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Comparative study among glycosides extracted from some species belongs to Brassiceae tribe (Brassicaceae) and measuring their ratios, concentrations and convergence ratio growing in Northern of Iraq

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Abstract :

The highest concentration of the glycoside Coumarin was found in the species *Rhamphospermum arvense*, reaching (114.47) micrograms/ml, while the lowest concentration of the glycoside Isorhamnetin was found in the species *Rapistrum rugosum* L, reaching (49.03) micrograms/ml. The highest percentage of the glycoside Coumarin was found in the species *Rhamphospermum* arvense L, reaching (21.69%), while the lowest percentage of the glycoside Glucotropaeolin was found in the species *Erysimum repandum* L, reaching (8.87%). It was found that the similarity percentage ranged between (0.25819 - 0.91287), and the shortest distance between the two species *Erysimum repandum* L. and *Rhamphospermum arvense* L. was (0.25819), while the farthest distance was recorded between the two species *Isatis tinctoria* L. And *Sisymbrium orientale* L., which reached (0.91287), the most closely related species were *Isatis tinctoria* L. and *Sisymbrium orientale* L., which reached 0.26, while the most divergent species were *Hirschfeldia incana* L. and *Rhamphospermum arvense* L., which reached 0.68. This chemical study of the glycosidic compounds, their ratios and concentrations, revealed the similarity between plant species of the mustard family.

Keywords: Chemical study, glycosides, Brassiceae tribe, Brassicaceae.

دراسة مقارنة للكلايكوسيدات المستخلصة من بعض الأنواع التابعة للعائلة الخردلية وقياس نسبها وتراكيزها ونسبة التقارب بينها النامية في شمال العراق

محمد إبراهيم أحمد الحتحوت ، نجلاء مصطفى محمد العبيد

مستخلص:

تم الحصول على المركبات الكلايكوسيدية التالية وهي: Sinigrin ,Glucobrassicin ,Glucoraphanin ,Glucotro-paeolin ,Gluconapin ,Glucosamine ,Coumarin, ,Isorhamnetin. تبين إن اعلى تركيز لـ كلايكوسيد Coumarin كان في النوع Rhamphospermum arvense L إذ بلغ (114.47) ميكروغرام/ ملیلتر بينما اقل تركيز لـ كلايكوسيد Isorhamnetin كان في النوع *Rapistrum rugosum L* إذ بلغ (49.03) ميكروغرام/ ملیلتر أما أعلى نسبة مئوية لـ كلايكوسيد Coumarin في النوع *Rhamphospermum arvense L* اذ بلغ (21.69٪) بينما أقل نسبة مئوية لـ كلايكوسيد Glucotropaeolin كان في النوع *Erysimum repandum L* اذ بلغ (8.87٪). تبين ان نسبة التشابه تتراوح بين (0.25819 – 0.91287) وكانت أقصر مسافة بين النوعين *Erysimum repandum L*. و *Rhamphospermum arvense L*. أذ بلغت (0.25819) في حين سجلت ابعد مسافة بين النوعين *Isatis tinctoria L*. و *Sisymbrium orientale L*. أذ بلغت (0.91287). كان أكثر الأنواع تقاربا هما النوعين *Isatis tinctoria L*. و *Sisymbrium orientale L*. أذ بلغ نسبة التقارب 0.26 اما أكثر الأنواع تباعدا هما النوعين *Hirschfeldia incana L*. و *Rhamphospermum arvense L*. أذ بلغ نسبة التقارب 0.68. تبين من خلال هذه الدراسة الكيميائية للمركبات الكلايكوسيدية للنسب والتراكيز ظهور نسبة التقارب بين الانواع النباتية من العائلة الخردلية.

الكلمات المفتاحية: دراسة كيميائية كلايكوسيد العائلة الخردلية .

Introduction

The Brassicaceae family (formerly Cruciferae) known as the mustard family or the Cabbage family is one of the large and widely spread plant families in the world. Its previous name is due to the Cruciform shape resulting from the presence of four petals and four sepals in its flowers. Among the important and prominent diagnostic characteristics of the family are the number of stamens and their length. The pistil contains one ovary divided by a false septum. Its fruits are narrow silicle or round silique and contain seeds in two chambers, due to the presence of the false septum. They are surrounded on each side by a valve from the fruit valves. Its leaves are simple, alternate, and often have simple, unbranched or branched forked hairs and single-celled stellate hairs. (Glimn-Lacy and Kaufan, 2006), Some of its plants are distinguished by their great economic importance, as they are widely used as vegetables, such as garden cress *Lepidium L*., turnip *Brassica rapa L*., radish *Raphanus L*., and cabbage *Brassica oleraceae L*. Some of them are used as ornamental plants, such as silver rose *Lobularia L.,* *Erysimum L.,* and *Matthiola L*. Oils are extracted from their seeds, and some of their species have medical importance, such as black mustard *Brassica nigra L*. (Al-Moussawi, 1987). As for Iraq, the mustard family is represented by about 80 genera, Al-Moussawi (1987) and more than 100 species, Al-Kateb (2000), of which 75 are wild species. As for the number of genera and species belonging to the mustard family, researchers Kock and Mummenhoff (2006) indicated that the family includes 338 genera and 3700 species in the world, through a review of Various scientific sources and periodicals show the lack of chemical and Chemical studies on the genera of the Brassicaceae family in Iraq. There are many studies on the family in the world, but that few in Iraq, including the study of Al-Naftaji (2000) on pollen grains and seeds of three families, including the Cruciferae family, and the study of Al-abide (2012) on certain species of the Brassiceae clan genera. Therefore, the current study aimed to:

Conducting a chemical study using HPLC technology to determine the concentrations and percentages of chemicals.

Material and Methods

Chemical Study

HPLC:

High-Performance Liquid Chromatography (HPLC) is a core technique in analytical chemistry. Routine HPLC is often used for analysis in laboratories that perform pharmaceutical drug development, quality control, and quality assurance, as well as food and environmental testing.

Uv detector: An ultraviolet detector is a type of non-destructive chromatography detector which measures the amount of ultraviolet or visible light absorbed by components of the mixture being eluted off the chromatography column. They are often used as detectors for high-performance liquid chromatography.

Glycosides extraction method

Glycosides were isolated from the leaves that were dried at room temperature in the form of powder and stored in the refrigerator at 20 degrees below zero, and (1) gram of dried powder of the species under study was taken and extracted using 50 ml of hexane, which removes fats, oils, waxes, etc. The extract was evaporated to obtain 1 ml containing a mixture of crude glycosides. The active components of the genera belonging to the Brassicaceae family were separated by using a reversed phase and using a C-18 separation column (with a radius of 50 X 2.1 micrometers) with a particle size of 3 micrometers and a mobile phase consisting of 5% acetic acid in distilled water and an equal proportion of Acetonitrile and using a linear gradient from 0-100% in 7 minutes and a UV detector at a wavelength of 254 nm and a flow rate of 0.7 ml/min and a temperature of 30 °C. Many glycosides have been isolated using liquid phase chromatographic equipment. This equipment separates glycosides found in plants belonging to the Brassicaceae family.

Separation condition

Glycosides were separated from the mixture by reversed phase using a C-18 column (50 x 2.1 mm radius) and 3 µm particle size, while the mobile phase consisted of 5% acetic acid in distilled water and the standard concentration was 50 mg/ml. The following glycosides were isolated: Sinigrin, Glucobrassicin, Glucoraphanin, Glucotropaeolin, Gluconapin, Glucosamine, Coumarin, Isorhamnetin. The separa-

tion peak was printed by UV detector at a wavelength of 254 nm and the quantitative analysis was done by comparing the areas of the samples with the areas of the standard concentration under the same separation conditions. The concentration of glycosidic compounds in the species under study was measured using the following equation: compound concentration ml/mg = area of compound bands in the sample / area of compound bands in the standard x standard concentration x number of dilutions. The percentage was measured using the following equation: percentage of compound = partial concentration / total concentration x 100 (Wollenweber, 2002).

Table 1: Standard analysis of glycosides, retention time, area and concentration.

NO:	Compounds	Retention time (Sec)	Area	Concentration µg/ml
1	Sinigrin	6314	6314	12.20
2	Glucobrassicin	4060	4060	10.17
3	Glucoraphanin	6984	6984	13.38
4	Glucotropaeolin	5688	5688	10.28
5	Gluconapin	8795	8795	16.70
6	Glucosamine	6953	6953	13.43
7	Coumarin	4060	4060	10.17
8	Isorhamnetin	6553	6553	12. 70
	Total	70.64	50.831	100٪

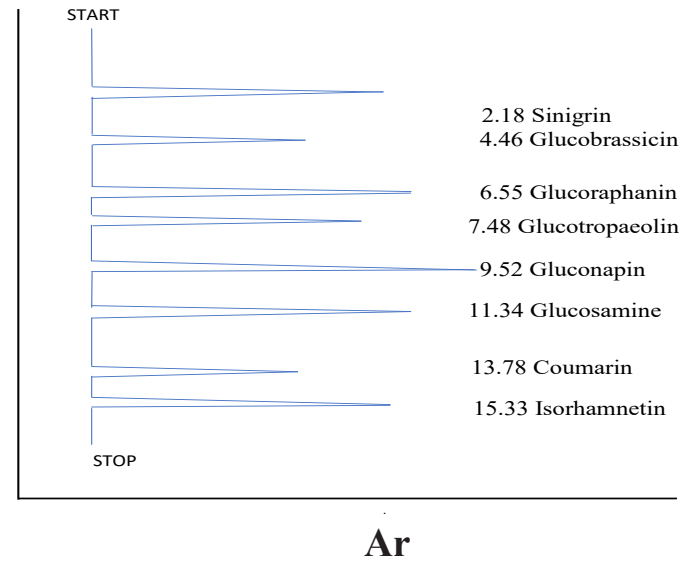

Figure 1: Glycosidesin compounds of the species under study and retention time in standard analysis.

Results & Discussion

Glycosides study

The results of the current study showed a clear variation in the quality of glycosidic compounds, their concentrations and percentages identified using HPLC technology. Some glycosidic compounds were identified in the leaves of species belonging to the Brassiceae clan. The glycosidic compounds are: Sinigrin: Glucobrassicin: Glucoraphanin: Glucotropaeolin: Gluconapin: Glucosamine: Coumarin: Isorhamnetin: The current study showed in general that the highest concentration of the glycoside Coumarin was in the species *Rhamphospermum arvense* L, reaching (114.47) micrograms/ml, while the lowest concentration of the glycoside Isorhamnetin was in the species *Rapistrum rugosum* L, reaching (49.03) micrograms/ml. The highest percentage of the glycoside Coumarin was in the species Rhamphospermum arvense L, reaching (21.69%) while the lowest percentage of glycoside Glucotropaeolin was in the species *Erysimum repandum* L, reaching (8.87%) as in Table (2). The study of the chemical content of the species under study also showed that the highest concentration of glycoside **Sinigrin** was in the species *Sisymbrium irio* L, reaching (92.16) micrograms/ml, while the lowest concentration was in the species *Hirschfeldia incana* L, reaching (51.59) micrograms/ml. The highest percentage was in the species *Sisymbrium irio* L, reaching (17.85%), while the lowest percentage was in the species *Hirschfeldia incana* L, reaching (9.13%) as in Table (2). As for the glycoside **Glucobrassicin**, the highest concentration was in the species *Aethionema cordifolium* L, reaching (108.33) micrograms/milliliter, while the lowest concentration was in the species *Neslia paniculata* L, reaching (69.51) micrograms/milliliter. The highest percentage was in the *Aethionema cordifolium* L species, reaching (20.22%), while the lowest percentage was in the species *Neslia paniculata* L, reaching (12.74%), as in Table (2). As for the glycoside **Glucoraphanin**, it was in the species *Rhamphospermum arvense* L, reaching (87.55) micrograms/milliliter, while the lowest concentration was in the species *Aethionema cordifolium* L, reaching (49.23) micrograms/milliliter. The highest percentage was in the species *Rhamphospermum arvense*, reaching (16.59%), while the lowest percentage was in the species *Aethionema cordifolium* L,

reaching (9.19%), as in Table (2). As for the glycoside **Glucotropaeolin**, its highest concentration was in the *Isatis tinctoria* L species, reaching (77.08) micrograms/milliliter, while the lowest concentration was in the *Erysimum repandum* L species, reaching (06.49) micrograms/milliliter. The highest percentage was in the *Isatis tinctoria* L species, reaching (14.42%), while the lowest percentage was in the *Erysimum repandum* L species, reaching (8.87%), as in Table (2). As for the glycoside **Gluconapin**, it was noted that its highest concentration was in the species *Erucaria microcarpa* Boiss, reaching (93.32) micrograms/milliliter, while the lowest concentration was in the species *Sisymbrium orientale* L, reaching (50.60) micrograms/milliliter. The highest percentage was in the species *Erucaria microcarpa* Boiss, reaching (17.85%), while the lowest percentage was in the species *Sisymbrium orientale* L, reaching (9.45%), as in Table (2). As for the glycoside **Glucosamine**, it was noted that its highest concentration was in the species *Sisymbrium orientale* L, reaching (76.68) micrograms/milliliter, while the lowest concentration was in the species *Aethionema cordifolium* L, reaching (49.44) micrograms/milliliter. The highest percentage was in the species Sisymbrium irio L, reaching (14.66%), while the lowest percentage was in the species *Aethionema cordifolium* L, reaching (9.23%), as in Table (2). As for the glycoside **Coumarin**, it was noted that its highest concentration was in the species *Rhamphospermum arvense* L, reaching (114.47) micrograms/milliliter, while the lowest concentration was in *Aethionema cordifolium* L, reaching (64.00) micrograms/milliliter. The highest percentage was in the species *Rhamphospermum arvense* L, reaching (21.69%), while the lowest percentage was in the species *Aethionema cordifolium* L, reaching (11.95%), as in Table (2). As for the glycoside **Isorhamnetin**, it was noted that its highest concentration was in the species *Erucaria microcarpa* Boiss, reaching (73.25) micrograms/ml, while the lowest concentration was in *Rapistrum rugosum* L, reaching (49.03) micrograms/ml. The highest percentage was in the species *Erucaria microcarpa* Boiss, reaching (14.01%), while the lowest percentage was in the species *Rapistrum rugosum* L, reaching (9.10%), as in Table (2).

Table 2: Glycosidic compounds in the studied species, concentrations and percentages.

Compounds / species	sinigrin		Glucobrassicin		Glucoraphanin		Glucotropaeolin		Gluconapin		Glucosamine		Coumarin		Isorhamnetin		T. con / T. per
	con	per	con	per	con	per	con	per	con	per	con	per	con	per	con	per	
Aethionema cordifolium L.	63.18	11.79	108.3	20.22	49.23	9,19	67.14	12.53	64.84	12.1	49.44	9.23	64	11.95	69.38	12.95	**428.4** / **99.97**
Capsella bursa-postoris L.	63.18	12.06	83.28	15.9	68.39	13.06	49.06	9.37	74.33	14.19	59.29	11.32	76.9	14.69	49.03	9.36	**418.8** / **99.96**
Erucaria microcarpa Boiss	63.18	12.08	83.28	15.92	72.22	13.81	-	-	93.32	17.85	63.16	12.08	74.39	14.22	73.25	14.01	**418.2** / **99.97**
Erysimum repandum L.	62.21	11.24	70.97	12.83	62.64	11.32	49.06	8.87	68.64	12.41	60.26	10.89	107	19.34	72.28	13.07	**553.0** / **99.97**
Hirschfeldia incana L.	51.59	9.13	110.8	19.62	55.94	9.9	51.77	9.16	69.59	12.32	64.12	11.35	94.43	16.72	66.47	11.76	**564.8** / **99.96**
Isatis tinctoria L.	51.59	9.65	69.51	13.01	72.22	13.51	77.08	14.42	61.99	11.6	53.5	10.01	94.49	17.68	53.87	10.08	**534.3** / **99.96**
Neslia paniculata L.	61.25	11.22	69.51	12.74	81.8	14.99	67.05	12.29	60.09	11.01	53.5	9.8	90.67	16.62	61.61	11.29	**545.5** / **99.96**
Rapistrum rugosum L.	72.84	13.52	95.81	17.79	58.81	10.92	57.2	10.62	74.33	13.8	53.5	9.93	76.9	14.28	49.03	9.1	**538.4** / **99.96**
Rhamphospermum arvense L.	63.18	11.97	70.76	13.4	87.55	16.59	58.1	11.01	74.33	14.08	59.29	11.23	114.5	21.69	-	-	**527.7** / **99.97**
Sisymbrium irio L.	92.16	17.85	97.19	18.82	63.6	12.31	68.94	13.35	68.64	13.29	75.71	14.66	-	-	50	9.68	**516.2** / **99.96**
Sisymbrium orientale L.	54.48	10.17	92.05	17.19	62.64	11.7	68.13	12.72	50.6	9.45	76.68	14.32	76.9	14.36	53.87	10.06	**535.4** / **99.97**
Strigosellea africana L.	80.57	15.14	83.41	15.68	87.55	16.46	67.14	12.62	-	-	63.16	11.87	80.65	15.16	69.38	13.04	**531.9** / **99.97**

(-) indicates absence of the compound.

The current study showed that the species vary in the concentration of their chemical content and percentages of glycosides and their presence in the plant leaves of the species under study, as the species were isolated based on the percentages and high and low concentrations, so some species were isolated from each other. The results of the standard analysis were as in Table (2).

The results showed that the species *Aethionema cordifolium L.* contains the following compounds: Sinigrin Glucobrassicin Glucoraphanin Glucotropaeolin Gluconapin Glucosamine Coumarin Isorhamnetin and that the highest concentration was in the glycoside Glucobrassicin, which reached (108.33) micrograms/ml, while the lowest concentration was in the glycoside Glucoraphanin, which reached (49.23) micrograms/ml. The highest percentage was in the species Glucobrassicin, which reached (20.22%), while the lowest percentage was in the species Glucoraphanin, which reached (9.19%), as shown in Table (2) and Figure (2). The study was consistent with the study of Sanaa et al., (1994) in terms of the chemical compound Sinigrin, but was not consistent with the rest of the compounds.

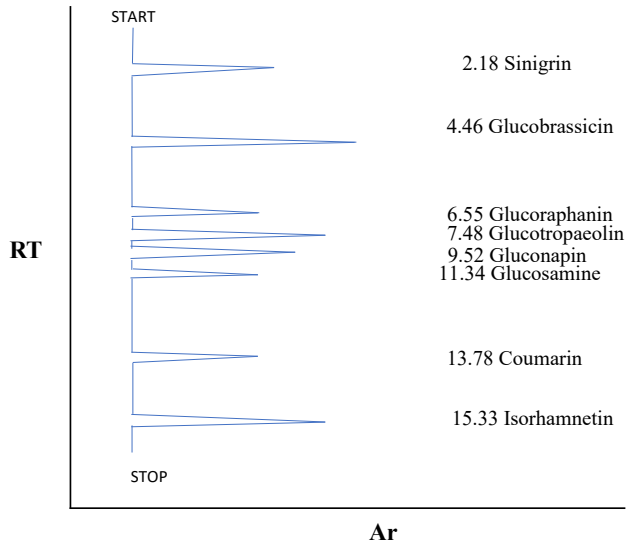

Figure 2: Chemical analysis of Glycosidesin compounds isolated from *Aethionema cordifolium* and retention time for each glycosid.

The species *Capsella bursa-postoris L* contains the following compounds: Sinigrin Glucobrassicin Glucoraphanin Glucotropaeolin Gluconapin Glucosamine Coumarin Isorhamnetin and the highest concentration was in

the glycoside Glucobrassicin, which reached (83.28) micrograms / milliliter, while the lowest concentration was in the glycoside Isorhamnetin, which reached (49.03) micrograms / milliliter. The highest percentage was in the species Glucobrassicin, which reached (15.90%), while the lowest percentage was in the species Isorhamnetin, which reached (9.36%), as shown in Table (2) and Figure (3). The study agreed with Abdulilah et al., (2024), but the study did not agree with the study of Joon et al., (2017).

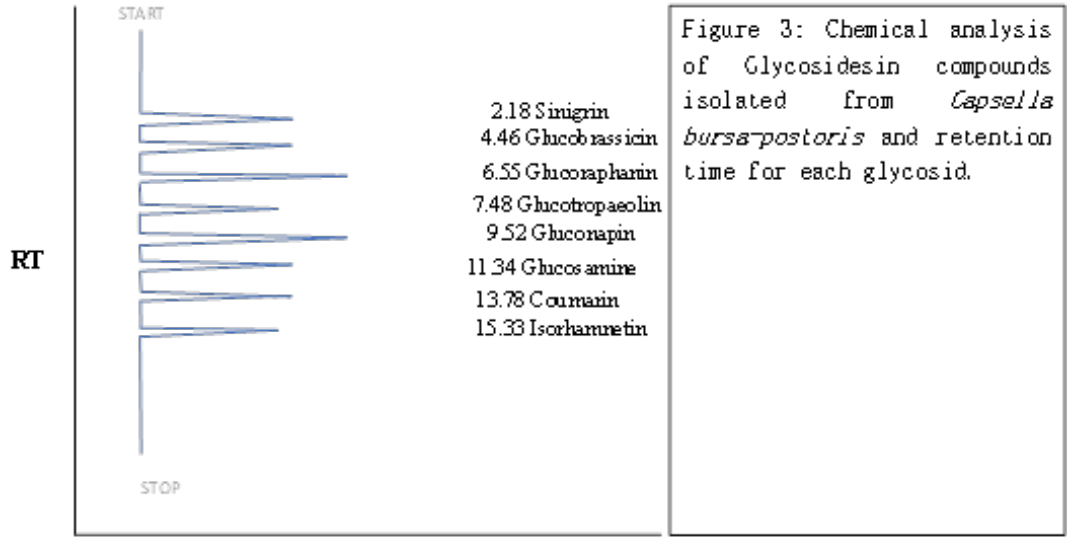

Figure 3: Chemical analysis of Glycosidesin compounds isolated from *Capsella bursa-postoris* and retention time for each glycosid.

The species *Erucaria macrocarpa L* contains the following compounds: Sinigrin Glucobrassicin Glucoraphanin Gluconapin Glucosamine Coumarin Isorhamnetin and did not contain the compound Glucotropaeolin and the highest concentration was in the glycoside Gluconapin, which reached (93.32) micrograms / milliliter, while the lowest concentration was in the glycoside Glucosamine, which reached (63.16) micrograms / milliliter. The highest percentage was in the species Gluconapin, which reached (17.85%), while the lowest percentage was in the species Glucosamine, which reached (%12.08), as shown in Table (2) and Figure (4). The study agreed with the study of Naglaa et al., (2022) in terms of the presence of glycosidic compounds. The study did not agree with the study of Naglaa et al., (2022) and Ashwaq et al., (2014) in terms of the percentage and concentration.

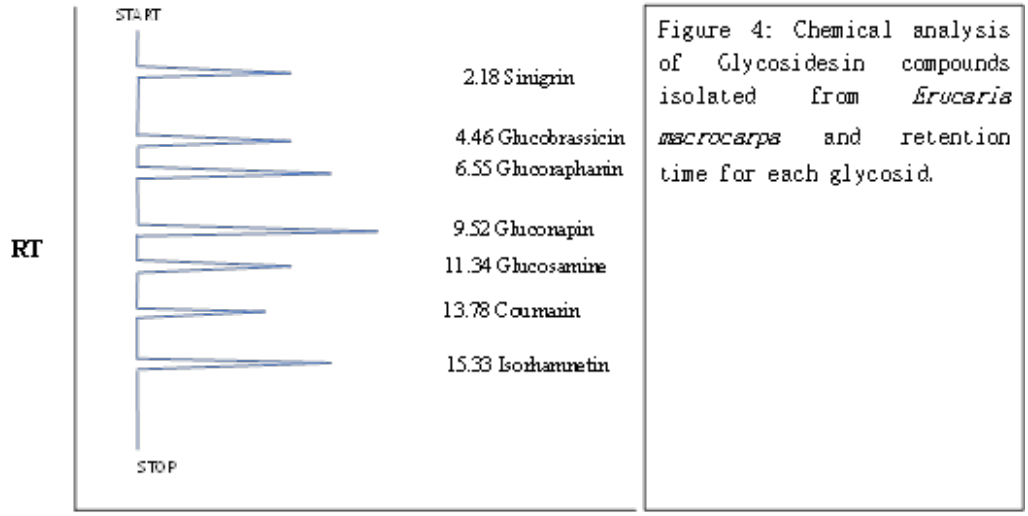

Figure 4: Chemical analysis of Glycosidesin compounds isolated from *Erucaria macrocarpa* and retention time for each glycosid.

The species *Erysimum repandum* L contains the following compounds: Sinigrin Glucobrassicin Glucoraphanin Glucotropaeolin Gluconapin Glucosamine Coumarin Isorhamnetin and the highest concentration was in the glycoside Coumarin, which reached (106.96) micrograms / milliliter, while the lowest concentration was in the glycoside Glucotropaeolin, which reached (49.06) micrograms / milliliter. The highest percentage was in the species Coumarin, which reached (19.34%), while the lowest percentage was in the species Glucotropaeolin, which reached (8.87%), as shown in Table (2) and Figure (5). The study agreed with the study of Tobias et al., (2018).

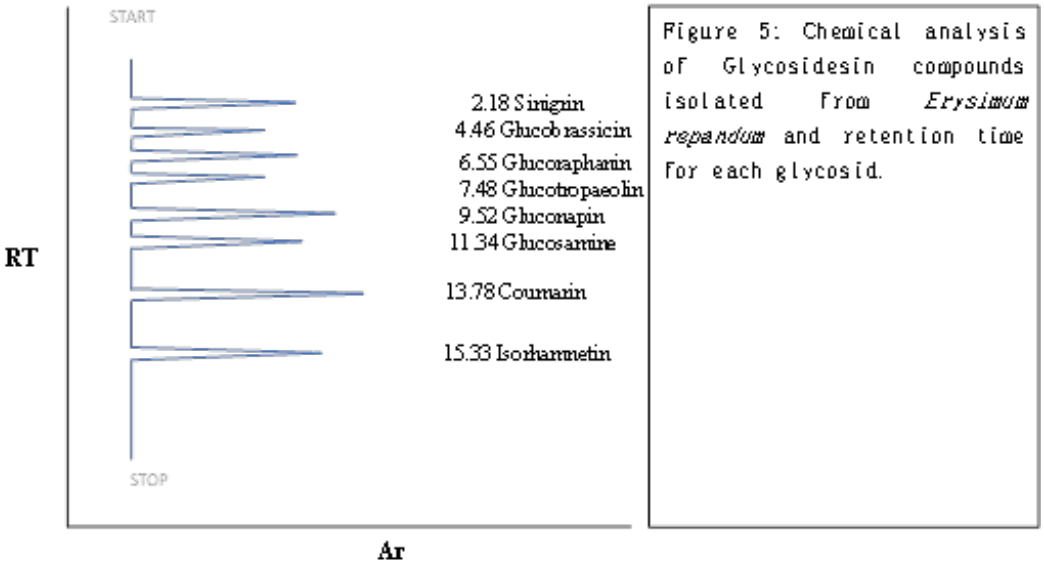

Figure 5: Chemical analysis of Glycosidesin compounds isolated from *Erysimum repandum* and retention time for each glycosid.

The species *Hirschfeldia incana L* contains the following compounds: Sinigrin Glucobrassicin Glucoraphanin Glucotropaeolin Gluconapin Glucosamine Coumarin Isorhamnetin The highest concentration was in the glycoside Glucobrassicin, reaching (110.84) micrograms / milliliter, while the lowest concentration was in the glycoside Sinigrin, reaching (51.59) micrograms / milliliter. The highest percentage was in the species Glucobrassicin, reaching (19.62%), while the lowest percentage was in the species Sinigrin, reaching (%9.13), as shown in Table (2) and Figure (6). The study agreed with the study of Naglaa et al., (2022) in terms of the presence of glycosidic compounds. The study did not agree with the study of Naglaa et al., (2022) in terms of the percentage and concentration.

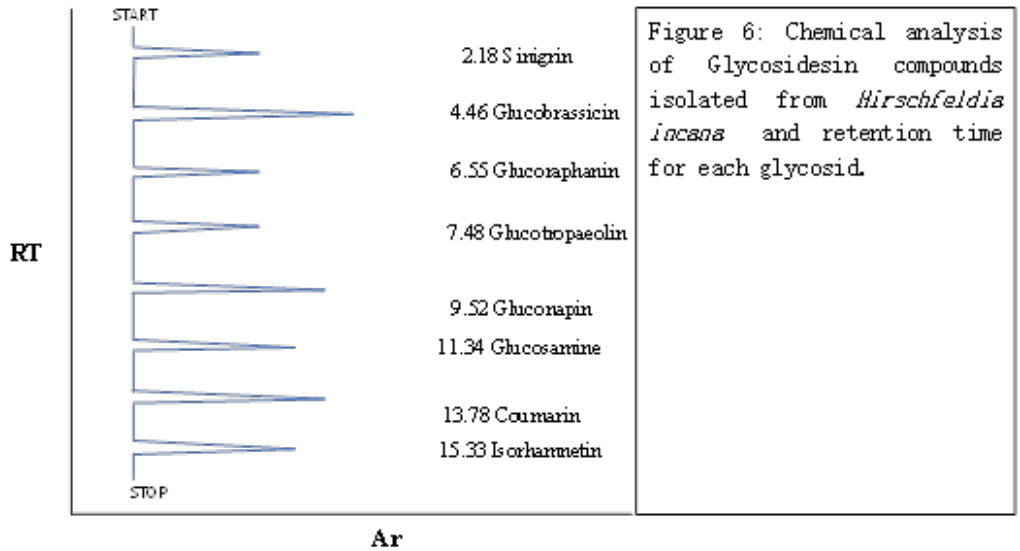

Figure 6: Chemical analysis of Glycosidesin compounds isolated from *Hirschfeldia incana* and retention time for each glycosid.

The species *Isatis tinctoria L* species contains the following compounds: Sinigrin Glucobrassicin Glucoraphanin Glucotropaeolin Gluconapin Glucosamine Coumarin Isorhamnetin The highest concentration was in the glycoside Coumarin, reaching (94.49) micrograms / milliliter, while the lowest concentration was in the glycoside Sinigrin, reaching (51.59) micrograms / milliliter. The highest percentage was in the Coumarin species, reaching (17.68%), while the lowest percentage was in the Sinigrin species, reaching (9.65%), as shown in Table (2) and Figure (7). The study agreed with the

study of Al-Abide (2021) in terms of the presence of glycosidic compounds, and the study did not agree with the study of Al-Abide (2021) in terms of the percentage and concentration. but the study did not agree with the study of Le et al., (2024).

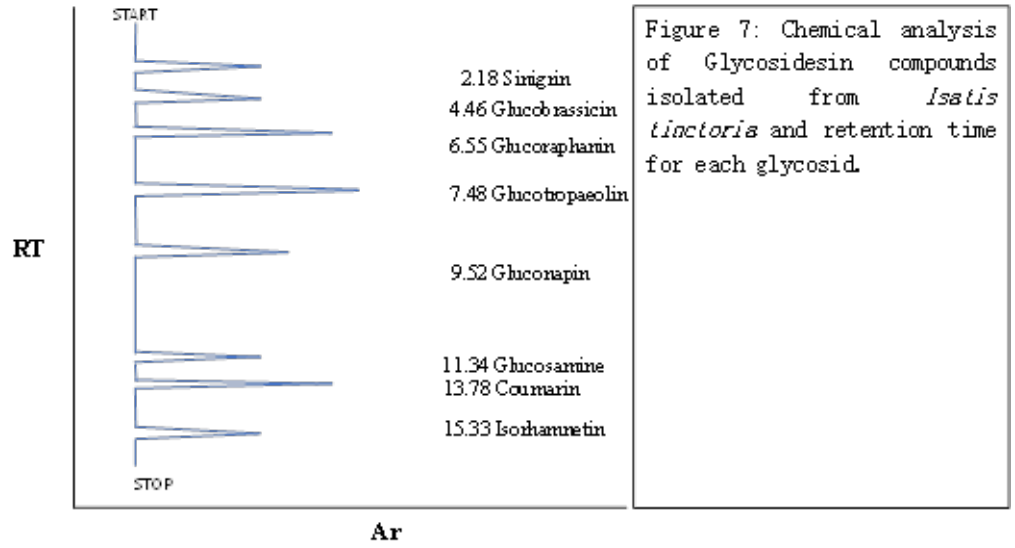

Figure 7: Chemical analysis of Glycosidesin compounds isolated from *Isatis tinctoria* and retention time for each glycosid.

The species *Neslia paniculata L* contains the following compounds: Sinigrin Glucobrassicin Glucoraphanin Glucotropaeolin Gluconapin Glucosamine Coumarin Isorhamnetin and the highest concentration was in the glycoside Coumarin, which reached (90.67) micrograms / milliliter, while the lowest concentration was in the glycoside Glucosamine, which reached (53.50) micrograms / milliliter. The highest percentage was in the species Coumarin, which reached (16.62%), while the lowest percentage was in the species Glucosamine, which reached (9.80%), as shown in Table (2) and Figure (8). The study agreed with the study of Mahmudur et al., (2017) in terms of some chemical compounds such as Sinapine and Isothiocyanates but did not agree in terms of the percentage and concentration.

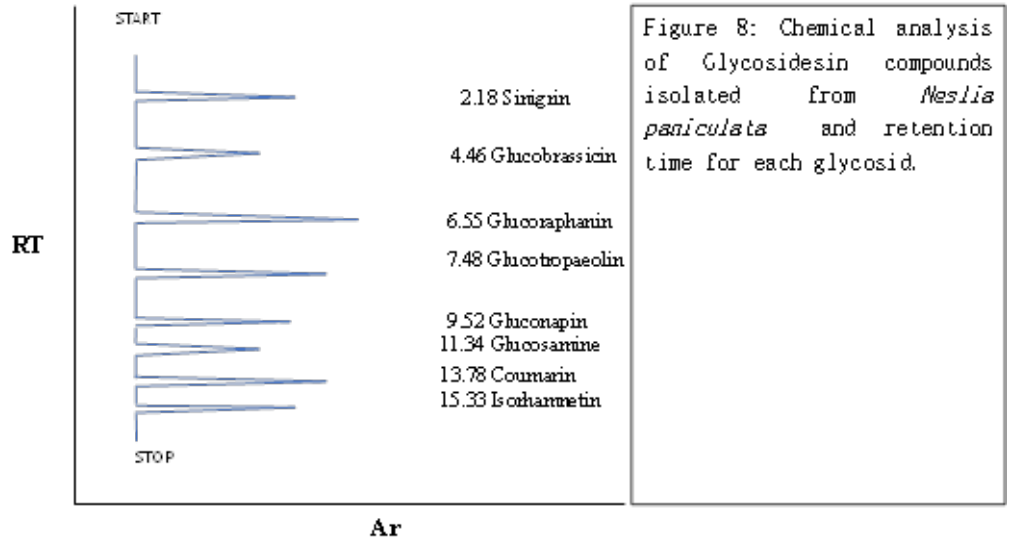

Figure 8: Chemical analysis of Glycosidesin compounds isolated from *Neslia paniculata* and retention time for each glycosid.

The species *Rapistrum rugosum L* contains the following compounds: Sinigrin Glucobrassicin Glucoraphanin Glucotropaeolin Gluconapin Glucosamine Coumarin Isorhamnetin and the highest concentration was in the glycoside Glucobrassicin, which reached (95.81) micrograms / milliliter, while the lowest concentration was in the glycoside Isorhamnetin, which reached (49.03) micrograms / milliliter. The highest percentage was in the species Glucobrassicin, which reached (17.79%), while the lowest percentage was in the species Isorhamnetin, which reached (9.10%), as shown in Table (2) and Figure (9). The study agreed with the study of Naglaa et al., (2022) in terms of the presence of glycosidic compounds. The study did not agree with the study of Naglaa et al., (2022) regarding the percentage and concentration.

As for the species *Rhamphospermum arvense L*, it contains the following compounds: Sinigrin Glucobrassicin Glucoraphanin Glucotropaeolin Gluconapin Glucosamine Coumarin. It did not contain the compound Isorhamnetin. The highest concentration was in the glycoside Coumarin, which reached (114.47) micrograms / milliliter, while the lowest concentration was in the glycoside Glucotropaeolin, which reached (58.10) micrograms / milliliter. The highest percentage was in the species Coumarin, which reached (21.69%), while the lowest percentage was in the species Glucotropaeolin, which reached (11.01%), as in Table (2) and Figure (10). The study agreed with Ma et al., (2024), but the study did not agree with the study of Xu et al., (2024).

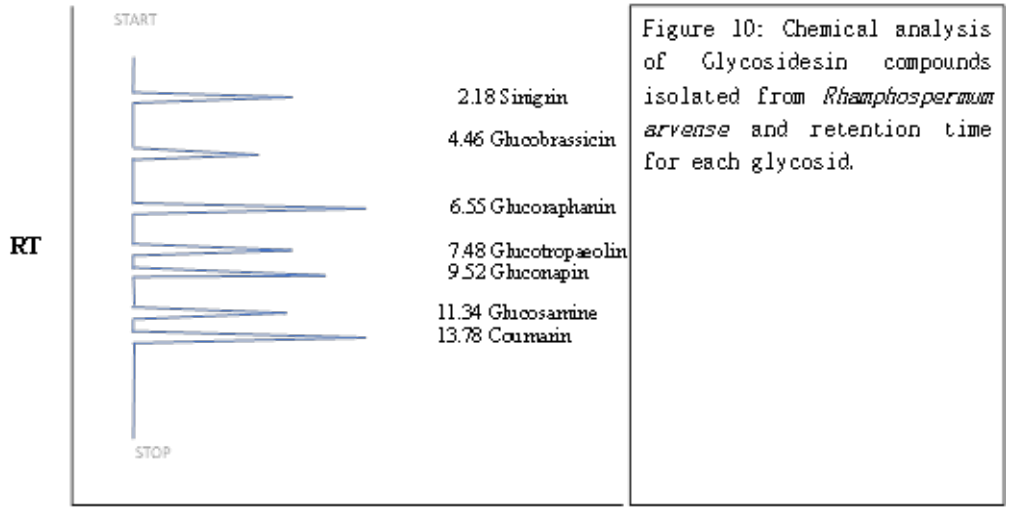

Figure 10: Chemical analysis of Glycosidesin compounds isolated from *Rhamphospermum arvense* and retention time for each glycosid.

The species *Sisymbrium irio L* contains the following compounds: Sinigrin Glucobrassicin Glucoraphanin Glucotropaeolin Gluconapin Glucosamine Isorhamnetin and did not contain the compound Coumarin and the highest concentration in the glycoside Glucobrassicin was (97.19) micrograms / milliliter while the lowest concentration was in the glycoside Isorhamnetin was (50.00) micrograms / milliliter. The highest percentage was in the species Glucobrassicin was (18.82%) while the lowest percentage was in the species Isorhamnetin was (9.68%) as shown in Table (2) and Figure (11).

The study agreed with the study of Naglaa et al., (2022) and the study of Abdulilah et al., (2024) in terms of the presence of compounds. The study did not agree with the study of Naglaa et al., (2022) and Ashwaq et al., (2014) in terms of percentage and concentration.

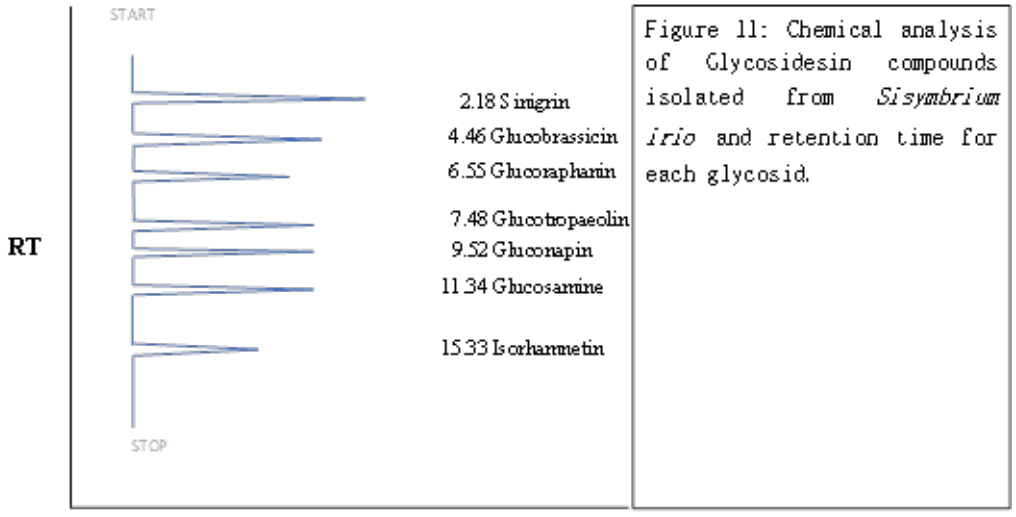

Figure 11: Chemical analysis of Glycosidesin compounds isolated from *Sisymbrium irio* and retention time for each glycosid.

As for the species *Sisymbrium orientale L*, it contains the following compounds: Sinigrin Glucobrassicin Glucoraphanin Glucotropaeolin Gluconapin Glucosamine Coumarin Isorhamnetin and the highest concentration was in the glycoside Glucobrassicin, which reached (92.05) micrograms / milliliter, while the lowest concentration was in the glycoside Gluconapin, which reached (50.60) micrograms / milliliter. The highest percentage was in the species Glucobrassicin, which reached (17.19%), while the lowest percentage was in the species Gluconapin, which reached (9.45%), as in Table (2) and Figure (12). The study in this species did not agree with the study of Azra et al., (2022).

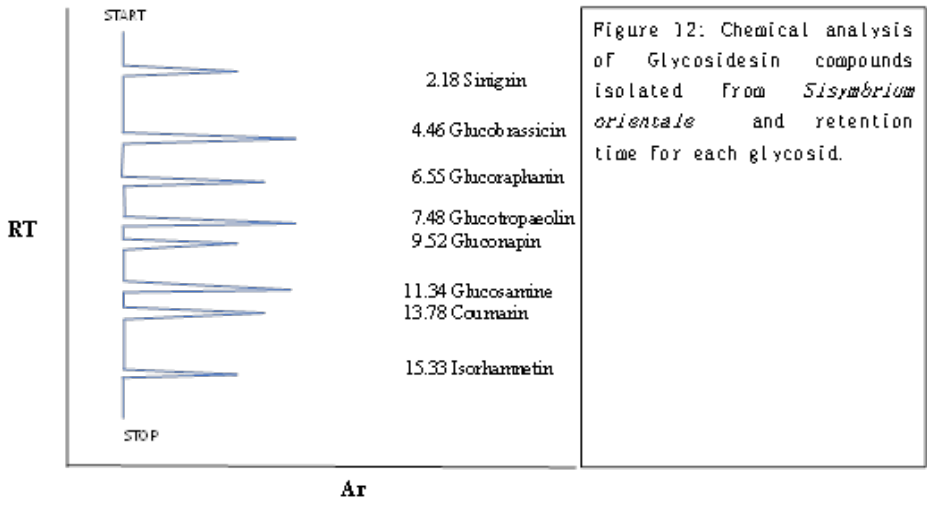

Figure 12: Chemical analysis of Glycosidesin compounds isolated from *Sisymbrium orientale* and retention time for each glycosid.

The species *Strigosellea Africana L* contains the following compounds: Sinigrin Glucobrassicin Glucoraphanin Glucotropaeolin Glucosamine Coumarin Isorhamnetin and did not contain the compound Gluconapin and the highest concentration was in the glycoside Glucoraphanin as it reached (87.55) micrograms / milliliter while the lowest concentration was in the glycoside Glucosamine as it reached (63.16) micrograms / milliliter while the highest percentage was in the species Glucoraphanin as it reached (16.46%) while the lowest percentage was in the species Glucosamine as it reached (%11.87) as in Table (2) and Figure (13). The study did not agree with the study of Abdulilah et al., (2024).

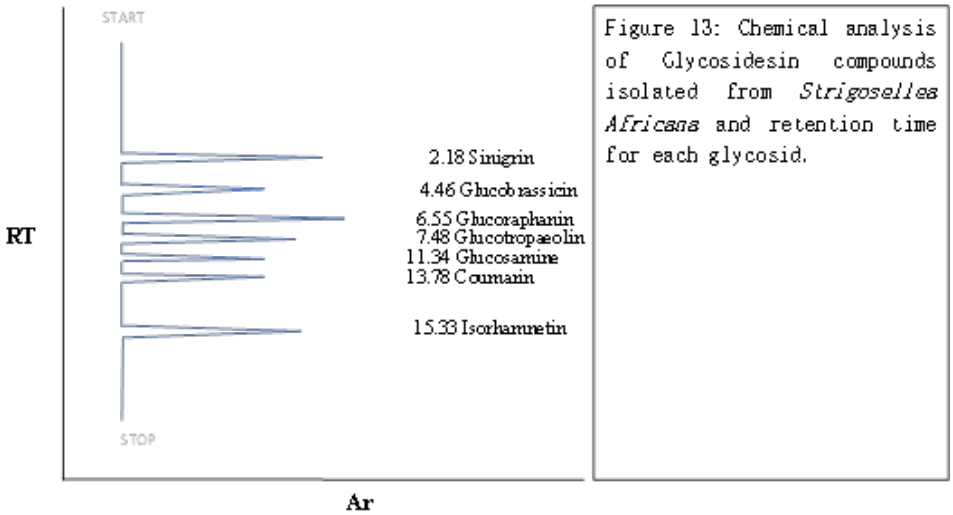

Figure 13: Chemical analysis of Glycosidesin compounds isolated from *Strigosellea Africana* and retention time for each glycosid.

Cluster analysis of species based on glycoside chemical content:

A was divided into two groups A1 and A2. Group A1 was also divided into two groups AB1 and AB2. AB1 was divided into two groups ABC1 and included the species *Aethionema cordifolium* L. and *Erysimum repandum* L. Group ABC2 included *Capsella bursa-postoris* L. and *Rapistrum rugosum* L. and *Neslia paniculata* L. Group AB2 included the species *Erucaria microcarpa* Boiss. Group A2 included *Sisymbrium irio* L. and *Strigosellea africana* L. Group B was divided into two groups B1 and B2. Group B1 included the species *Hirschfeldia incana* L. and *Isatis tinctoria* L. and *Sisymbrium orientale* L. B2 included the species *Rhamphospermum arvense* L.

In terms of chemical distance, the most closely related species were *Isatis tinctoria* L. and *Sisymbrium oriental* L. The convergence ratio was (0.26) while the most divergent species were *Hirschfeldia incana* L. and *Rhamphospermum arvense* L. The convergence ratio was (0.68) as shown in Figure 2. Not all previous studies were consistent with the results of my study in terms of cluster analysis. This is because the samples used in the current chemical study were of higher quality or more representative of the species compared to previous studies, or that the data in previous studies were limited or less accurate. With the development of chemical technology, more accurate and modern analysis methods have become available that may change the previous understanding, or that old studies may not have used advanced techniques or expanded genetic data. Figure (14).

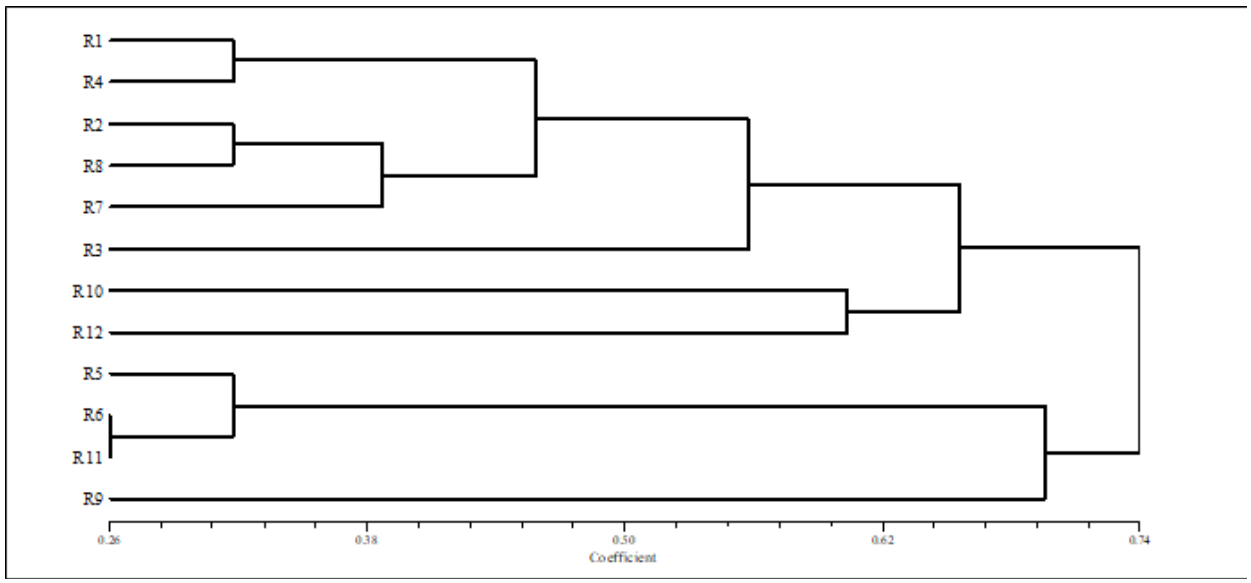

Figure 14: Dendritic diagram according to apparent glycoside content.

Convergence and divergence between species based on glycoside chemical content:

The values of divergence and convergence between the studied species were calculated based on the chemical content of alkaloids and glycosides by analyzing the results obtained from the studied species using the program (NTSYS pc v.2.02e). The similar percentage ranged between (0.25819 - 0.91287). The shortest distance between the two species was *Erysimum repandum* L. and *Rhamphospermum arvense* L., which reached (0.25819) While the farthest distance between the two species was *Isatis tinctoria* L. and *Sisymbrium orientale* L., which reached (0.91287) as in Table (2). All previous studies did not agree with the results of my study in terms of convergence and divergence. This is because the samples used in the current chemical study are of higher quality or more representative of the species compared to previous studies, or that the data in previous studies were limited or less accurate. With the development of chemical technology, there are now more accurate and modern analysis methods that may change the previous understanding, or older studies may not have used advanced techniques or extensive genetic data. Table 3.

Table 3 Diversity values between species according to apparent glycoside content.

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.00000											
2	0.44721	0.00000										
3	0.60553	0.54732	0.00000									
4	0.31622	0.31622	0.57635	0.00000								
5	0.73029	0.68313	0.60553	0.75279	0.00000							
6	0.70610	0.65828	0.51639	0.73029	0.31622	0.00000						
7	0.57635	0.36514	0.54772	0.48304	0.68313	0.65828	0.00000					
8	0.48304	0.31622	0.51639	0.42721	0.70517	0.63245	0.40824	0.00000				
9	0.96609	0.85634	0.75247	0.91287	0.68313	0.70410	0.81649	0.83666	0.00000			
10	0.68313	0.68313	0.75227	0.70710	0.89442	0.91287	0.73029	0.65828	0.68313	0.00000		
11	0.75277	0.65828	0.57735	0.73029	0.31622	0.25819	0.60553	0.68313	0.70315	0.94868	0.00000	
12	0.70118	0.60553	0.68313	0.60245	0.83666	0.81649	0.48304	0.57735	0.70213	0.60553	0.77459	0.00000

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