dishes containing a 3% Sodium Hydroxide (NaOH) solution for 15–20 days. The solution was periodically replaced until the mesophyll tissue was completely decolorized. The leaves were then washed several times with distilled water to remove residual alkali. Subsequently, they were transferred to Petri dishes containing 1% Safranin stain (prepared in 70% ethyl alcohol) for 30 seconds. Excess stain was removed by washing with 70% ethyl alcohol, followed by absolute alcohol. Finally, the cleared leaves were mounted on clean glass slides using glycerin and covered with coverslips for microscopic examination.

2.3. Phytochemical Study

2.3.1. Preparation of Crude Alcoholic Extracts

The ethanolic extract was prepared following the procedure of [16]. (5) g of leaf powder from each cultivar was macerated in 50 ml of 95% Ethyl Alcohol for 48 hours. A simple extraction was performed using a separatory funnel with Chloroform to remove chlorophyll and other oil-soluble pigments. The phenolic compounds remained in the intermediate (ethanol) layer in the form of glycosides.

2.3.2. Acid Hydrolysis

Based on the method of [17], 2 g of the alcoholic extract was dissolved in 200 ml of 2 M Hydrochloric Acid (HCl). The mixture was heated in a water bath at (90–100) °C for 30 minutes with continuous stirring. After cooling, the mixture was extracted with Ethyl Acetate (100 ml x 2) using a separatory funnel to isolate the aglycones.

2.3.3. Identification of Phenolic and Alkaloid Compounds via High-Performance Liquid Chromatography (HPLC)

Standard samples and plant extracts were filtered through a 0.45 µm membrane filter prior to analysis. The identification was performed using a Shimadzu (Japan) HPLC system equipped with a Phenomenex C_{18} column (100Å, 250 × 60 mm). The mobile phase consisted of a Methanol:Water mixture at a volume ratio of (80:20 v/v). To ensure optimal separation, the mobile phase was filtered and degassed using an ultrasonic sonicator.

The flow rate was maintained at 1 ml/min, and detection was carried out at a wavelength of 280 nm. An injection volume of 20 µl was used for both the standard compounds (phenols and alkaloids) and the samples. The identification of compounds isolated from the ethyl acetate-soluble extracts was based on a comparison of their retention times (t_R) with those of the standards [16].

3. Results

3.1. Anatomical Study

3.1.1. General Epidermal Cells

The ordinary epidermal cells of both the adaxial (upper) and abaxial (lower) surfaces in all studied cultivars were characterized as simple and uniseriate (single-layered). Their shapes ranged from polygonal to oblong. The study revealed variation in the configuration and dimensions of the internal and external tangential walls between the two surfaces; the adaxial epidermis and abaxial epidermis exhibited straight to straight-curved walls, while the abaxial epidermis showed straight to curved-undulate walls across all cultivars

The epidermal cell dimensions displayed significant variation, as shown in Table (1) and Figure (1), with ranges of (20–56 μm) for the adaxial surface and (10–42 μm) for the abaxial surface. Regarding the foliar appendages, the surface was covered with non-glandular, unicellular, unbranched, and straight trichomes. Furthermore, prismatic crystals were observed in clusters within the epidermal cells of both surfaces.

3.1.2. Stomatal Complexes

All studied cultivars exhibited a single stomatal type: the Anomocytic type (also known as the Ranunculaceous type). This pattern is characterized by the absence of specialized subsidiary cells, where the stoma is surrounded by (3–5) ordinary epidermal cells. The leaves were confirmed to be Hypostomatic, as stomata were entirely absent on the adaxial surface and confined to the abaxial surface. The stomatal shape varied between elliptical and oblong, while the guard cells surrounding the stomatal pore were reniform (kidney-shaped) in all cultivars. However, the stomatal density (number of stomata per microscopic field of view) varied significantly among the studied cultivars.

3.1.3. Leaf Venation

The investigation showed that the venation system in all studied cultivars is of the Palmately Reticulate type. In this pattern, several primary veins of equal size radiate from the point where the petiole meets the lamina, spreading like the fingers of a hand. Secondary and tertiary veins branch out from these primaries, interweaving throughout the blade, with the main veins extending toward the leaf margin. The areoles (the small spaces formed by the vein network) were irregular in shape, appearing triangular, square, or branched. The veinlets within these areoles were inconsistent in shape across the cultivars, as illustrated in Figure (2).

Table 1. Quantitative and Qualitative Variations in Adaxial and Abaxial Leaf Epidermal Cell Walls and Stomatal Complexes of the Studied Grapevine Cultivars (Measurements in μm).

No	Cultivars	Epidermal Cell Dimensions		Average (L \times W)	Stomatal Index	Stomatal Dimensions		Abaxial Cell Walls	Adaxial Cell Walls
		Length (L)	Width (W)			Length	Width		
1	Sarkoula	- 20) (55 39.7	- 10) (42 23.1	X 39.7 23.1	4.80	- 5) (11 8.8	- 4) (8 5.8	Straight- Undulate	Straight- Curved
2	Shadda Beidha	- 25) (53 38.2	- 12) (42 21.8	X 38.2 21.8	5.20	- 5) (12 8.1	- 5) (11 7	Straight- Undulate	Straight- Curved
3	Beidhawi	- 28) (56 40.5	- 12) (38 23.0	X 40.5 23.0	4.56	- 7) (10 8.5	- 4) (8 5.8	Straight- Curved	Straight- Curved
4	Muscat Sebi	- 27) (55 39.3	- 13) (35 22.4	X 39.3 22.4	5.81	- 6) (10 7.9	- 4) (9 5.6	Straight- Undulate	Straight- Undulate
5	Sloobi	- 22) (55 37.8	- 13) (33 20.6	X 37.8 20.6	5.29	- 6) (12 8.4	- 4) (8 6.2	Straight- Undulate	Straight- Curved
6	Rashmi	- 20) (52 37.0	- 15) (32 21.7	X 37.0 21.7	5.43	- 6) (9 6.8	- 3) (6 4.1	Straight- Curved	Straight- Curved

7	Faleen Turki	- 30) (49 38.2	- 12) (35 24.4	X 38.2 24.4	5.78	- 5) (9 6.9	- 4) (8 4.5	Straigh t- Undula te	Straigh t- Undula te
8	Bakira Black	- 25) (50 38.2	- 18) (33 22.8	X 38.2 22.8	6.21	- 6) (11 8.6	- 4) (6 6.6	Straigh t- Curved	Straigh t- Curved
9	Zah-r Bakira	- 25) (50 37.1	- 15) (28 22.6	X 37.1 22.6	5.84	- 7) (10 8.6	- 4) (10 7.6	Straigh t- Curved	Straigh t- Undula te

Note: Numbers within parentheses represent the minimum and maximum limits, while numbers outside parentheses represent the mean (average).

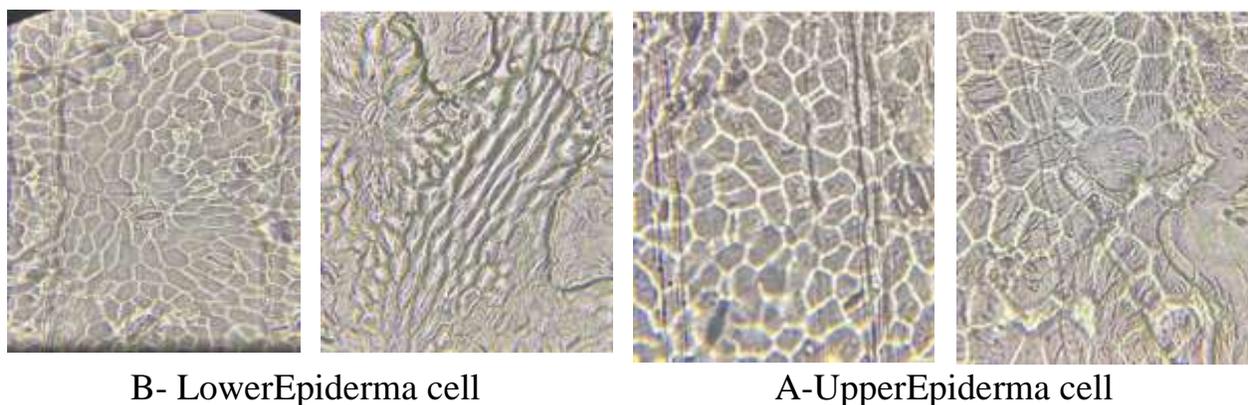


Figure 1. Morphological patterns of epidermal cells and stomatal complexes in the studied grapevine leaves.

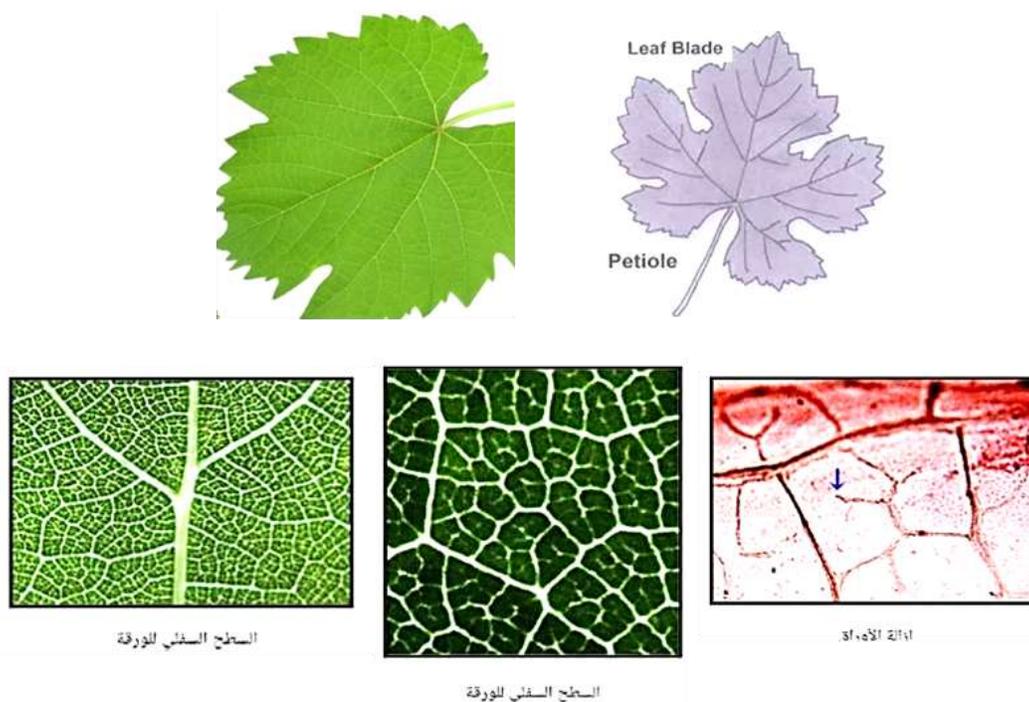


Figure 2. Leaf venation patterns in the studied grapevine cultivars.

3.4. Phytochemical Study

The results of the **High-Performance Liquid Chromatography (HPLC)** analysis of the leaf extracts from the studied grapevine cultivars revealed significant variations in the presence and concentration of phenolic and alkaloid compounds. Based on the standard reference compounds, five phenolic compounds and one alkaloid were identified, as detailed in **Tables (2, 3, 4)** and **Figures (3, 4, 5, 6, 7, 8, 9)**. These compounds are:

1. **Apigenin:** This flavonoid compound was detected in all studied cultivars.
2. **2,6-Dimethylphenol:** This compound was present in all cultivars except for *Sarkoula* and *Shadda Beidha*.
3. **Gallic acid:** This phenolic acid was identified in all studied cultivars.
4. **Kaempferol:** A flavonoid that appeared in five cultivars (*Sarkoula*, *Beidhawi*, *Muscat Sebi*, *Sloobi*, and *Rashmio*) and was absent in the remaining cultivars.
5. **Quercetin:** This compound was recorded in all cultivars except for *Shadda Beidha* and *Faleen Turki*.

Caffeine: An alkaloid compound that was present in (*Sarkoula*, *Beidhawi*, *Sloobi*, *Faleen Turki*, and *Bakira Black*) and was not detected in the other cultivars.

Table 2. Retention Times (tR) of Standard Compounds..

No.	Standard Compounds	Standard Retention Time (tR, min)
1	Apigenin	3.044
2	2,6-Dimethylphenol	6.855
3	Gallic acid	4.028
4	Kaempferol	7.925
5	Quercetin	4.839
6	Caffeine	5.790

Table 3. Distribution (Presence/Absence) of Phenolic and Alkaloid Compounds in the Studied Grapevine Cultivars.

No.	Scientific Cultivars	Apigenin	-6,2 Dimethylphenol	Gallic acid	Kaempferol	Quercetin	Caffeine
1	Sarkoula	+	-	+	+	+	-
2	Shadda Beidha	+	-	+	-	-	-
3	Beidha wi	+	+	+	+	+	+
4	Muscat Sebi	+	+	+	+	+	-
5	Sloobi	+	+	+	+	+	+
6	Rashmi o	+	+	+	-	+	-
7	Faleen Turki	+	+	+	+	-	+
8	Bakira Black	+	+	+	-	+	+
9	Zah-r Bakira	+	+	+	-	+	-

Table 4. Comparative Retention Times (tR) of Identified Phenolic and Alkaloid Compounds Across the Studied Grapevine Cultivars.

No.	Scientific Cultivars	Apigenin	2,6 - Dimethylphenol	Gallic acid	Kaempferol	Quercetin	Caffeine
	Standard (min)	3.044	6.855	4.028	7.925	4.839	5.790
1	Sarkoula	3.031	—	4.196	7.742	4.763	—
2	Shadda Beidha	3.030	—	4.191	—	—	—
3	Beidhawi	3.027	6.829	4.258	7.835	4.834	5.600
4	Muscat Sebi	3.014	6.863	4.178	7.917	4.782	—
5	Sloobi	3.015	6.930	4.133	7.860	4.771	5.158
6	Rashmio	3.039	6.715	4.269	—	4.700	—
7	Faleen Turki	3.112	6.592	4.195	7.808	—	5.426
8	Bakira Black	3.013	6.844	4.164	—	4.734	5.229
9	Zah-r Bakira	3.010	6.883	4.180	—	4.421	—

Note: (—) indicates the absence of the compound in the cultivar. All values are expressed as retention time (tR) in minutes.

3.5. Concentration of Phenolic and Alkaloid Compounds

The concentrations of the identified compounds in the leaf extracts varied significantly across the studied grapevine cultivars, as summarized in Table (5).

- Apigenin: The highest concentration was recorded in the cultivar 'Faleen Turki' at 58.49 ppm, while the lowest concentration was found in 'Zah-r Bakira' at 9.4 ppm.
- 2,6-Dimethylphenol: This compound reached its maximum concentration of 10.80 ppm in the 'Beidhawi' cultivar, whereas the minimum concentration of 0.01 ppm was observed in 'Zah-r Bakira'.
- Gallic Acid: The peak concentration was noted in 'Shadda Beidha' at 15.67 ppm, while the lowest value was recorded in 'Muscat Sebi' at 0.10 ppm.

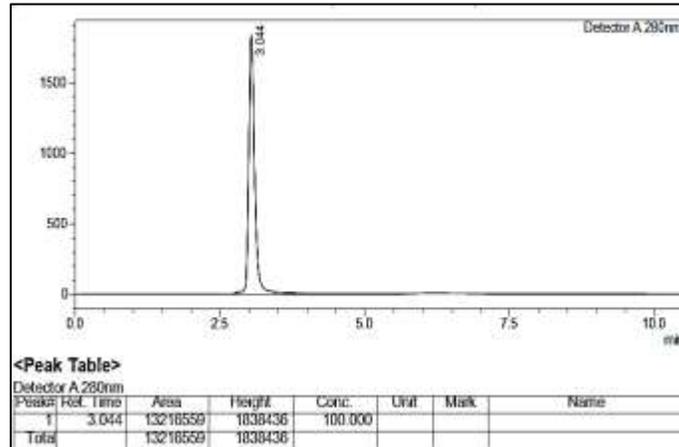
- Kaempferol: The cultivar 'Beidhawi' yielded the highest concentration of 42.20 ppm, while the lowest concentration was detected in 'Muscat Sebi' at 0.46 ppm.
- Quercetin: The maximum concentration was documented in 'Sarkoula' at 84.62 ppm, and the minimum was in 'Zah-r Bakira' at 0.64 ppm.
- Caffeine (Alkaloid): The highest concentration was registered in the 'Sloobi' cultivar at 10.69 ppm, while the lowest concentration was found in 'Bakira Black' at 3.07 ppm.

Table 5. Concentrations of identified phenolic and alkaloid compounds in the studied grapevine cultivars (ppm).

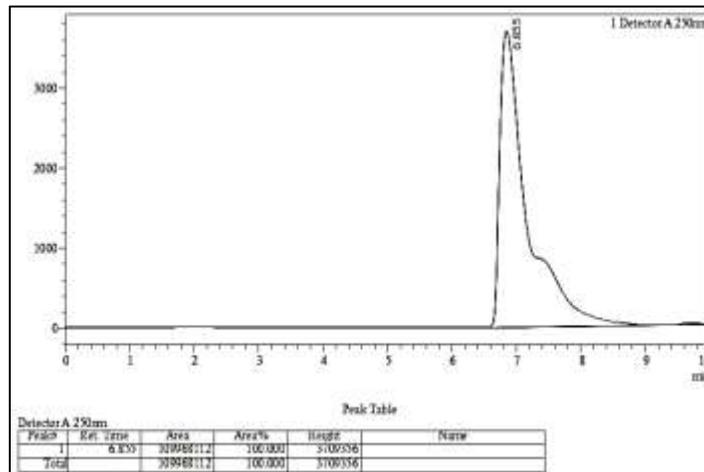
No	Scientific Cultivars	Apigenin	2,6-Dimethylphenol	Galliac acid	Kaempferol	Quercetin	Caffeine
1	Sarkoula	15.48	—	5.91	9.64	84.62	—
2	Shadda Beidha	11.36	—	15.67	—	—	—
3	Beidhawi	13.79	10.80	6.25	42.20	51.19	9.29
4	Muscat Sebi	12.21	0.67	0.10	0.46	2.85	—
5	Sloobi	17.20	1.22	1.93	4.79	7.14	10.64
6	Rashmio	11.88	6.00	1.72	1.29	10.32	—
7	Faleen Turki	58.49	1.16	10.27	—	—	4.29
8	Bakira Black	13.82	0.39	2.43	—	5.88	3.07
9	Zah-r Bakira	9.4	0.01	0.66	—	0.64	—

Note: (—) indicates that the compound was not detected in the cultivar. Concentrations are measured in parts per million (ppm).

Apigenin



2,6-Dimethylphenol



Gallic acid

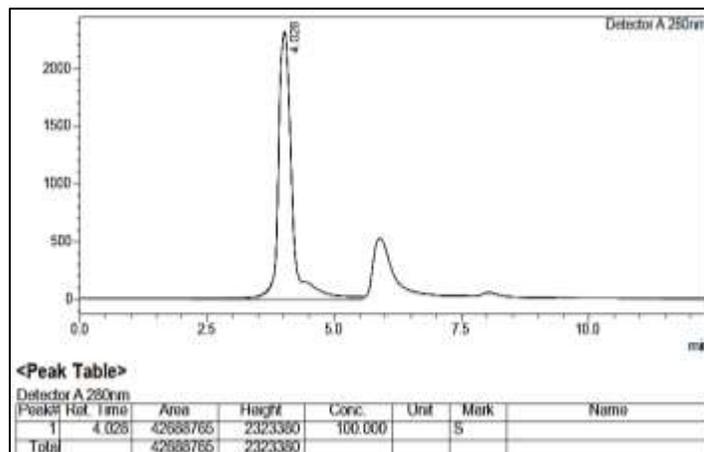
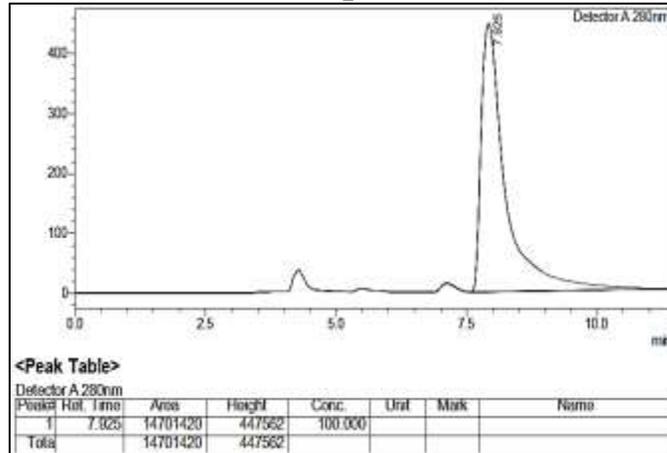
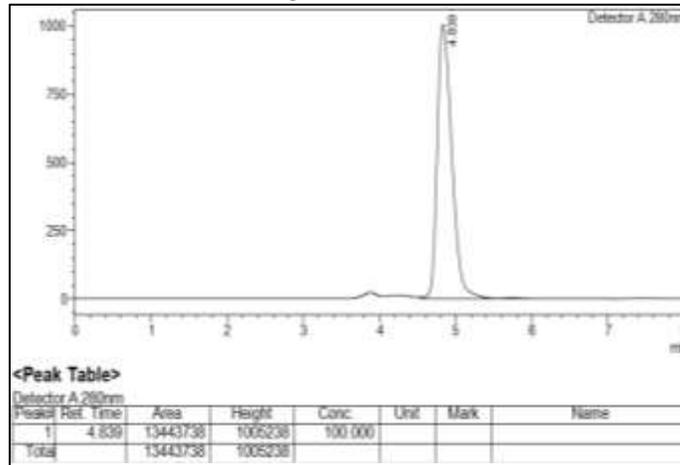


Figure 3. HPLC Chromatogram of the Standard Reference Compounds: 1. Apigenin, 2. 2,6-Dimethylphenol, 3. Gallic acid.

Kaempferol



Quercetin



caffeine

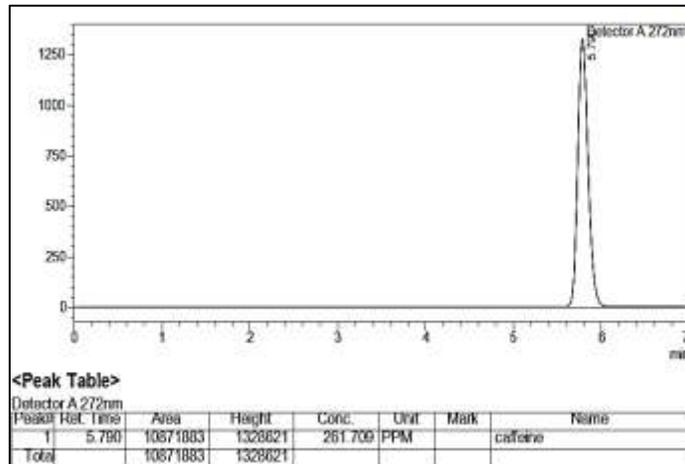
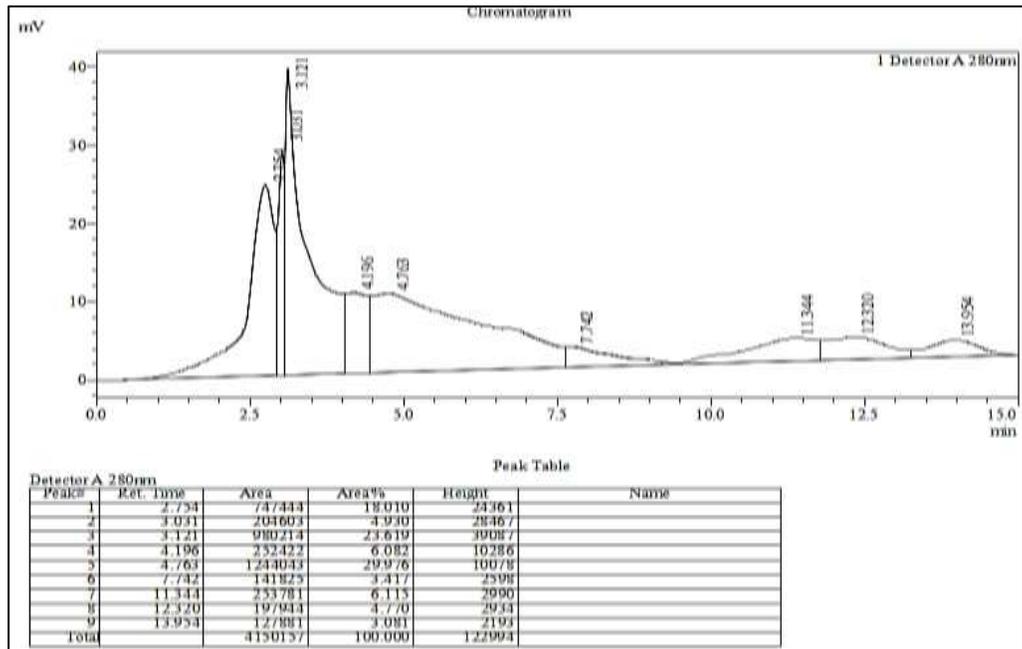


Figure 4. HPLC Chromatogram of the Standard Reference Compounds: 1. Kaempferol, 2. Quercetin, 3. Caffein.

1



2

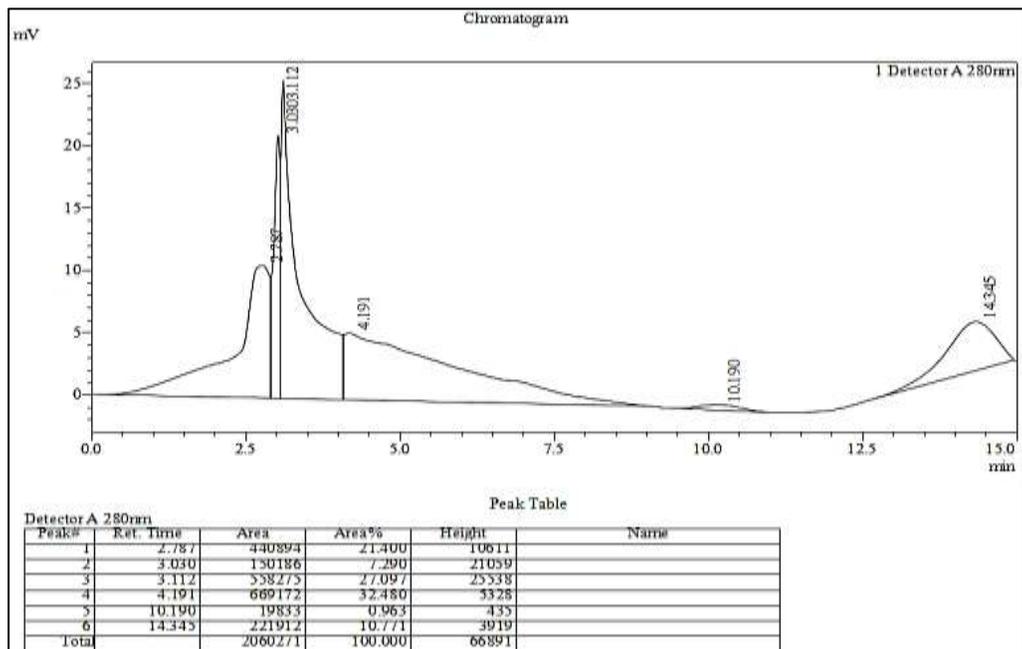
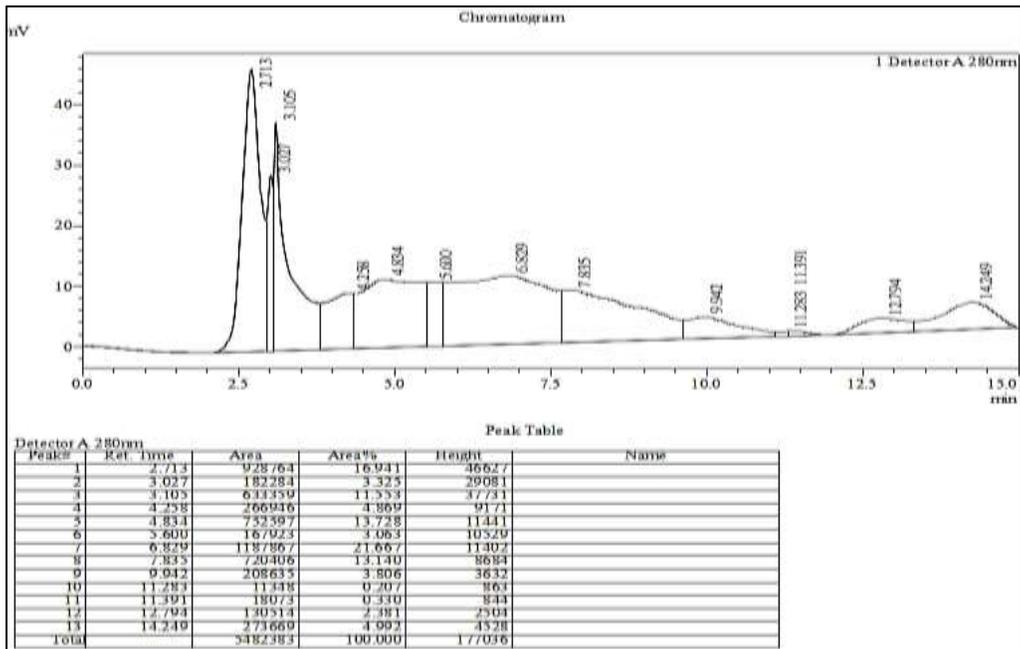


Figure 5. HPLC Chromatograms of Identified Phenolic and Alkaloid Compounds for the Studied Cultivars.

1. Sarkoula, 2. Shadda Beidha.

3



4

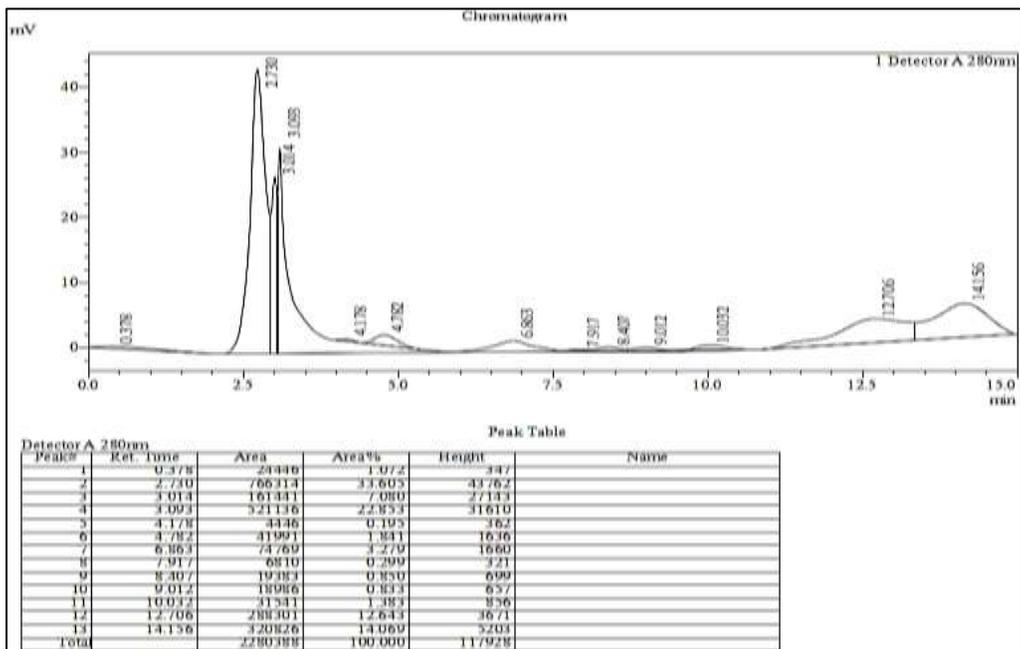
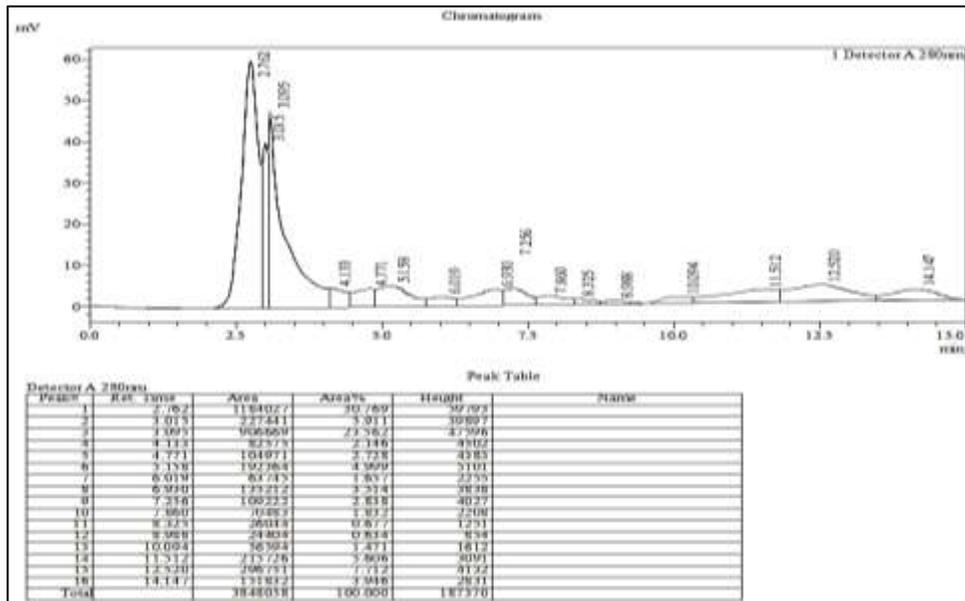


Figure 6. HPLC Chromatograms of Identified Phenolic and Alkaloid Compounds for the Studied Cultivars:

3. Beidhawi, 4. Sloobi.

5



6

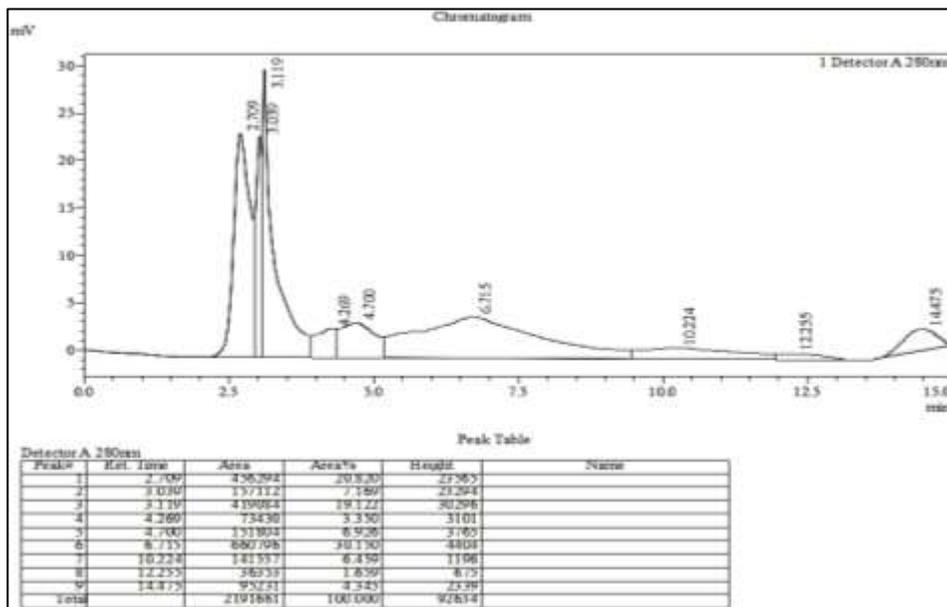
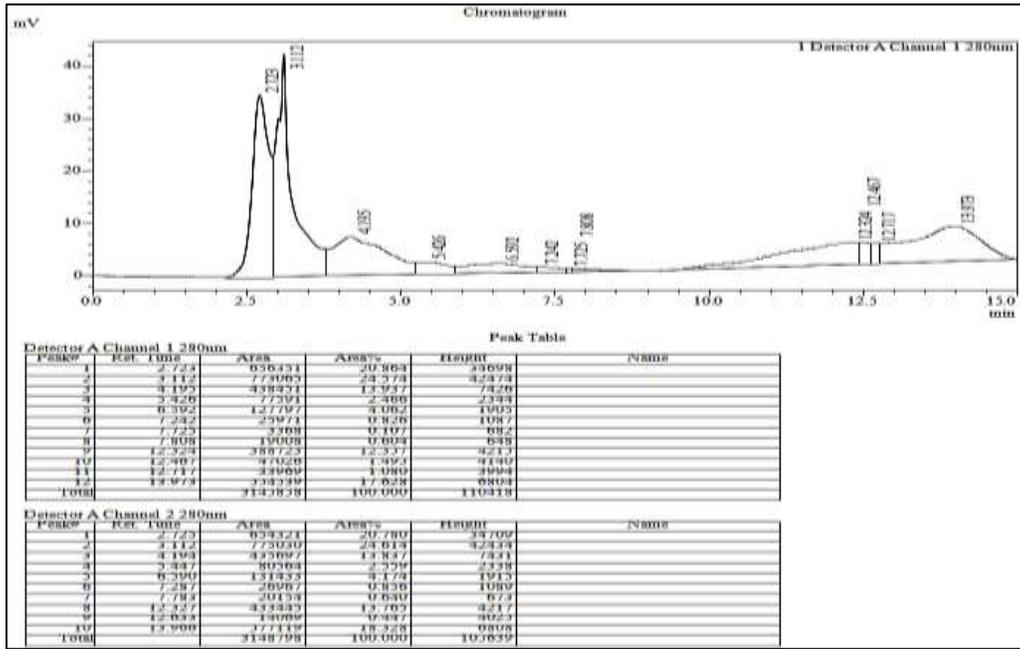


Figure 7. HPLC Chromatograms of Identified Phenolic and Alkaloid Compounds for the Studied Cultivars:

5. Muscat Sebi, 6. Rashmio.

7



8

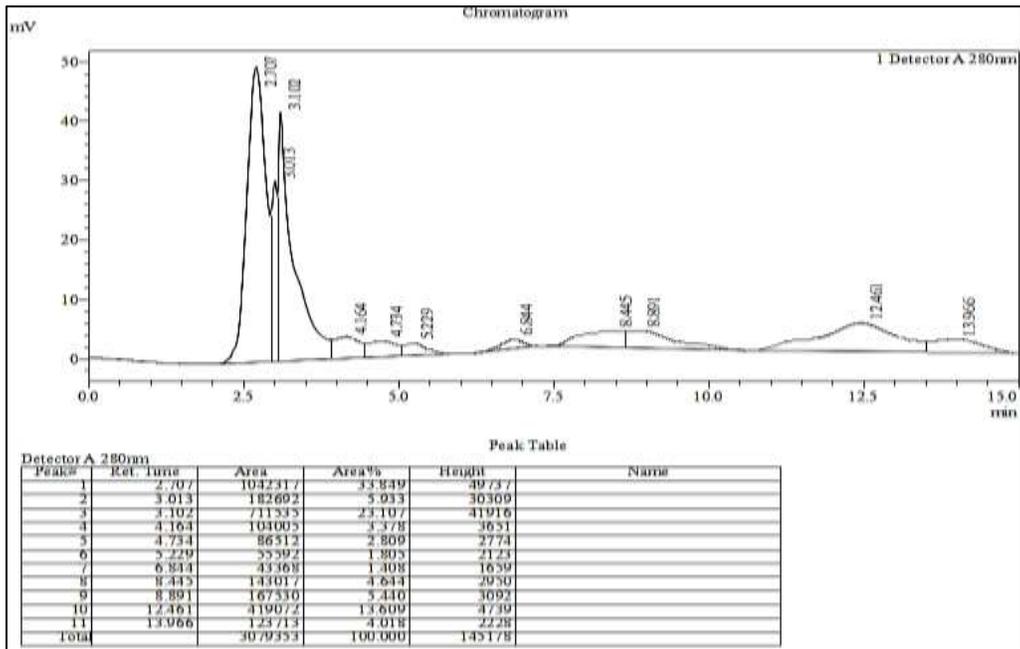


Figure 8. HPLC Chromatograms of Identified Phenolic and Alkaloid Compounds for the Studied Cultivars:

7. Faleen Turki, 8. Bakira Black.

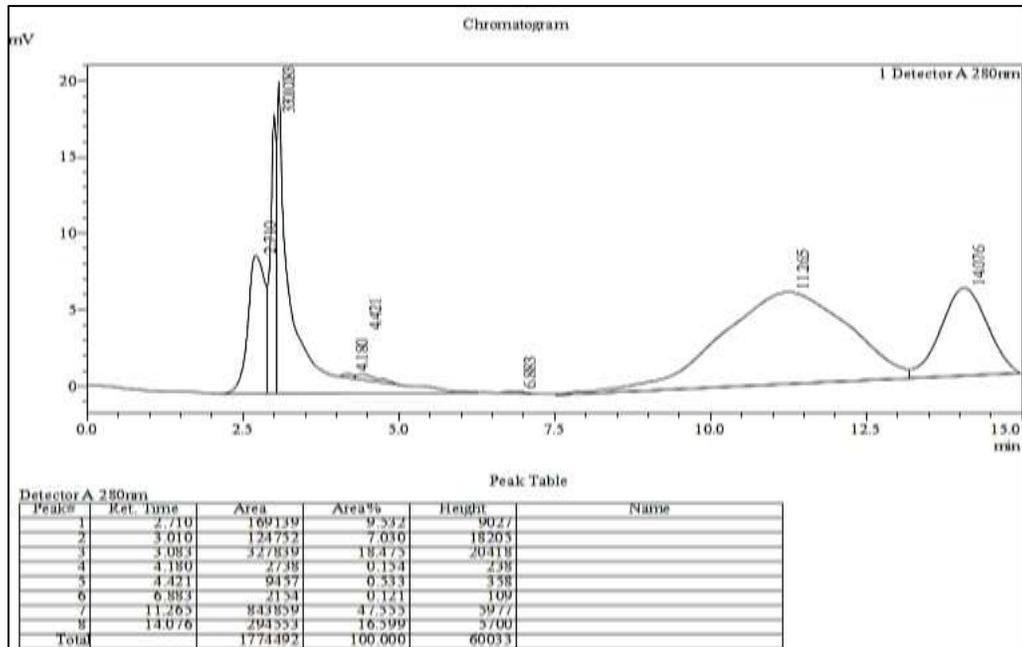


Figure 9. HPLC Chromatogram of Identified Phenolic and Alkaloid Compounds for the Studied Cultivar: 9. Zah-r Bakira.

4. Discussion

The current study of anatomical variations in cell wall shape and crystal distribution are of high taxonomic importance and can be utilized for cultivar delimitation. Stomata were exclusively restricted to the abaxial surface, [18, 19].

The study of the anatomical characteristics of the leaf epidermis, stomatal complexes, and surface indumentum, combined with venation patterns and areole morphology, provides taxonomically significant data for cultivar identification and classification, [20, 21, 22].

The phytochemical analysis revealed that certain phenolic compounds were restricted to specific cultivars, while others showed a broader distribution. This variation in presence and concentration across the studied cultivars is consistent with the findings of [22], who identified phenolic compounds in eight cultivars of apple (*Malus domestica* L.) and six cultivars of pear (*Pyrus communis* L.).

Furthermore, the results demonstrated a clear correlation among the studied cultivars through the consistent presence of Apigenin and Gallic acid in all

samples. This aligns with several researchers who identified these two compounds as common constituents in grapevines, including [23, 24]. The ubiquitous presence of these compounds represents an evolutionary trait of significant importance, reinforcing their shared taxonomic rank within the species *Vitis vinifera* L.

On the other hand, the qualitative and quantitative variations in the identified chemical compounds among the cultivars can be attributed to genetic diversity and the influence of environmental conditions on compound biosynthesis, [25]. Consequently, these chemical differences serve as a robust taxonomic marker and evidence that supports other diagnostic tools, such as morphological, anatomical, and palynological (pollen) studies.

5. Conclusions

The research was beneficial led to examination of Important anatomical and chemical differences between the local grape vine (*Vitis vinifera* L.) Celltivars. Presence Variation in the shape and dimension of antidual Walls epidermis cells, Stomatal index and the Content and Concentration of chemical Compounds extracted for leaf by using (HPLC)

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7. Conflicts of interest

The authors declare that there is no conflict of interest for this work.

8. Financial support affiliation of the study

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9. References

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دراسة مقارنة للصفات التشريحية والكيميائية لبعض أصناف العنب *Vitis vinifera L.* المحلية المزروعة في شمال العراق

المستخلص:

تضمن البحث الحالي دراسة مقارنة للصفات التشريحية والكيميائية ل (9) أصناف من العنب *Vitis vinifera L.* المحلية المزروعة في شمال العراق وهي (سرقولة, شدة بيضاء, بيضاوي, مسكاة سبي, صلوبي, رشميو, فلين تركي, باكيرو اسود, زهر باكيرو).

شملت الدراسة التشريحية صفات الأوراق من حيث شكل خلايا البشرة العليا والسفلى وابعادها والكساء السطحي لها والثغور والمعدن الثغري *Stomata complex* والذي كان من النوع الشاذ *Anomocytic* type وأن الثغور موجودة على السطح السفلي فقط ونظام التعرق في الورقة من النوع الشبكي الكفي في جميع الأصناف المدروسة. أما في الجانب الكيميائي فشخصت بعض المركبات الفينولية والقلويدية باستخدام تقانة الكروماتوغرافيا السائل عالي الأداء (HPLC) *performance Liquid Chromatography* – High عن طريق استخلاصها من الأوراق خلال فترة التزهير إذ تم تشخيص (5) مركبات فينولية وهي (Galicacid, 2-6-Dimethylphenol, Quercetin, Kaempferol, Apigenin) (ومركب قلويدي *caffeine*) فضلا عن تقدير كمية تواجدها في الأصناف المدروسة واتضح ان لهذه المركبات أهمية في عزل الأصناف بعضها عن البعض.