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ORIGINAL ARTICLE

THE EFFECT OF HARVEST TIME ON THE CHEMICAL CONTENT OF WILD CRESS (*LEPIDIUM AUCHERI* BOISS) LEAVES GROWING IN THE PLAINS REGIONS OF SOUTHERN IRAQ

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Abstract: The study was conducted in the laboratories of the College of Agriculture, University of Basrah, Iraq, during the winter season 2019, with the aim of knowing the effect of the harvest time on the chemical components and mineral elements of the wild cress leaves growing in the lands of the Shatt al-Arab district, east of Basrah Governorate, in the Jazirah region, which is within the sedimentary plain. The experiment included three plant harvest times, which are February 7, February 21, and March 7, 2019. This experiment was carried out according to the Randomized complete blocks design and with three replicates for each treatment. The data were statistically analyzed by the method of analysis of variance. The means of the treatments were compared between them according to the revised least significant difference test at a probability level of 5%. The third harvest time significantly exceeded the other two times in the leaf content of total chlorophyll, soluble carbohydrates and proteins, volatile essential oils, total nitrogen and phosphorous, reaching 221.0 mg 100 gm^{-1} fresh weight, 80.7 mg g^{-1} dry weight, 31.09%, 0.888%, 5.65% and 0.97%, respectively. While, this harvest time resulted in a significant decrease in the total carotenoids pigment, which reached 0.004 mg 100 g^{-1} fresh weight. As for the first harvest time, it was significantly higher than the calcium content of leaves, which reached 0.368%. Harvest times had no significant effect on leaves content of potassium, sodium, magnesium, iron and zinc minerals. The results of chemical analyses of the wild cress leaf extract showed that using the GC-Mass device was identified 49 bioactive compounds.

***Key words*:** Essential oil, Bioactive compounds, Carbohydrate, Chlorophyll, Minerals, Carotenoids.

Cite this article

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1. Introduction

In recent years, interest in wild plants has increased in terms of food and medicine in a large number of countries of the world, with a focus on their content of nutrients, as this has an important role in achieving food security for a world whose population is steadily increasing [Smith *et al*. (1996)]. The wild cress plant is one of these wild plants that are spread in the southern regions of Iraq, especially the desert and the sedimentary plain areas during the winter after the rains. The wild cress plant belongs to the Cruciferae family and is native to the Middle East. This plant is a wintery annual herbaceous plant, branching at the base, with large, lobed lower leaves and few-lobed upper leaves that disorganized shape. The flowers of this plant are very small, compact white, growing early from the ends of the branches. The part that is eaten from this plant is its crisp fresh leaves or eaten with a salad. Its leaves are considered to have a spicy taste similar to agricultural cress, only its fruits and seeds are smaller than it [Takruri *et al*. (2008)]. The wild cress plant is of good nutritional value because it is rich in minerals such as iron, manganese, iodine, calcium, potassium and arsenic, as it is rich in vitamin C and contains a small percentage of vitamins A, B, PP and E [Maghrani *et al*. (2005)]. This plant is also one of the most important medicinal plants for its many benefits, as it is a tonic for anaemia, an expectorant, a sedative, a hypotensive

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diuretic, and effective for the vitality of the hair follicles, a barrier to hair loss, a treatment for skin ulcers, and abdominal pain reliever, a repellent to worms, effective in breaking up stones, sand, a treatment for cancer, rheumatism, diabetes, detoxification and antioxidants cold and headache, appetizing and easy to digest, rich in iodine and useful in absorbing unpleasant odors from the body. Recent studies also indicate that this plant contains bioactive compounds against microbes. The seeds of this plant are bioactive in stimulating sexual processes when used in specific doses because they contain vitamin E [Kheder (2008), Kadhim and Kuredi (2016)]. Samples of wild cress leaves were taken during three different times during the plant growth season from the Shatt al-Arab district in Basrah, southern Iraq, in order to identify the content of this plant's leaves from the chemical components in order to determine the best time of the plant harvest which the nutritional and medicinal value is its highest.

2. Materials and Methods

The study was conducted in the Laboratories of the College of Agriculture, University of Basrah, Iraq, during the winter season of 2019. Three samples were taken from the wild cress plant growing in the plains area in the Shatt al-Arab district, east of Basra, in the Jazira region, in Southern Iraq, at three times: February 7, February 21 and March 7, 2019. The experiment was carried out according to the design of Randomized complete blocks and with three replications [Al-Rawi and Khalaf Allah (2000)]. Table 1 shows some of the physical and chemical characteristics of the soil in which the plants grew. Table 2 shows the weekly averages of temperature and relative humidity during the period of the experiment. Samples were washed with distilled water to get rid of dust and impurities.

The leaf content of total chlorophyll was determined in mg per 100 g^{-1} fresh weight according to the method described by Goodwin (1976) and total carotene was mg per 100g^{-1} fresh weight according to the method described by Wellburn (1994). Then the leaves of the wild cress plant samples were dried at room temperature. Then the dry samples were milled with an electric mill and then the following analyzes were performed: which included total soluble carbohydrates (mg g^{-1}) according to the method described by Duboise *et al*. (1956), the percentage of total protein according to A.O.A.C. (1970) and the percentage of volatile essential oils according to the method described by Guenther (1972) and the estimation of the leaves content of nitrogen, potassium, sodium, magnesium, iron and zinc according to the method described by Page *et al*. (1982) and phosphorous according to the Black (1965) method.

Table 1: Some of the physical and chemical characteristics of the soil in experiment location.

No.	Characteristic	Value
1	Electricity conductivity (E.C)	5.465 dS m^{-1}
2	pH of soil	7.2
3	Total Nitrogen	0.5 mg kg^{-1}
4	Uptake Phosphorous	32.04 mg kg^{-1}
5	Uptake potassium	20.63 mg kg^{-1}
6	Organic matter	0.29%
Soil texture		
Clay		12.7%
Silt		16.6%
Sand		70.7%

Table 2: Decimal average of maximum and minimum temperatures and maximum and minimum relative humidity during 2019 season of the growth period of the wild cress plant.

Day-month	Temperatures (°C)		Relative humidity (%)	
	Maximum	Minimum	Maximum	Minimum
1-10 February	21.71	8.98	84.28	26.85
11-20 February	20.79	9.89	86.81	30.01
21-28 February	23.83	11.25	80.98	27.45
1-10 March	21.72	9.47	70.45	23.98

GC-MS analysis was by gas chromatography instrument that contacted to a Mass Spectrometer Model: GC MS QP210 Ultra, Shimadzu, APAN supplied with capillary column DB-MS5 (95% methyl polysiloxane, 5% phenyl) as stationary phase in addition to use helium gas (99.9%) employing. The following conditions: Column Oven Temperature: 50°C, Injection Mode: Split, Injection Temperature: 250°C, Pressure: 90.0 kPa, Column flow: 1.53 ml min^{-1}, Purge flow: 6.0 ml min^{-1}, Total flow: 79.2 ml min^{-1}, Split ratio: 46.9, Linear velocity: 44.8 cm sec^{-1}. The mass spectrometer: Ion Source Temperature: 200°C, Interface Temperature: 250°C, Cut time of solvent Cut: 4.00 min, Detector Gain : 0.84 kV +0.40 kV, Start Time: 4.00min, End Time: 41.71min, ACQ Mode: Scan, Event Time: 0.40 sec, Scan Speed: 2000, Start m/z: 35.00, End m/z: 800.

The data were analyzed statistically according to

the used experimental design by the analysis of variance using the statistical program Genstat Versions 24. The means of the treatments were compared by testing revised least significant difference at a probability level of 5% [Al-Rawi and Khalaf Allah (2000)].

3. Results and Discussion

It is evident from Table 3 that the harvest times had a significant effect on the chemical components content of leaves. The third harvest time was significantly higher compared to the first and second times in terms of increasing the leaf content of total chlorophyll by an increase of 81.14% and 11.05%, respectively and carbohydrates by an increase of 18.85% and 5.49%, respectively and an increase in protein amounting to 11.19% and 6.94%, respectively. The second harvest time significantly surpassed the first, with an increase of 63.11% total chlorophyll, 12.66% carbohydrates and 3.96% proteins, respectively.

Whereas, the third harvest time led to a significant decrease in the leaves content of carotene pigment compared to the first and second harvest times, with a decrease of 91.48% and 93.58%, respectively. As for their content of volatile essential oils, both the second and third times recorded a significant increase compared to the date of the first harvest time, with an increase of 27.33% and 27.76%, respectively. The times of the second and third harvest did not differ significantly between them in the percentage of volatile essential oils.

The significant increase at the third harvest time in the leaves content of total chlorophyll, carbohydrates and proteins may be due to the improvement in weather conditions such as temperature and relative humidity (Table 2), which in turn affected the activity and vitality of chloroplasts and the process of photosynthesis, which reflected positively on the chemical components of plant leaves [Mohammed and Al-Yunus (1991)]. Peter and Carl (2005) also indicated that the structure of the chlorophyll pigment has a positive relationship with the content of the leaves of nitrogen, iron, manganese and magnesium [Al-Sahaf (1989)]. Also, the boron component that maintains the bioactivity of this pigment by increasing the activity and effectiveness of some growth hormones, especially cytokinins such as kinetin, which increases leaf greenness. This increases the rate of photosynthesis in leaves, carbohydrates and proteins, and their accumulation in leaves and this is accompanied by a decrease in the leaves' content of carotenoids pigment [Mengel and Kirkbly (1982)]. The reason for the increase in volatile essential oils in the second and third harvest times is due to the appropriate temperatures and their effect on the synthesis of oils as a result of the activity of bioactivities in the plant, including the

Table 3: Effect of harvest time on some chemical components of wild cress leaves.

Harvest time	Total chlorophyllmg 100 g^{-1}	Total carotenoids mg 100 g^{-1}	Total carbohydrates mg g^{-1}	Proteins (%)	Volatile essential oils (%)
7th February	122.0	0.0470	67.90	27.96	0.695
21st February	199.0	0.0624	76.50	29.07	0.885
7th March	221.0	0.0040	80.70	31.09	0.888
R-LSD 0.05	18.5	0.0496	3.10	0.87	0.028

Table 4: Effect of harvest time on leaves content of wild cress plant of mineral elements

Mineral content (%)	Harvest time			R-LSD 0.05
	7th February	21st February	7th March	
Nitrogen	4.420	4.650	5.650	0.120
Phosphorous	0.840	0.900	0.970	0.070
Potassium	8.210	8.670	8.810	NS*
Magnesium	0.394	0.412	0.395	NS
Sodium	0.360	0.371	0.366	NS
Calcium	0.368	0.313	0.286	0.016
Iron	0.0283	0.0285	0.0285	NS
Zinc	0.0024	0.0029	0.0028	NS

*NS: Not significant

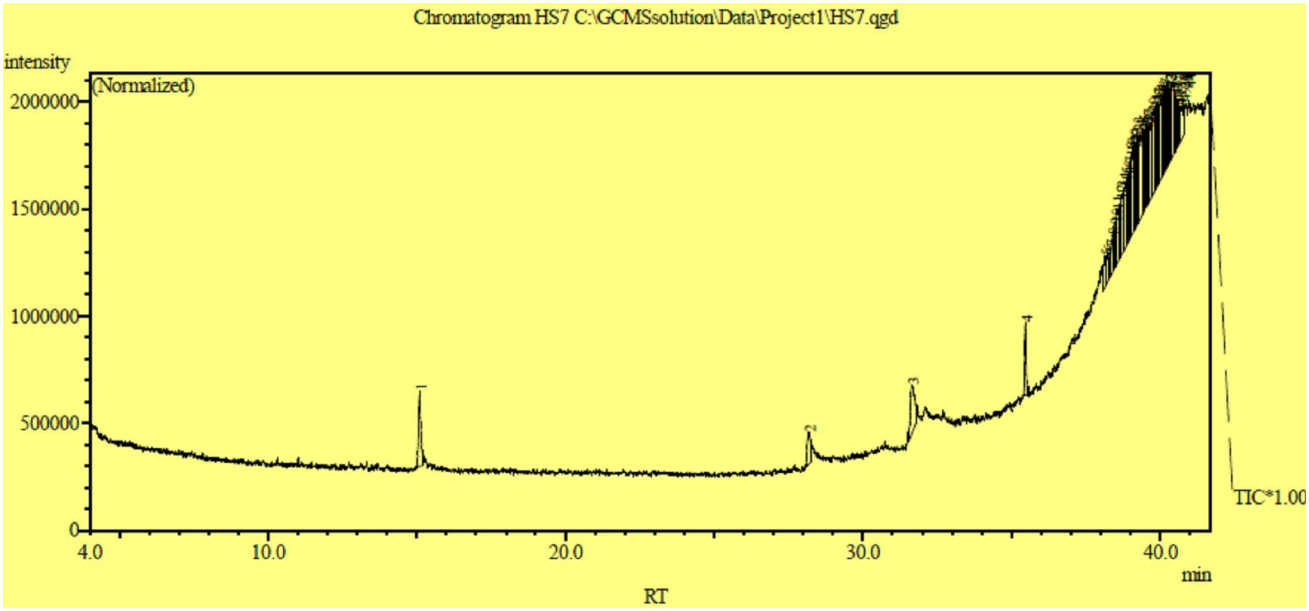


Fig. 1: A bioactive compound in wild cress leaves that identified by GC-Mass device

photosynthesis process that ultimately leads to an increase in the secondary products, including volatile essential oils [Rajeswere and Roa (1999)]. The results of the study agree with the results obtained by Salman and Sachit (2013) on *Anethum graveolens*.

The results from Table 4 show that the harvest dates had a significant effect on the nitrogen, phosphorous and calcium content of the leaves, while it did not significantly affect the potassium, magnesium, sodium, iron and zinc elements. The leaves of plants significantly outperformed at the third harvest time compared to the first and second times in increasing their nitrogen and phosphorous content, with an increase of 27.82%, 21.50% nitrogen, 15.47% and 7.77% phosphorous, respectively. The second harvest time was significantly higher compared to the first time, with an increase of 5.20% nitrogen, while these two harvest times did not differ significantly between them with regard to the content of phosphorus in the leaves.

The reason for the significant increase in nitrogen and phosphorus concentration is due to the favorable environmental conditions (Table 2) that led to an increase in the readiness and absorption of both elements nitrogen and phosphorous [Mohammed and Al-Yunus (1991)]. As for the reason for the low content of calcium in the leaves in the second and third harvest dates, it is attributed to the resumption of plants to active growth, which led to the consumption of calcium in the formation of new growths, as it enters the composition of cell membranes in plant tissues [Al-Sahaf (1989)].

The data from Table 5 showed that the chemical analyses of the wild cress leaf extract by using the GC-Mass device was identified 49 bioactive compounds (Fig. 1, Table 5). These data from the same table also indicate that the leaf extract contained high levels in eight compounds, including: 9,10-Dibromopentacosane, Propanenitrile,3-(5-diethylamino-1-methyl-3-pentynyloxy), 1,37-Octatriacontadiene, Methyl 2-acetylamino-3,4-dihydro-4-oxo-7-(2-acetylamino-2-deoxy-3,4-diacetyl-.beta.-arabinofuranosyl)-7H-pyrrolo[2,3-d]pyrimidine-5-carb, Fumaric acid, 4-heptyl tridecyl ester, Phthalic acid, ethyl isoporpyl ester,1H-Indole-2-carboxylic acid, 3-methyl-4-oxo-6-(3,4,5-trimethoxyphenyl)-4,5,6,7-tetrahydro-, ethyl ester, and Silane, dimethyl (pentafluorobenzyloxy) docosyloxy, which the percentage of peak area ranged between 3.37-6.00%. Of the 49 compounds, seven were bioactive compounds that were diagnosed with low levels; with a percentage peak area of 0.55 - 0.90%.

The results in Table 5 indicate the diagnosis of important bioactive compounds that contain in their chemical formula organic, fatty and amino acids, and nitrogenous bases in the wild cress leaf extract, such as Pthalic acid, Palmitic acid, Fumaric acid, Stearic acid, Butyric acid, Cysteine and Pyridine. The current study recommends conducting a wide and extensive study of the bioactive compounds in wild cress plant for the purpose of isolating, extracting and using them in the drugs and pharmaceutical industries.

Table 5 : Bioactive compounds identified in wild cress plant by GC-Mass.

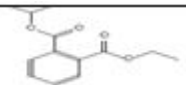
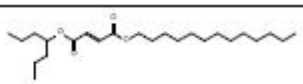
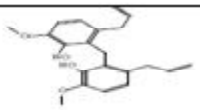
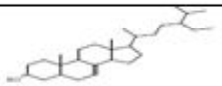
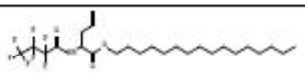
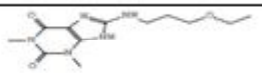
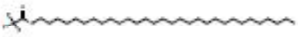
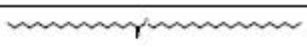
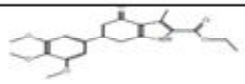
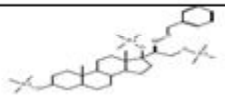
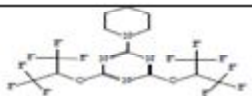
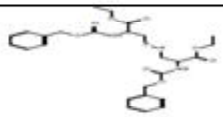
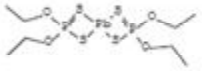
No.	RT.	Mw	Peak area (%)	Bioactive compound	Molecular structure
1	15.096	236	3.63	Phthalic acid, ethyl isoporpyl ester	
2	28.159	256	1.86	Palmitic acid	
3	31.654	396	3.99	Fumaric acid, 4-heptyl tridecyl ester	
4	35.472	340	2.08	Phenol,2,2'-methylenebis[6-methoxy-3-(2-propenyl)]	
5	38.141	226	1.60	Z-11-Pentadecenol	
6	38.233	414	1.45	Stigmast-7-en-3-ol, (3.beta.,5.alpha.,24S)	
7	38.315	535	0.55	d-Allylglycine,n-heptafluorobutyryl-,hexadecyl ester	
8	38.393	281	1.88	Purine-2,6-dione,8-(3-ethoxypropylamino)-1,3-dimethyl-3,9-dihydro-	
9	38.461	534	0.88	Triacontyl trifluoroacetate	
10	38.493	564	0.90	Stearic acid, eicosyl ester	
11	38.547	387	3.41	1H-Indole-2-carboxylic acid, 3-methyl-4-oxo-6-(3,4,5-trimethoxyphenyl)-4,5,6,7-tetrahydro-, ethyl ester	
12	38.660	587	0.80	9-Octadecenoic acid (Z)-, 2-(octadecyloxy)ethyl ester	
13	38.687	671	2.91	Pregnan-20-one, 3,17,21-tris[(trimethylsilyl)oxy]-, O-(phenylmethyl)oxime, (3.alpha.,5.beta.)	
14	38.780	496	0.86	1,3,5-Triazine,2,4-bis(2,2,2-trifluoro-1-trifluoromethylethoxy)-6-(1-piperidyl)	
15	38.843	564	2.84	L-Cystine,N,N'-bis[(phenylmethoxy)carbonyl]-, diethyl ester	
16	38.913	578	1.58	Lead[II] bis(O,O'-diethyldithiophosphate)	

Table 5 continued...

Table 5 continued...

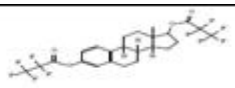
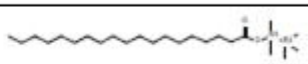
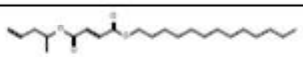
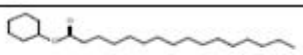
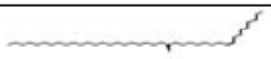
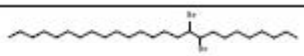
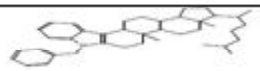
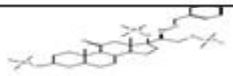
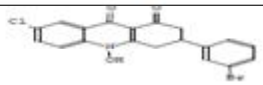
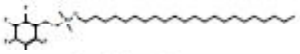
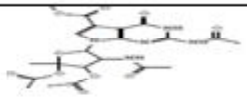
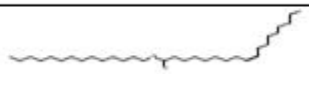
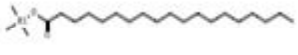
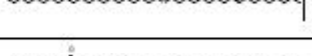
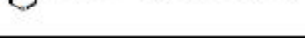
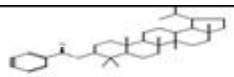
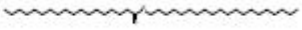
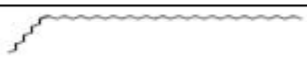
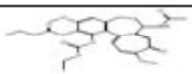
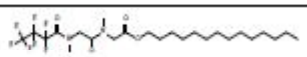
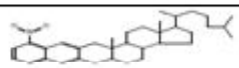
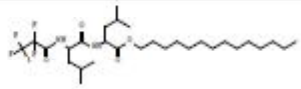
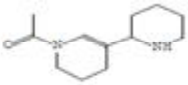
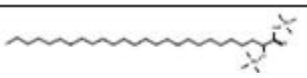
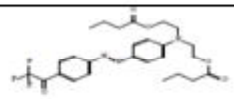
17	38.940	564	1.21	beta.-Estradiol, bis(pentafluoropropionate)	
18	39.000	428	2.43	n-Nonadecanoic acid, pentamethyldisilyl ester	
19	39.034	366	1.12	Fumaric acid, pent-4-en-2-yl tridecyl ester	
20	39.100	222	4.04	Propanenitrile,3-(5-diethylamino-1-methyl-3-pentynyloxy)	
21	39.153	338	1.13	Hexadecanoic acid, cyclohexyl ester	
22	39.180	578	2.37	Octasiloxane,1,1,3,3,5,5,7,7,9,9,11,11,13,13,15,15-hexadecamethyl	
23	39.238	578	1.84	9-Octadecenoic acid (Z)-, 2-(octadecyloxy)ethyl ester	
24	39.327	508	6.21	9,10-Dibromopentacosane	
25	39.422	549	1.14	1'H-Cholest-3-eno[3,4-b]indole, 1'-(phenylmethyl)-, (5.alpha.)	
26	39.453	685	2.52	3,17,21-Tris[(trimethylsilyl)oxy]	
27	39.573	417	2.20	3-(3-Bromophenyl)-7-chloro-10-hydroxy-3,4-dihydro-1,	
28	39.607	222	1.02	2,3,5,5,8a-Pentamethyl-6,7,8,8a-tetrahydro-5H-chromen-8-ol	
29	39.647	580	3.37	Silane, dimethyl(pentafluorobenzyloxy)docosyloxy-	
30	39.740	507	3.67	Methyl 2-acetylamino-3,4-dihydro-4-oxo-7-(2-acetylamino-2-deoxy-3,4-diacetyl-.beta.-arabinofuranosyl)-7H-pyrrolo[2,3-d]pyrimidine-5-carb	
31	39.844	280	2.81	2-Myristynoyl-glycinamide	
32	39.900	478	2.49	9-Octadecenoic acid (Z)-, tetradecyl ester	
33	39.947	394	1.68	Fumaric acid, 2,2-dichloroethyl tridecyl ester	
34	40.020	370	3.51	Nonadecanoic acid, trimethylsilyl ester	
35	40.073	564	1.59	9-Octadecene, 1-[2-(octadecyloxy)ethoxy	
36	40.101	401	1.07	Picolinyl 5-eicosenoate	

Table 5 continued...

Table 5 continued...

37	40.140	532	1.89	Lupan-3-ol, benzoate	
38	40.180	424	1.97	Stearic acid, decyl ester	
39	40.220	564	1.11	Stearic acid, eicosyl ester	
40	40.254	578	1.45	Propane, 1-(9-octadecenyloxy)-3-(octadecyloxy)-, (Z)	
41	40.280	515	1.11	1,2-Diethoxycarbonyl-dedimethylcolchicine	
42	40.307	578	1.01	Propane, 1-(9-octadecenyloxy)-3-(octadecyloxy)-, (Z)	
43	40.339	552	1.47	Sarcosylsarcosine, n-heptafluorobutyryl-, tetradecyl ester	
44	40.386	530	4.00	1,37-Octatriacontadiene	
45	40.480	515	0.82	Cholest-2-eno[3,2-b]naphthalene, 5'-nitro	
46	40.528	586	2.30	l-Leucyl-l-leucine, n-pentafluoropropionyl-, tetradecyl ester	
47	40.627	208	1.30	Pyridine, 1-acetyl-1,2,3,4-tetrahydro-5-(2-piperidinyl)	
48	40.653	565	0.59	Hexacosanoic acid, 2-[(trimethylsilyl)oxy]-, trimethylsilyl ester	
49	40.790	521	2.34	Butyric acid, 2-{(2-butyryloxy-ethyl)-[4-(4-trifluoroacetyl-phenylazo)-phenyl]-amino}-ethyl ester	

RT: Retention time; Mw: Molecular weight.

4. Conclusion

It was concluded from the current study that harvesting the wild cress plant at the beginning of the month of March in the plains areas of the Shatt al-Arab district, east of Basra, southern Iraq, leads to obtaining a good quality foliar crop. The wild cress leaf extract contained a large number of important bioactive compounds. Some of these important compounds were diagnosed which contained important organic, fatty and amino acids and nitrogenous bases.

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