

Chemical Composition of Essential Oil and Screening of Antiproliferative Activity of *Paronychia argentea* Lam. Aerial Parts: an Ethno-Medicinal Plant from Jordan

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ABSTRACT

Background & Aim: in the present study, composition of the volatile (essential) oil hydrodistilled from flowering tops of *Paronychia argentea* Lam. (Caryophyllaceae) grown in Jordan was examined. **Methods:** Analyses were performed by means of GC and GC-MS. *In-vitro* cytotoxicity of the aqueous and alcohol extracts of the plant aerial parts was screened against different cell lines; human breast adenocarcinoma (MCF-7), colorectal adenocarcinoma (Caco-2), pancreatic carcinoma (Panc-1) as well as normal fibroblast cells. **Results:** Forty-one components were identified in the essential oil from flowering tops of *P. argentea*. The oil was found to be very rich in sesquiterpenes (60.96%), while, 6,10,14-trimethyl-2-pentadecanone (16.14%), a non-terpenoidal ketone, was identified as principal component of the oil. Other major identified components included *o*-cymene (7.51%), *allo*-aromadendrene epoxide (6.99%), isolongifolan-7-a-ol (5.19%), 9-*epi*-E-caryophyllene (4.89%), and isobicyclogermacrene (4.33%). **Conclusion:** Hydrodistillation of *P. argentea* EO revealed its richness in sesquiterpenes, while the cytotoxicity assays of the plant extracts failed to conclude any antiproliferative activity against the tested cancer cell lines over the investigated concentration range.

Keywords: *Paronychia argentea*, essential oil, *in-vitro* cytotoxicity, MCF-7, Caco-2, Panc-1, Jordan, 6,10,14-trimethyl-2-pentadecanone.

INTRODUCTION

Jordan's flora plays a key role in health maintenance and is widely utilized in the treatment of different ailments. Complementary and alternative medicine (CAM) usage among Jordanian patients with cancer is estimated to be as high as 50%, and traditional herbal medicine occupies the principal CAM modality used¹⁻². It is believed that the accessibility of herbal remedies alongside with their safety, lower cost and symptoms relieving effects encourage their usage by patients¹. Recently, a wide variety of different

medicinal plants grown in Jordan have been screened for their cytotoxic activities using different cancer cell lines, nevertheless, many others still need to be evaluated².

Paronychia argentea Lam. (Caryophyllaceae) is one of the widely distributed medicinal plants in Jordan. The plant, commonly known as 'Whitlow Wort' in English or 'Rejel Alhamama' in Arabic, is considered an herbaceous plant that can be encountered all around the Mediterranean Sea. It is a perennial, hairy plant with branching stems³. *P. argentea* has been traditionally used for many illnesses. A decoction of aerial parts claimed to control diabetes⁴, treat urinary tract infections (UTI) and kidney stones^{5,6}, and prostate disorders⁷. Studies on ethanol extract of *P. argentea*

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Received on 24/3/2019 and Accepted for Publication on 29/11/2019.

aerial parts reported the presence of major flavonoids⁵, flavonol glycosides⁷ and oleanane saponins⁵. With regard to biological activities, many recent efforts have been made to investigate the claimed efficacy of *P. argentea* in traditional medicine. Jordanian species of *P. argentea* were shown to have significant α -amylase inhibitory activity³. A dose dependent inhibition of pancreatic lipase was observed as described by Bustanji *et al.*⁸ Also, studies carried out in Jordan showed that *P. argentea* aqueous extract in doses of ≥ 250 mg/kg of body weight decreased significantly the plasma sugar increments 90 minutes after glucose loading in normal rats⁴ and revealed that the plant ethanol extract could modulate the *in-vitro* pancreatic insulin secretion⁹. A flavonoids-rich crude extract has been reported to possess high anti-microbial activity against *Bacillus subtilis*¹⁰ and to induce moderate cytotoxicity against some clinical isolates of *H. pylori*¹¹. Saponins-rich extracts have showed a synergistic interaction with conventional antibiotics with remarkable antioxidant and antimicrobial activities¹². Butanol extract of the plant aerial parts has, moreover, been reported to prevent the growth of urinary stones in experimental rats¹³.

On the other hand, despite that *P. argentea* is a well-known medicinal plant used in traditional medicine, little if any is known about its essential oil composition or its potential antiproliferative activity. This study reveals the chemical composition of the essential oil (EO) hydrodistilled from flowering tops of *P. argentea* grown wild in Jordan, analyzed by GC and GC-MS. Also, *in-vitro* cytotoxic activities, of the plant aqueous and ethanol extracts, against human breast adenocarcinoma (MCF-7), colorectal adenocarcinoma (Caco-2) and pancreatic carcinoma (Panc-1) cancer cell lines were also evaluated. To the best of our knowledge, this is the first report investigating the chemical composition of the essential oil from flowering tops of Jordanian *P. argentea* as well as screening the cytotoxic activity of the plant extracts.

2. Materials and Methods

2.1. Plant material

Approximately, 700 g of aerial parts of *P. argentea* were collected from north Amman in early summer time in May, 2016 [specimen ID: PA-Hudaib-MAY16-001]. Plant was set to air dry in a cool place for further study. Another sample of approximately 1 kg dried flowering tops of *P. argentea* was purchased from Amman of material claimed to be collected in late November, 2016 [specimen ID: PA-Hudaib-NOV16-002]. All samples were taxonomically identified by Professor Khaled Tawaha (School of Pharmacy, the University of Jordan). Voucher specimens have been deposited in the Department of Pharmaceutical Sciences, School of Pharmacy, The University of Jordan.

2.2. Crude plant extracts

Aqueous and ethanol extracts were prepared from the dried aerial parts by maceration. A powdered 100 g quantity was placed in round-bottomed flask and a 1 L volume of 70% ethanol (EtOH) was added (in ratio 1:10). The same previous step was repeated but using distilled water as the solvent this time. Flasks were kept in a cool place for one week. Then, filtrates were collected and solvents were evaporated to dryness using rotary evaporator at 40°C. The dried crude extracts were kept tightly closed in refrigerator for further study.

2.3. TLC

Qualitative chemical fingerprinting of the prepared crude extracts was performed by thin layer chromatography (TLC). TLC was performed on pre-coated TLC silica gel plates (Alugram sil G/UV 254, Machery-Nagel GmbH & Co., Germany), using different mobile phases. Detection of chemical constituents (classes) was conducted as reported by Wagner and Bladt¹⁴. TLC test was performed in duplicate.

2.4. Essential oil extraction

To obtain the EO, hydrodistillation was carried out using Clevenger type apparatus. 300 g of dried flowering tops of *P. argentea* was soaked in 2.5 L of distilled water, then hydrodistilled for 2 hours. The EO was then collected,

dried under anhydrous sodium sulphate, and kept in tightly closed vials at 4°C (refrigerator) until analysis. The procedure was replicated to prepare another oil sample from an additional 300 g dried plant material.

2.5. GC-MS analysis

An aliquot of each of the EO samples ($n = 2$), obtained as mentioned above, was dissolved in GC grade n-hexane and analyzed (in duplicate) using GC-MS. Approximately 1 μ L of diluted oil sample was injected directly into a Varian Chrompack CP-3800 GC/MS/MS-200 (Saturn, Netherlands) equipped with DB-5 (5% diphenyl, 95% dimethyl polysiloxane) capillary column (30 m length \times 0.25 mm ID, 0.25 μ m film thickness) and a split-splitless injector. The column temperature was kept isothermal at 60°C for 1 minute and programmed to increase up to 246°C at a rate of 3°C/minute, then kept isothermal at 246°C for 3 minutes. The injector temperature was kept at 250°C with a split ratio of 1:10. Helium was used as a carrier gas with a flow rate of 1 mL/minute. The MS ionization source temperature was 180°C with an ionization voltage of 70 eV.

2.6. GC-FID analysis

Quantitatively, the analysis was carried out using a Hewlett Packard HP-8590 gas chromatograph equipped with OPTIMA-5 (5% diphenyl 95% dimethyl polysiloxane) fused silica capillary column (30 m length \times 0.25 mm ID, 0.25 μ m film thickness). GC column was coupled to a split-splitless injector and flame-ionization detector (FID). The same temperature program was used as mentioned above in GC-MS analysis section. Injector temperature was maintained at 250°C with split ratio of 1:50 while FID temperature was held at 300°C. Assuming a unity response by all components, the percentage composition for each component was calculated using its corresponding normalized relative area obtained by FID. Analysis was performed in duplicate.

2.7. EO composition

Qualitative identification of essential components was performed by GC-MS using the built-in MS libraries (e.g.

NIST, Wiley, Terpenes, and Adams' libraries). MS spectrum matching and a comparison of the calculated arithmetic retention index (RI) of each identified component with literature reference value measured with a column of identical polarity (DB-5 equivalent) helped to make unambiguous identification¹⁵. RIs of oil components were calculated relative to n-alkane hydrocarbons (C₈-C₂₀) analyzed under the same conditions. The identified components were analyzed quantitatively as mentioned in the GC-FID section above.

2.8. In-vitro cytotoxicity

2.8.1. Cell Culture

Anti-proliferative activity was tested against three different adherent cancer cell lines; named MCF-7 (ATCC: HTB-22TM), Caco-2 (ATCC: HTB-37TM) and Panc-1 (ATCC: CRL-1469TM) cells. Normal periodontal fibroblast cell line (provided from school of dentistry, University of Jordan, Jordan) was used for testing selective toxicity of the different extracts and reference drugs. Cells were cultured in Dulbecco's Modified Eagle's Medium (DMEM, Caisson Laboratories Inc., USA), at 37°C. After they achieved approximately 80% confluent, cells were diluted with medium to give optimal plating densities determined by the supplier for each cell line before they plated in 96-well plates.

2.8.2. Extracts and reference drugs pretreatment for cytotoxicity assay

The aqueous and ethanol extracts of *P. argentea* were weighed accurately (10 mg each) and dissolved in 1 mL solvent. Solvents used were DMEM for AE and Dimethyl sulfoxide (DMSO, tissue culture grade, Merck-Schuchardt, Germany) for EE. Doxorubicin and Cisplatin (both Ebewe Pharma GMBH Nfg. KG, Austria) were used as positive control drugs for comparisons of anti-proliferative activity. Appropriate dilutions were made to obtain increasing concentrations of each extract and reference drugs. The concentration range tested for different extracts was (0.1 - 800 μ g/mL) and for positive controls was (0.1 - 200 μ g/mL).

2.8.3. Cytotoxicity assay

Plated cells were subjected to increasing concentrations of control drugs and extracts. For each test material; each concentration was added in three replicates, and the test was repeated three times independently. For EtOH extract, the different concentrations used contain no more than 2% of solvent DMSO. DMEM and 2% DMSO served as assay control while some empty wells were seeded with cells-free media to serve as blank. Plates were incubated for 72 hours as indicated in previous studies¹⁶. As the exposure time has finished, growth was analyzed using Tetrazolium reduction (MTT) assay as described by Riss¹⁷. Absorbance was read by multiwell plate reader (Bio-Tek Instrument, USA) at 570 nm using a reference wavelength of 630 nm.

2.8.4. IC₅₀ value calculation

Percent Cytotoxicity at each concentration was calculated from the optical density (OD) obtained by multiwell plate reader as described by equation 1 and 2, all data were blank adjusted prior to further interpretation. Equations obtained from the logarithmic plot of % cytotoxicity versus concentration ($\mu\text{g/mL}$) were used to calculate IC₅₀ as described by equation 3.

$$\% \text{ cells viability} = \text{mean OD of extract wells} / \text{mean OD of control wells} \times 100 \% \quad (1)$$

$$\% \text{ Cytotoxicity} = 1 - \% \text{ cells viability} \quad (2)$$

$$50 = \text{slope} \times \text{Ln IC}_{50} + \text{constant} \quad (3)$$

4. Results and discussion

4.1. TLC

TLC data revealed the presence of different secondary metabolites in the different extracts as shown in Table 1. Qualitative TLC chromatograms indicated the presence of flavonoids as the major constituents. To a lesser extent, coumarins and minor fractions of terpenoids were also detected only in the ethanol extracts. This agrees, however, with previous studies which have reported the presence of flavonoids in *P. argentea*⁵.

4.2 Oil composition

A representative GC-MS chromatogram of the EO

hydrodistilled from *P. argentea* is shown in Figure 1. While, Table 2 shows the identified components of the essential oil. The air-dried flowering tops of *P. argentea* gave a trace amount of a colorless oil (with less than 0.05 mL/g plant material) indicating the poor EO yield of the plant. Forty-one essential principles were recognized in the EO as analyzed by GC-MS (Figure 1). Generally speaking, the oil was shown to be rich in sesquiterpenes (60.96%), of which the majority being oxygenated (53.35%). The analysis showed that 6,10,14-trimethyl-2-pentadecanone, an aliphatic ketone, is the main component identified in *P. argentea* oil (16.14%). The other major identified compounds were: *o*-cymene (7.53%), *allo*-aromadendrene epoxide (6.99%), isolongifolan-7- α -ol (5.19%) and 9-*epi*-E-caryophyllene (4.89%). Noteworthy, monoterpenes and non-terpenoidal compounds were reported with comparable total percentages (19.72% and 19.31%, respectively). The major identified monoterpenes were *o*-cymene (7.53%), *trans*-dihydrocarvone (2.75%) and 1,8-cineole (2.1%). On the other hand, the mass spectra of some peaks spiking the underlying broadened unresolved band (Rt range ~ 34.2-37.5) suggested the presence of oxygenated sesquiterpenes, most possibly isospathulenol and spathulenol derivatives, as major constituents and referred to as unknown in Table 2. Unfortunately, all our attempts to resolve this latter band, which is possibly constitutes of non-volatile plant and/or oil contaminant(s), were unsuccessful.

Sadaka¹⁹ conducted a similar research and had steam-distilled the Syrian species of *P. argentea* aerial parts. The oil was found to contain 50 components, accounting for 97.47 %. The major components determined were Carvacrol 11.45%, n-Hexadecanoic acid 11.45%, bis(2methylpropyl) ester 10.19%, n-Decanoic acid 8.50%, n-Dodecanoic acid 7.43%, Diethyl Phthalate 7.10%, and n-Nonanoic acid 6.50%. The oil was shown to be rich in carboxylic acids (39.56%) and esters (27.93%).

Interestingly, several sesquiterpenes, abundant in other Caryophyllaceae members²⁰, were also found to occur in

the EO of Jordanian *P. argentea* under study. This includes for example: caryophyllene oxide (1.75%), germacrene D-4-ol (0.76%), (E)-nerolidol (2.71%), farnesol (1.83%), β -caryophyllene (0.48%) and (E)- β -farnesene (0.46%). Of the major identified sesquiterpenes, it is notable the presence of β -caryophyllene and its derivatives. This latter volatile component, in herbal medicine, was reported to possess mild sedative properties with an *in-vitro* cytotoxic activity against breast cancer cells. Farnesol, interestingly, has also received considerable attention due to its apparent anticancer properties²¹. The main identified volatile principle, 6,10,14-trimethyl-2-pentadecanone, is a non-aromatic hydrocarbon and has a slightly fatty aroma with reported antimicrobial²² and antioxidant properties²³.

4.3. Cytotoxicity Evaluation

Table 3 illustrates the *in-vitro* calculated IC₅₀ values ($\mu\text{g/mL}$) for the tested extracts and control drugs (cisplatin and doxorubicin). Regarding the EO, only a trace amount of the oil was isolated and this hindered its further biological evaluation. The *in-vitro* cytotoxicity profiles of the different tested extracts alongside with the control drugs are shown in Figures 2-4. Unfortunately, both extracts did not show a dose dependent inhibition on MCF-7 cells. According to the American National Cancer Institute (NCI) guidelines, it sets the limit of activity for crude extracts at 50% inhibition (IC₅₀) of proliferation to be < 30 $\mu\text{g/mL}$ after the exposure time of 72 hours²⁴. Despite the higher IC₅₀ values on fibroblast cells compared with doxorubicin and cisplatin; all extracts unfortunately lacked cytotoxic potential against the tested cancer cell lines in the tested concentration range. Figures 2-4

illustrate the different effects of the tested extracts and control drugs. Unfortunately, none of the extracts inhibits the growth of MCF-7 cells on a dose dependent manner. *P. argentea* AE did not show a dose-dependent cytotoxicity except for Panc-1 cell line with IC₅₀ value of (427.38 \pm 0.38 $\mu\text{g/mL}$). Several studies have revealed the richness of *P. argentea* with flavonoids; mainly quercetin and its derivatives^{5,7}. These compounds are well known to possess potent anti-oxidant and free radical scavenging activities. Nevertheless, and despite the potential protective effect of these compounds against cancer induction²⁵, this study failed to conclude any anti-proliferative potential of *P. argentea* extracts against the tested cancer cell lines.

5. Conclusion

The essential oil of *P. argentea* was found to be rich in sesquiterpenes and 6,10,14-trimethyl-2-pentadecanone, a no-terpenoidal ketone, as the predominant principle. Despite the richness of *P. argentea* in many biologically active compounds, unfortunately, this research failed to conclude any *in-vitro* cytotoxic potential for the plant aqueous and alcohol extracts on the tested cancer cell lines.

Acknowledgment of Financial & competing interests' Disclosure

The authors are grateful to Professor Khaled Tawaha, for plants identification, and Mr. Ismail Abaza for his technical assistance. Also, the authors wish to thank the Deanship of Scientific Research and Quality Assurance at the University of Jordan for financial support.

Table 1. Major identified secondary metabolites' groups of different *P. argentea* crude extracts by TLC

Sample	Flavonoids	Coumarins	Alkaloids	Terpenoids
<i>P. argentea</i> AE	+	-----	-----	-----
<i>P. argentea</i> EE	+++	++	-----	+

AE: Aqueous extract; EE: Ethanol extract

Table 2. Chemical composition of essential oil hydrodistilled from the flowering tops of Jordanian *P. argentea* analyzed by GC-MS.

No.*	Rt. ^a	RI Lit. ^b	RI Exp. ^c	Compound	% Content ^d
1	7.03	932	934	α -pinene	0.89
2	10.07	1022	1024	o-cymene	7.53
3	10.33	1026	1031	1,8-cineole	2.10
4	13.21	1101	1104	<i>cis</i> -thujone	1.41
5	17.57	1200	1206	<i>Trans</i> -dihydrocarvone	2.75
6	19.10	1238	1241	cumin aldehyde	0.95
7	21.99	1304	1307	isomenthyl acetate	0.56
8	23.82	1346	1351	α -terpinyl acetate	1.41
9	24.36	1359	1363	9-decenoic acid	0.61
10	25.93	1400	1401	n-tetradecane	0.55
11	26.13	1400	1405	β -longipinene	0.77
12	26.28	1407	1409	decyl acetate	0.63
13	26.81	1417	1422	β -caryophyllene	0.48
14	27.27	1431	1433	β -gurjenene	0.61
15	27.63	1439	1442	Aromadendrene	1.73
16	28.08	1453	1454	geranyl acetone	1.33
17	28.22	1454	1457	(E)- β -farnesene	0.46
18	28.51	1464	1464	9-<i>epi</i>-E-caryophyllene	4.89
19	29.45	1487	1487	β -ionone	0.87
20	29.69	1493	1493	β -vetispirene	0.63
21	29.89	1496	1498	Viridiflorene	0.59
22	30.40	1509	1511	Tridecanal	0.62
23	30.99	1530	1526	citronellyl butanoate	0.80
24	32.45	1561	1564	(E)-nerolidol	2.71
25	32.86	1574	1575	α -cedrene epoxide	0.63
26	33.00	1574	1578	germacrene D-4-ol	0.76
27	33.19	1577	1583	<i>trans</i> -sesquisabinene hydrate	0.59
28	33.32	1582	1587	caryophyllene oxide	1.75
29	34.57	1618	1620	isolongifolan-7-a-ol	5.19
30	34.70	---	1623	Unk ^e	7.43
31	34.89	---	1628	Unk ^e	8.19
32	35.22	---	1638	Unk ^e	5.69
33	35.50	1639	1645	allo-aromadendrene epoxide	6.99
34	36.20	1666	1664	Z-14-hydroxy caryophyllene	Tr. ^f
35	38.07	1714	1716	2E,6Z-farnesol	1.83
36	38.91	1733	1739	Isobicyclgermacrenal	4.33
37	39.69	1759	1762	Cyclocolorenone	1.50
38	41.63	1816	1818	2E,6E-farnesoic acid	0.63
39	42.61	1845^g	1847	6,10,14-trimethyl-2-pentadecanone	16.14
40	44.50	NA ^h	1904	2-heptadecanone	0.76
41	45.04	1913	1921	5E,9E-farnesyl acetone	1.70
				Monoterpenes (MT)	19.72
				Hydrocarbons MT: No. 1,2	8.42
				Oxygenated MT: No. 3,4,5,6,7,8,16,23	11.31
				Sesquiterpenes (ST)	60.96
				Hydrocarbons ST: No. 11,13-15,17,20,21,38,41	7.60
				Oxygenated ST: No. 18,19,24-37	53.35
				Non-terpenoid non-aromatic compounds: No. 9,10,12,22,39,40	19.31
				Total identified	99.99

Compounds are listed in order of their elution times from a DP-5 column; a: Retention time; b: Literature RI based on reference¹⁵; c: Experimental RI relative to (C₈-C₂₀) n-alkanes; d: The percent content is based on the compound relative peak area

and represents an average of 4 determinations (two oil samples, each analyzed in duplicate); e: Unknown, unidentified oxygenated sesquiterpene; f: Traces: below 0.1% content; g: Value obtained from reference¹⁸; h: Value not available in literature; Compounds in bold are the major ($\geq 4\%$).

Table 3. Cytotoxicity IC₅₀ values (mean \pm standard deviation (SD)) of cisplatin, doxorubicin and *P. argentea* extracts tested in a panel of cancer cell lines.

Treatment	Cytotoxicity (IC ₅₀ value: mean \pm SD; $\mu\text{g/mL}$)			
	MCF-7	Caco-2	Panc-1	Periodontal Fibroblasts
Doxorubicin	0.01 \pm 0.001	0.10 \pm 0.01	0.06 \pm 0.01	0.14 \pm 0.02
Cisplatin	1.17 \pm 0.13	1.11 \pm 0.15	5.97 \pm 0.57	9.08 \pm 0.29
<i>P. argentea</i> AE	Non-toxic *	Non-toxic *	Non-toxic *	427.38 \pm 0.38
<i>P. argentea</i> EE	Non-toxic *	68.91 \pm 7.52	134.70 \pm 6.27	160.97 \pm 10.76

* Non toxic within the investigated concentration range (0.1 - 800 $\mu\text{g/mL}$); AE: aqueous extract; EE: ethanol extract.

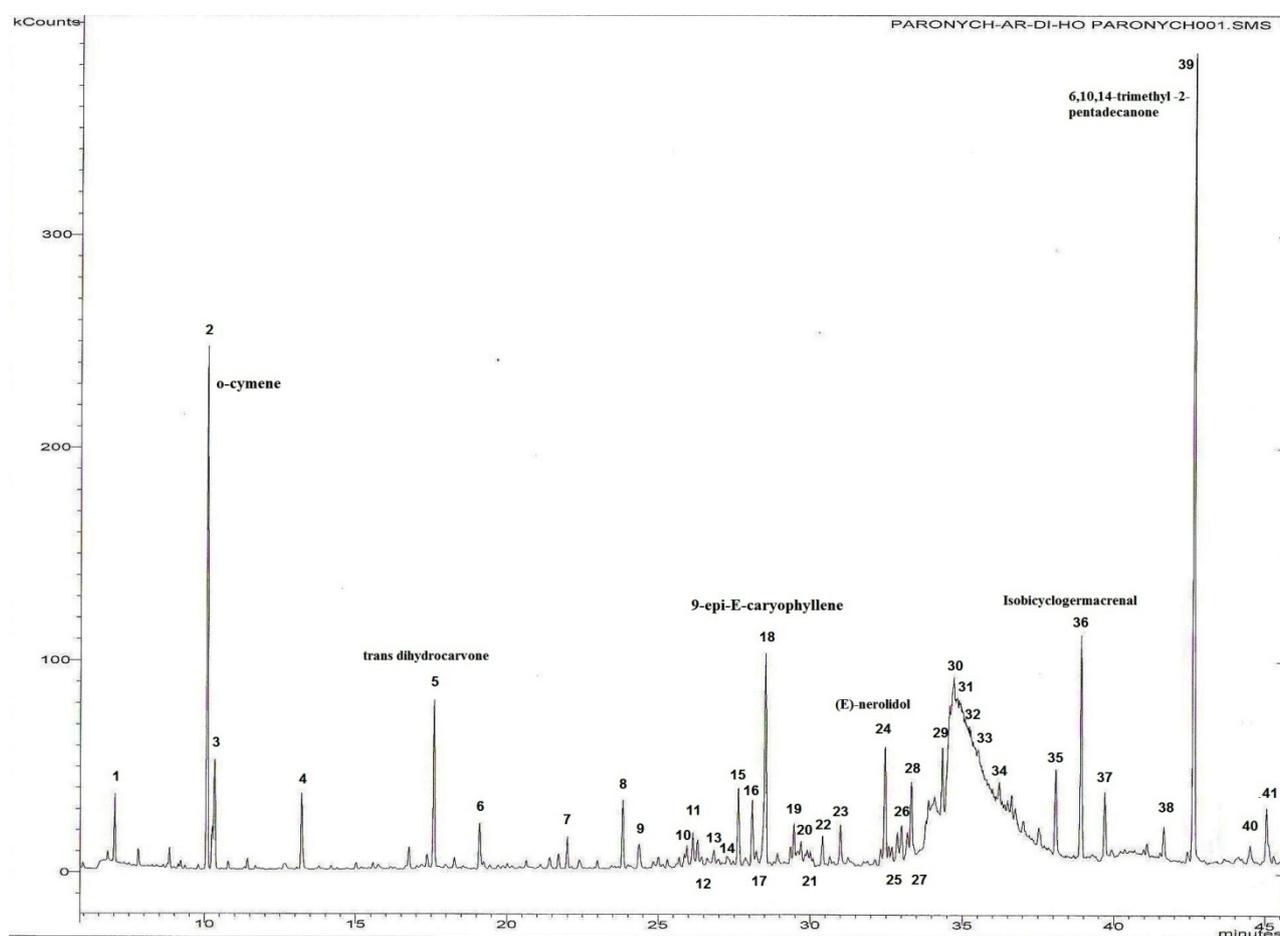


Figure 1. GC-MS chromatogram of the essential oil hydrodistilled from flowering tops of *P. argentea* growing in Jordan.

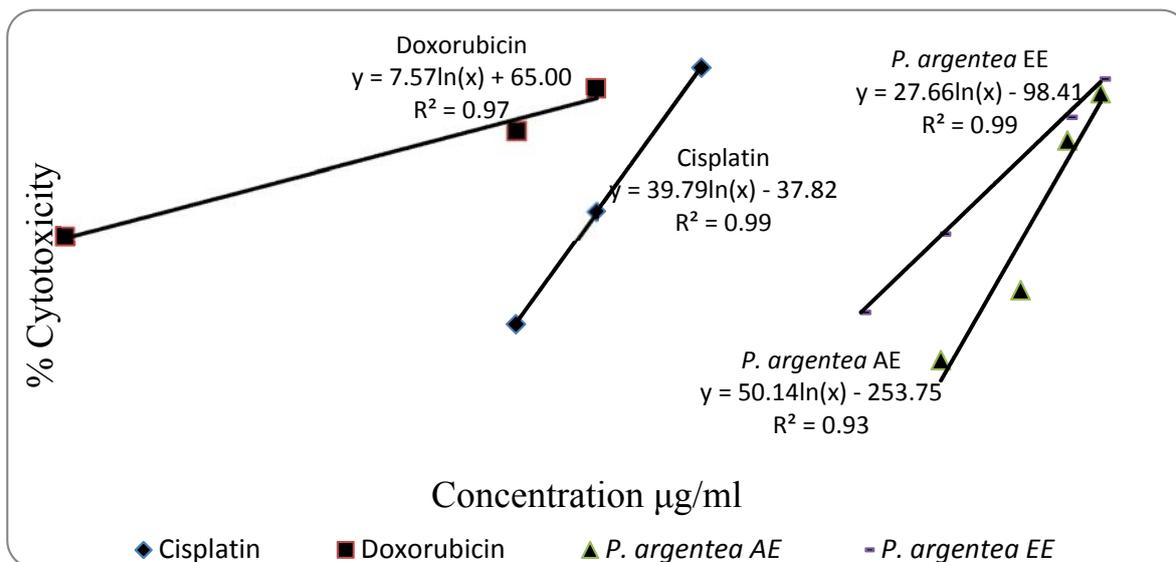


Figure 2. *In-vitro* cytotoxic activity of cisplatin, doxorubicin, *P. argentea* AE and EE tested against normal Fibroblast cells.

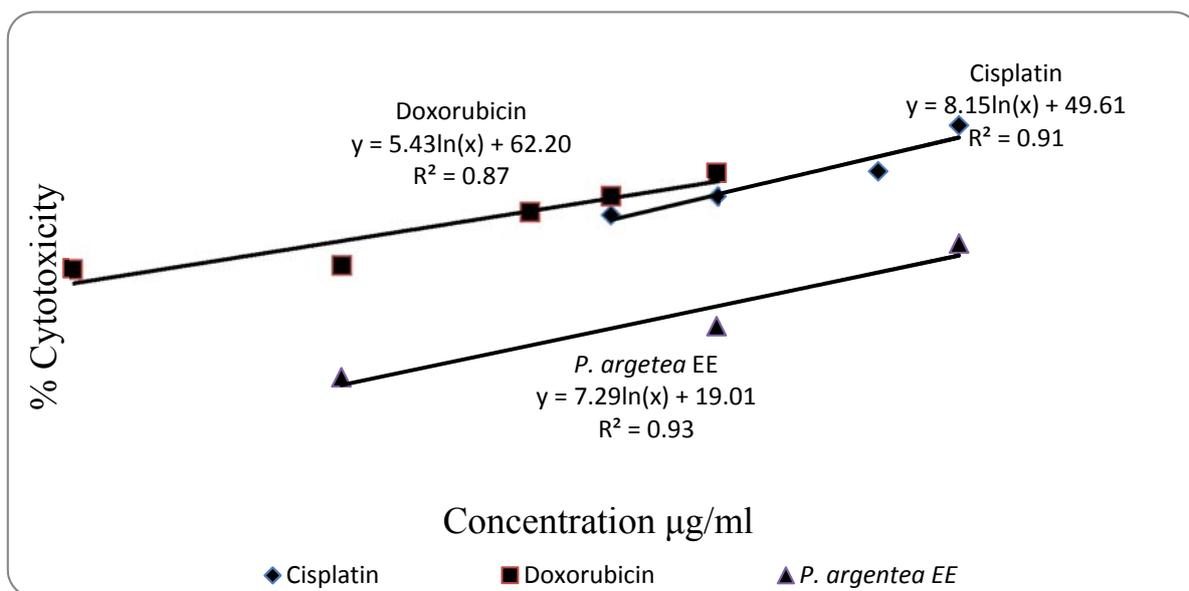


Figure 3. *In-vitro* cytotoxic activity of cisplatin, doxorubicin and *P. argentea* EE tested against Caco-2 colorectal cancer cell line.

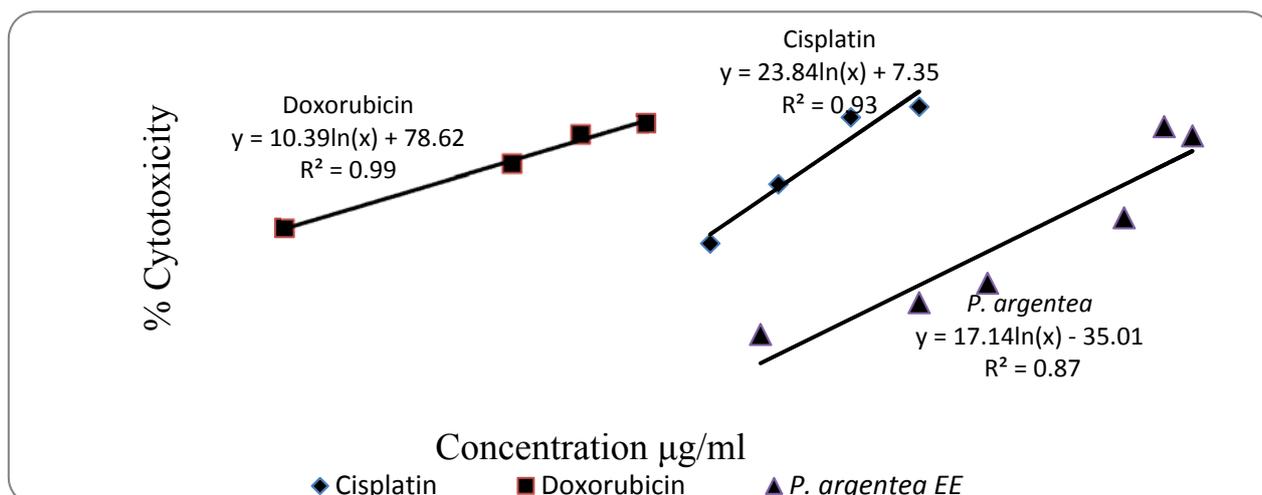


Figure 4. *In-vitro* cytotoxic activity of cisplatin, doxorubicin and *P. argentea* EE tested against Panc-1 pancreatic cancer cell line.

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فحص السمية الخلوية لنبات رجل الحمامة (*Paronychia argentea* Lam.) وتقييم التركيب الكيميائي لزيت الطيار: نبات طبي في الأردن

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ملخص

هدفت هذه الدراسة إلى تقييم التركيب الكيميائي للزيت الطيار المستخلص من القمم المزهرة لنبات رجل الحمامة (*Paronychia argentea* Lam.; Caryophyllaceae) والتي تشكل جزءاً من النباتات الطبية واسعة الانتشار على أرض الوطن الأردن. تم استخراج الزيت الطيار عن طريق التقطير المائي من الأزهار المجففة لنبات رجل الحمامة بواسطة جهاز الاستشراب الغازي- مطياف الكتلة. هذا وقد تم فحص السمية الخلوية مختبرياً لكل من المستخلص المائي والكحولي للأجزاء العلوية من النبتة ضد كل من سرطان الثدي MCF-7، وسرطان القولون Caco-2 وسرطان البنكرياس Panc-1 وذلك بفحص نشاط أبيض الخلية. تم استخلاص واحد وأربعين عنصراً من زيت رجل الحمامة الطيار ومعظمه غني بالتيريبيانات نصف الثلاثية (60,96%)، ووجد أن المركب الرئيس المكون للزيت الطيار هو 6,10,14-trimethyl-2-pentadecanone، وهو هيدروكربون غير أروماتي. هذا ويشتمل الزيت الطيار على مكونات رئيسية أخرى منها *o*-cymene (7.51%)، allo-aromadendrene epoxide (6.99%)، isolongifolan-7-a-ol (5.19%)، 9-epi-E-caryophyllene (4.89%) و isobicyclogermacrenal (4.33%). على الرغم من أن اختبار الاستشراب اللوني بالطبقة الرقيقة الأولي كشف عن ثراء المستخلصات بالفلافونويدات، إلا أنه لم تلاحظ أي أنشطة مضادة لتكاثر الخلايا السرطانية مختبرياً على مدى التركيز الذي تم فحصه.

الكلمات الدالة: رجل الحمامة، زيت طيار، السمية الخلوية في المختبر، MCF-7، Caco-2، Panc-1، الأردن.

تاريخ استلام البحث 2019/3/24 وتاريخ قبوله للنشر 2019/11/29.