Novelty Journals

ISSN 2394-9651

International Journal of Novel Research in Physics Chemistry & Mathematics
Vol. 5, Issue 1, pp: (24-31), Month: January - April 2018, Available at: www.noveltyjournals.com

Chemical Composition of Essential Oils Extracted From Leaves of Taion Plant (Inula Viscosa L.) From Two Different Regions of Lattakia – Syria

[1]Dr. Emad Hwija, [2]Dr. Yaseer Mossa, [3]Mohannad Hasan

[1]Prof; Department of Chemistry, Faculty of Sciences, Tishreen University, Lattakia, Syria
[2]Prof. Ass; Department of Chemistry, Faculty of Sciences, Tishreen University, Lattakia, Syria
[3]Postgraduate Student (Master Degree), Department of Chemistry, Faculty of Sciences, Tishreen University, Lattakia, Syria

Abstract: **Leaves of Inula viscosa (L.) plant (Inula genus, Asteraceae family), locally known as Taion, was collected from two different regions of Lattakia: the Jubt Barghal region (a mountainous area), the Qaya region (a coastal area), and the essential oil was extracted by Hydrodistillation using the Cleveger apparatus, where the weight percentage of essential oil stood at (0.672%, 0.530%) for both mountainous and coastal region, respectively. The Chemical composition of essential oil obtained from flowers of Inula viscosa (L.) was analyzed by GC/MS.**

The essential oil of the mountainous area contained 55 components, which were identified, that accounting for (99.76%) of total essential oil. The main components were:

11-hydroxy-Eremophyl-6(7),9(10)-dien-8-one (30.11 %), Veridiflorol (9.30 %), Cedr-8-en-13-ol (7.44 %) , (-)-Caryophyllene oxide (4.87 %), β-Selinene (4.46 %) , Terpineol (2.66%), β-Bisabolene (2.53 %).

The essential oil of the coastal region contained 42 components, which were identified, that accounting for (99.77%) of total essential oil. The main components were:

Hexachloro-1,3-Butadiene (11.75%) , Terpineol (10.19%) , Linalool L (9.67%) , Benzophenone (5.70%) , beta.-Damascenone (4.44%), (-)-Caryophyllene oxide (3.24%) .

Keywords: **Tion plant, Inula viscosa (L.), Asteraceae family, hydrodistillation, GC-MS.**

I. INTRODUCTION

In the quest for new therapeutics, plants were and still are considered as one of the main sources of biologically active materials[1]. Inula viscosa (L.) Aiton (Compositae) (common local name: Taioon) is a perennial plant distributed in different regions of the Mediterranean Basin[2]. In traditional medicine, Inula viscose has many uses, including anti-inflammatory [3, 4], anthelmintic, antipyretic, antiseptic, antitumoral [5, 6] and antiphlogistic activity [7], in addition to treating gastro duodenal and lung disorders [8, 9].

Crude extracts prepared from different parts of Inula viscose exhibit antioxidant[10], antiulcerogenic[11] and anthelmintic[12] properties and prevent zygote implantation[13].

Aqueous extracts of Inula viscose (L.) are shown to exhibit antifungal activity in vitro[14-16], and organic solvent extracts are shown to be antibacterial[17]. Cohen et al. provides evidence for the antifungal activity of extracts made with organic solvents, including methanol, ethanol, ethyl acetate, acetone, chloroform, and n-hexane [18].

This plant is distributed in several areas of Syria and contains some pharmacologically active compounds, including flavonoids and terpenoids [4]. The volatile constituents of the roots and the aerial parts of this plant have been previously reported from different countries[19-23].

Taking into account the use of Inula viscose in traditional medicine, its wide distribution, and the difference in chemical composition of essential oil depending on regions, the present study is undertaken to report the GC/MS analyses of the oil extracted from the Leaves of the Syrian species Inula viscosa (L.) growing in Lattakia, which has not been reported previously.

II. EXPERIMENTAL

2.1. Plant material

The leaves of wild inula viscosa (L.) were collected in October 2016 from two different regions of lattakia:

Jubt Barghal area, a mountainous area located at an altitude of about 900 m from the sea level

Qaya area, a coastal area located at sea level.

The plant samples were dried in the shadow for some weeks, then well grinded and kept in plastic bags emptied from the air to be ready for the extraction stage.

The samples were placed in the Chemistry Department, Faculty of Science, Tishreen University, Syria

2.2. Isolation of the essential oil:

The samples of leaves (130 g) were hydro distilled for 6 hours using modified Clevenger-type apparatus. The oils obtained were recovered with hexane, dried over anhydrous sodium sulfate, concentrated with nitrogen and stored at -4 Co until analysis by gas Chromatography/Mass spectrometry (GC/MS).

The weight of oil obtained from plant leaf samples was 0.873 g, 0.715 g for the mountainous and coastal region, respectively.

2.3. GC-MS analysis:

Quantitative analysis was carried out using a Agilent-7890A gas chromatograph equipped with Capillary column : HP-5MS 30 m × 250 µm , 0.25 µm film thickness phass of 5% phenyl methyl silox . The amounting injected was 1 µl .Carrier gas helium 1 ml/min constant flow; split ratio 10:1. Oven temperature program: 2.5 min at 40 ℃ , then 4 ℃/min to 200 ℃ , then 35 ℃/min to 250 ℃ , with hold 1 min at 250 ℃ . Temperature of the injector and detector were maintained at 250 ℃ , 280 ℃ , respectively .

Mass spectra were acquisition at 70 ev in scan mode from 20 to 650 u.m.a; source 230 ℃ , quadrup 150 ℃ .

Then the components of the essential oils were identified by comparing the resulting mass spectra for each peak of Chromatogram (GC-MS) with the mass spectra found in the libraries available in the machine computer. The resulting Chromatograms were shown in Fig.1 and Fig.2.

III. RESULTS AND DISCUSSION

The hydro distillation of the Inula viscosa leaves yielded yellow- colored essential oils(0.671% , 0.55%) for the mountainous and coastal regions ,respectively.

The obtained oil was analyzed by GC/MS , the chromatogram of essential oils of leaves for mountainous and coastal regions shown in figure 1 and figure 2, respectively.

Novelty Journals

ISSN 2394-9651

International Journal of Novel Research in Physics Chemistry & Mathematics
Vol. 5, Issue 1, pp: (24-31), Month: January - April 2018, Available at: www.noveltyjournals.com

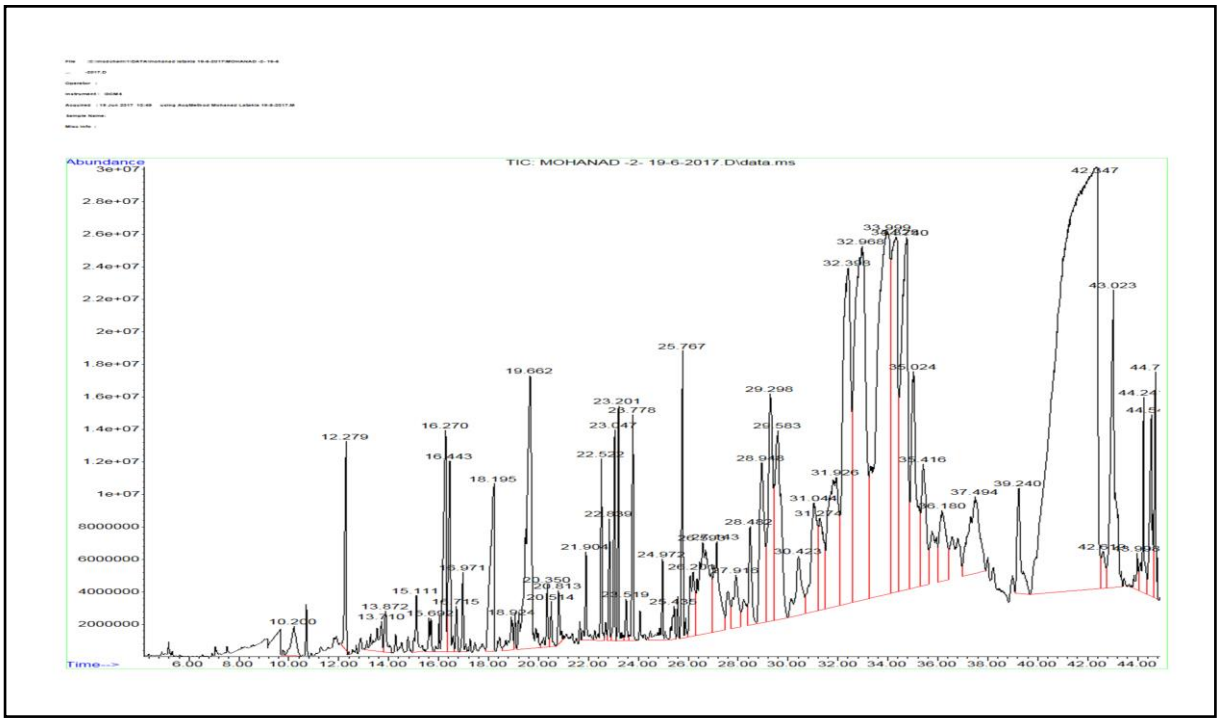

Fig.1: GC/MS chromatogram of the essential oil extracted from the inula viscose (l.) leaves for mountainous area

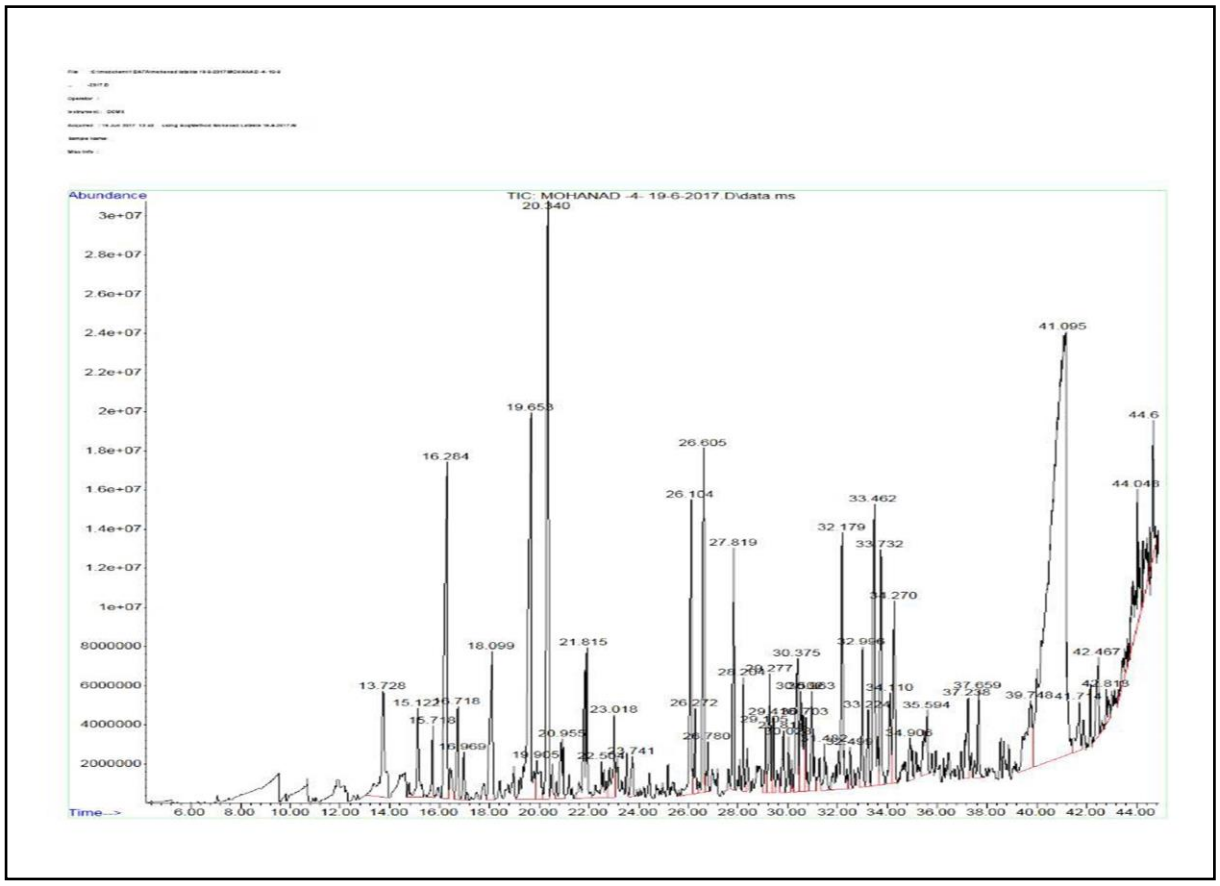

Fig.2: GC/MS chromatogram of the essential oil extracted from the inula viscose (l.) leaves for coastal area.

Fifty five and Forty two components, representing 100 % and 99.99 % of the peak area of the oil extracted from plant leaves for the mountainous and coastal region, respectively, were identified and listed in Table1 and Table2.

Novelty Journals

ISSN 2394-9651

International Journal of Novel Research in Physics Chemistry & Mathematics
Vol. 5, Issue 1, pp: (24-31), Month: January - April 2018, Available at: www.noveltyjournals.com

Table 1: chemical composition (%) of essential oil of inula viscosa (L.) leaves for a mountainous area.

PK	RT	Compound	Area Pct%
1	10.2015	Tetrahydropyran-3-one	0.29
2	12.2789	n-Decane	0.63
3	13.7113	Hexanoic acid	0.32
4	13.8742	2(3H)-Furanone, 5-ethenyldihydro-5-methyl-	0.19
5	15.1097	Linalool oxide	0.23
6	15.6935	cis-Linaloloxide	0.15
7	16.2706	(+-)-Linalool	1.21
8	16.4403	(E)-6-Methyl-3,5-heptadien-2-one	0.77
9	16.7186	Benzeneethanol	0.14
10	16.9698	α-Isophorone	0.22
11	18.1917	3-Methyl-4-propyl-2,5-furandione	1.20
12	18.9249	2-Isopropylidene-3-methylhexa-3,5-dienal	0.21
13	19.6649	Terpineol	2.66
14	20.3505	(E)-4,4-Dimethyl-2-pentene	0.20
15	20.5135	β-Cyclocitral	0.12
16	20.8122	(+)-2-CARENE	0.18
17	21.9051	2,4,4-trimethyl-3-(3'-oxo-1'-butyl-)-2-cyclohexen-1-yl acetate	0.26
18	22.5229	vitispirane	0.48
19	22.842	2-Amino-5-methyl-3,5,6,8-tetrahydropyrido[2,3-d]pyrimidin-4,7-dione	0.28
20	23.0456	Edulan I, dihydro-	0.54
21	23.2018	2,6,10,10-Tetramethyl-1-oxa-spiro[4.5]dec-6-ene	0.54
22	23.5208	6-Ethoxy-2-pyridinamine	0.12
23	23.7788	Theaspirane A	0.60
24	24.9736	Naphthalene, 1,2-dihydro-1,1,6-trimethyl-	0.30
25	25.4352	(+)-Cyclosativene	0.16
26	25.7679	α-Copaene	0.78
27	26.2023	β-Damascenone	0.57
28	26.5961	Isoaromadendrene epoxide	1.77
29	27.146	trans-Caryophyllene	0.95
30	27.9131	(-)-Alloaromadendrene	0.50
31	28.4833	(-)-Alloaromadendrene	0.53
32	28.9517	Homoadamantane	1.41
33	29.298	α-Patchoulene	2.02
34	29.5831	1-Methyl-3-isopropylindole	2.14
35	30.4249	γ-Cadinene	0.70
36	31.0426	α-Calacorene	1.31
37	31.2735	4,8,11,11-Tetramethyl-8-tricyclo[7.2.0.0(2,5).]undecen-4-ol	0.93
38	31.9252	β-Bisabolene	2.53
39	32.4004	(-)-Caryophyllene oxide	4.87
40	32.9706	Cedr-8-en-13-ol	7.44
41	33.9957	Veridiflorol	9.30
42	34.3216	Cycloheptene, 5-ethylidene-1-methyl-	4.05
43	34.7424	β-Selinene	4.46
44	35.0208	1-[(1E)-1-Propenyl]-3-propyladamantane	2.18
45	35.4145	Alloaromadendrene oxide-(1)	1.11
46	36.1816	4,6-Dimethybicyclo[5.3.0]dec-5-en-10-ol	0.93
47	37.4918	(+)-β-COSTOL	1.54
48	39.2433	2-Undecanone, 6,10-dimethyl-	0.77
49	42.3457	11-Hydroxy-Eremophyl-6(7),9(10)-dien-8-one	30.11
50	42.6173	10-epi-Italicene - ether	0.26
51	43.0246	Hexadecanoic acid	2.36
52	43.9954	Longifolenaldehyde	0.15
53	44.2398	2-Hexadecen-1-ol, 3,7,11,15-tetramethyl-, [R-[R*,R*-(E)]]-	0.56
54	44.5452	1,2-Epoxy-1-vinylcyclododecene	0.87
55	44.7082	n-Docosane	0.66

Table 2: chemical composition (%) of essential oil of inula viscosa (l.) leaves for a coastal area.

PK	RT	Compounds	Area Pct
1	13.7316	Benzenemethanol	1.88
2	15.1233	Linalool oxide	1.19
3	15.7207	Linalool oxide trans	0.97
4	16.3045	β-Linalool	9.67
5	16.4335	2,6-Dimethylcyclohexanol	0.65
6	16.7254	Benzeneethanol	1.46
7	16.9698	α-Isophorone	0.63
8	18.1239	Methyl sorbate	4.13
9	19.6717	Terpineol	10.19
10	20.3573	Hexachloro-1,3-Butadiene	11.75
11	20.8801	cis-Geraniol	1.00
12	21.8237	trans-Geraniol	1.87
13	21.9119	alpha.-Ionone	1.66
14	23.0185	Edulan I, dihydro-	0.63
15	26.1141	.beta.-Damascenone	4.44
16	26.2702	Ionene	1.09
17	26.6097	Pterin	5.09
18	26.7862	Pentamethylcyclopentadiene	0.6
19	27.8316	(5R)-5-Ethyl-2-methylteneetyrahydrpyran	3.84
20	28.205	11.alpha.-Methoxy-8-methyl-(1H.beta.,6H.beta.)-bicyclo[4.4.1]undeca-2,4,8-triene	1.21
21	28.3747	Hydroxydihydroedulan	0.64
22	29.1079	Dimethyl - (methylpropenyl) - cyclohexenone	0.63
23	29.2844	3-Buten-2-one, 4-(2,2,6-trimethyl-7-oxabicyclo[4.1.0]hept-1-yl)-	1.48
24	29.4202	3-ethyl-4-methyl-5-(methylthio)isothiazole	0.85
25	29.8207	1-Oxaspiro[4.5]decan-2-one	1.21
26	30.0311	Butylated Hydroxytoluene	0.84
27	30.3977	Cyclohexanecarboxylic acid, 3-fluorophenyl ester	3.02
28	30.4995	3-(2'-Thiophenyl)propyn-1-ol	1.04
29	30.968	.alpha.-Copaen-11-ol	1.37
30	32.1831	(-)-Caryophyllene oxide	3.24
31	32.5022	Ethyl phthalate	0.70
32	32.9978	13-nor-Eudesm-4(14)-en-11-one	1.88
33	33.2286	1-Cycloheptene, 1,4-dimethyl-3-(2-methyl-1-propene-1-yl)-4-vinyl-	1.35
34	33.473	Benzophenone	5.70
35	33.7377	5-.alpha.-Hydroxycaryophylla-4(12),8(13)-diene	2.89
36	34.1111	beta.-Eudesmol	1.03
37	34.274	1.beta.,4.beta.H,10.beta.H-Guaia-5,11-diene	3.54
38	37.2475	1,5-Dimethyltricyclo[3.3.0.0(2,6)]octane	0.80
39	37.6616	Citronella	1.24
40	42.1624	Dibutyl phthalate	0.66
41	44.0429	tert-Butyl 8-Methyl-10-azabicyclo[4.3.1]deca-3,7-diene-10-carboxylate	0.61
42	44.6471	n-Docosane	1.10

As noticed in Table3, the oil components of leaves can be classified into 8 different groups depending on their chemical composition.

Table 3: the main chemical groups in the essential oil extracted from inula viscosa (l.) leaves for a mountainous and coastal area

Classification	Area % Joubt Bourghal	Area % Qaya
Hydrocarbons	5.08	1.70
Oxygenated Monoterpenes	8.13	36.82

Hydrocarbon Monoterpenes	4.53	1.89
Oxygenated Sesquiterpenes	57.48	10.41
Hydrocarbon Sesquiterpenes	13.94	4.89
Nitrogenated & Sulfated Compound	2.54	5.70
Oxygenated Compound	4.82	16.21
Carboxylic Acids & Esters	2.68	8.51
Other	0.56	13.64

The essential oils of leaves Inula viscosa for mountainous area characterized by high content of Oxygenated Sesquiterpenes (57.48%), with 11-hydroxy-Eremophyl-6(7),9(10)-dien-8-one (30.11%), Veridiflorol (9.30%), Cedr-8-en-13-ol (7.44%), (-)-Caryophyllene oxide (4.87%), as the main components , followed by Hydrocarbon Sesquiterpenes (13.94%) , with β-Selinene (4.46%) , β-Bisabolene (2.53%) , as the main components , followed by Oxygenated Monoterpenes (8.13%), with Terpineol (2.66%), as the main component .

The essential oils of Inula viscosa (L.) leaves for coastal area characterized by high content of Oxygenated Monoterpenes (36.82%) , with Terpineol (10.19%) , Linalool L (9.67%) , beta.-Damascenone (4.44%) as the main components , followed by Oxygenated Compound (16.21%) , with Benzophenone (5.70%) as the main component , followed by Oxygenated Sesquiterpenes (10.41%) , with (-)-Caryophyllene oxide (3.24%) , as the main component . In addition to the above found another compound as a major compound is : Hexachloro-1,3-Butadiene (11.75%)

Similar studies were carried out on the same plant in each Italy, Turkey ,France, Jordan and Algeria the major compounds of the essential oil of Inula vicosa as well as from Syria are shown in table 4.

Table 4: major components of essential oils of inula viscosa obtained from different locations.

No	Compounds	Area% (Syria-Joubt Bourghal)	Area% (Syria-Qaya)	Area% (Italy) [19]	Area% (Turkey) [20]	Area% (France) [21]	Area% (Jordan) [22]	Area% (Algeria) [23]
1	11-Hydroxy-Eremophyl-6(7),9(10)-Dien-8-one	30.11	-----	-----	-----	-----	-----	-----
2	Veridiflorol	9.30	-----	2.2	-----	-----	-----	0.2
3	Cedr-8-en-13-ol	7.44	-----	2.1	-----	-----	-----	-----
4	(-)-Caryophyllene oxide	4.87	3.24	8	1.5	2.5	2.57	5.5
5	.beta.-Selinene	4.46	-----	-----	0.2	0.2	0.47	0.1
6	Cycloheptene, 5-ethylidene-1-methyl-	4.05	-----	-----	-----	-----	-----	-----
7	Hexachloro-1,3-Butadiene	-----	11.75	-----	-----	-----	-----	-----
8	Terpineol	2.66	10.19	-----	0.1	0.8	1.06	-----
9	Linalool L	1.21	9.67	-----	0.2	1	0.44	-----
10	Benzophenone	-----	5.70	----	----	----	----	-----
11	Pterin	-----	5.09	----	----	----	----	-----
12	.beta.-Damascenone	0.57	4.44	----	0.2	----	----	----
13	Methyl sorbate	-----	4.13	----	----	----	----	----
14	12-Carboxyeudesma-3,11(13)diene	-----	-----	-----	-----	-----	-----	-----
15	(E)-Nerolidol	-----	-----	1.9	1.5	8.6	19.75	25.3
16	Eucalyptol	-----	-----	----	----	----	----	----
17	Ethyl palmitate	-----	-----	----	----	----	----	----
18	Globulol	-----	-----	16.8	----	----	1.79	----
19	Valerianol	-----	-----	12	----	----	----	----
20	Eudesma-6-en-4α-ol	-----	-----	----	----	6.2	5.64	----
21	Borneol	-----	-----	----	25.2	----	----	1.6
22	Bornyl acetate	-----	-----	----	19.5	----	----	0.9

23	Fokienol	-----	-----	----	----	21.1	20.87	4.4
24	neo-Intermedeol	-----	-----	----	----	----	----	6.4
25	Isocostic acid	-----	-----	----	----	----	----	10.1
26	Costic acid	-----	-----	---	---	---	---	8

The main constituents of the Inula vicosa essential oil vary depending on regions, these constituents are known for some countries, for example the essential oil from Italy[20] has: (16.8%) Globulol, (12.0%) Valerianol and (8.0%) Caryophyllene oxide , in Turkey[21]: (25.2%) Borneol, (19.5%) Bornyl acetate, in France[22] : (21.1%) Fokienol, (8.6%) (E)- Nerolidol and (6.2%) Eudesm-6-en-4α-ol, in Jordan[23]: (20.87 %) Fokienol , (19.75 %) (E)-Nerolidol and (5.64 %) Eudesma-6-en-4α-ol , and in Algeria[24]: (25.3 %) (E)- Nerolidol , (10.1%) Isocostic acid , (8 %) Costic acid and (6.4 %) neo-Intermedeol.

IV. CONCLUSIONS

In conclusion, the major constituents of essential oils of Inula viscosa leaves from study regions are different, where the major constituent from Joubt Bourghal region is oxygenated sesquiterpenes (11-Hydroxy-Eremophyl-6(7),9(10)-Dien-8-one , Veridiflorol) ,while the major constituent from qaya is oxygenated monoterpenes (Terpineol , Linalool L), In addition, another compound is found as a main compound is: Hexachloro-1,3-Butadiene (11.7506 %) . This contrasts with the composition reported for Inula viscosa (L.) oil from other countries; which may be explained by the influence of the soil nature and of the environment.

ACKNOWLEDGEMENTS

I would like express my sincere gratitude to my supervisor Dr.Emad Hwija and Dr.YaseerMossa Department of Chemistry, Tishreen University, Syria, for stimulating my interest in my work and for the fruitful discussions.

REFERENCES

[1] Krvavych AS, Konechna RT, Petrina RO, Kyrka MS, Zayarnuk NL, Gulko RM, Stadnytska NE, and Novikov VP. Phytochemical research of plant extracts and uses in vitro culture in order to preserve rare wild species Gladiolus imbricatus. RJPBCS 2014; 5(1): 240-246.

[2] De Laurentis N, Losacco V, Milillo M,Lai O. Chemical investigations of volatile constituents of Inulaviscosa (L.) Aiton (Asteraceae) from different areas ofApulia, Southern Italy. Delpinoa 2002; 44:115-119.

[3] Belayachi L, Aceves-Luquero C, Merghoub N,Bakri Y, Fernández de Mattos S, Amzazi Sand Villalonga P. Screening of North African Medicinal Plant Extracts for Cytotoxic Activity Against Tumor Cell Lines. European Journal of Medicinal Plants 2013; 3(3):310-332.

[4] Amin S, Kaloo ZA, Singh S, and Altaf T. Medicinal importance of genus inula- a review. IJCRR 2013; 5(2):20-26.

[5] Merghoub N, Benbacer L, Amzazi S, Morjani H, and El Mzibri M. Cytotoxic effect of some Moroccan medicinal plant extracts on human cervical cell lines. Journal of Medicinal Plants Research 2009; 3:1045–1050.

[6] Benbacer L, Merghoub N, ElBtaouri H, Gmouh S, Attaleb M, Morjani H, Amzazi S,and El Mzibri M. Antiproliferative Effect and Induction of Apoptosis by Inula viscosa L. and Retamamonosperma L. Extracts in Human Cervical Cancer Cells. Topics on Cervical Cancer with an Advocacy for Prevention, Dr. R. Rajamanickam (Ed.) 2012, ISBN: 978-953-51-0183-3.

[7] Lauro L, and Rolih C. Observations and research on an extract of Inula viscose Ait. Boll. Soc. Ital. Biol.Sper.1990; 66:829–834.

[8] Çelik TA and Aslantürk OS. Evaluation of Cytotoxicity and Genotoxicity of Inula viscosa Leaf Extracts with Allium Test. Journal of Biomedicine and Biotechnology 2010; 2010:8.

[9] Al-Qura'n S. Ethnopharmacological survey of wild medicinal plants in Showbak, Jordan. J. Ethnpharmacol.2009; 123:45–50.

[10] Ortal D, Hugo E, Gottlieb SH, and Grossman MB. Antioxidant activity of 1, 3-dicaffeoylquinic acid isolated from Inula viscosa, Food Research International 2009; 42:1273.

[11] Alkofahi A, and Atta A. Pharmacological screening of the anti-ulcerogenic effects of some Jordanian medicinal plants in rats. J. Ethnopharmacol. 1999; 67:341–345.

[12] Oka Y, Ben-Daniel B, and Cohen Y. Nematicidal activity of powder and extracts of Inula viscosa. Nematology 2001; 3:735–742.

[13] Issa D. Studies toward isolation andidentification of bioactive substances from medicinal plants. Degree of Master of Science in Chemistry, Faculty of Graduate Studies, an- Najah National University, Palestine2011.

[14] Al-Dissi N, Salhab A, and Al-Hajj H. Effects of Inulaviscosa leaf extracts on abortion and implantation in rats. J. Ethnopharmacol. 2001; 77:117–121.

[15] Nawafleh E, Irshedat M, Bataineh T, Muhaidat R, Al-Qudah M, and Alomary A. The Effects of Inula viscosa Extract on Corrosion of Copper in NaOH Solution. Res. J. Chem. Sci. Vol. 2012; 2(9):37-41.

[16] Cafarchia, C, De-Laurentis N, Milillo MA, Losacco V and Puccini V. Antifungal activity of essential oils from leaves and flower of Inula viscosa (Asteraceae) by Apulian region. Parasitologia 2002; 44:153-156.

[17] Ravi Kant U, Pratibha D, and Shoeb A. Screening of Antibacterial Activity of Six Plant Essential Oils against Pathogenic Bacterial Strains. Asian Journal of Medical Sciences 2010; 2(3):152-158.

[18] Debat J. Inula extract, its method of preparation and its use as pharmaceutical. US Patent 1981; 4,254,112.

[19] Marongiu,B.; Pairas,A.; Pani,F.; Porcedda,S.; Ballero,M. Extraction, Separation and isolation of essential oils from natural matrices by supercritical CO2. flavor Fragr.J.18, 2003,505-509.

[20] Perez-Alonso,M.J.; Velasco-Negueruela,A.; Emin-Duru,M.; Garcia Vallejo,M.C. Composition of the volatile oil from the Aerial parts of Inula viscosa (L.) Aiton.FlavourFragr.J.11, 1996,349-351.

[21] BLANC,M.C.; BRADESI,P.; GONCALVES,M.J.; SALGUEIRO,L.; CASANOVA,J. Essential oil of Dittricha viscosa ssp. Viscosa: analysis by 13C-NMR and antimicrobial activity.Flavour and Fragrance Journal.21, 2006,324-332.

[22] AL-Qudah,M.A.; AL-Jaber,H.I.; Mayyas,A.S.; Abu-Orabi,S.I.; Abu-Zarga,M.H. Chemical compositions of the Essential oil from the Jordanian Medicinal plant Dittrichia viscosa. Jordan Journal of Chemistry.VOL.5,No.4, 2010,pp.343-348.

[23] Haoui,I.E.; Derriche,R.; Madani,L.; Oukali,Z. Analysis of the Chemical composition of essential oil from Algerian Inula viscosa (L.) Aiton. Arabian Journal of Chemistry.Vol.8,No.4, 2015,pp.587-590.