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Study of the Antioxidant Activity of Cactus *(Opuntia dellienii)* Fruits (Pulp and Peels) and Characterisation of their Bioactive Compounds by GC-MS

Alya J. A. Alsaad*& Lina S. Mohammed[1]

Department of Food Science, College of Agriculture, University of Basrah, Iraq

*Correspondence E-mail: alyaalsaad63@yahoo.com;[1]linasamer234@gmail.com

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Abstract: The present study aims to identify and characterize the chemical compounds present in the extracts of cactus pear *Opuntia dillenii* (OD) fruit which grow in southern Iraq and offer different health benefits. The physicochemical properties of the fruit juices (pulp and peels) were investigated. Fruit pulp and peel extracts carried the symbols: hexane pulp extract (HPuE), hexane peel extract (HPeE), ethanolic pulp extract (EPuE), and ethanolic peels extract (EPeE). The activel compound screened by gas chromatography-mass spectrometry (GC-MS). HPuE and HPeE contained 40 bioactive compounds and 60 bioactive compounds were detected in EPuE and EPeE. The scavenging activity of DPPH free radicals records a high level of inhibition ranging from 34.8 to 90.3% for EPeE and from 32.9 to 89.9% for EPuE, while hexane extracts scavenging activities (HPeE and HPuE) were 24.9-78.9% and 20.7-73.3% respectively at concentrations of 20 – 80 µg.ml^{-1} this activity has received considerable attention because of their physiological functions.

Keywords: Cactus, DPPH assay, Fruits, GC-MS, Physcochemical parameter.

Introduction

The southern part of Iraq is distinguished by the abundance of cactus fruits *Opuntia dillenii* (OD) grown at the Peninsula called Al-Faw. The *Opuntia* genus belongs to the *Cactaceae* family, and the common name is prickly pear (Habibi *et al*., 2002). Arid and semi-arid regions are special areas for cultivating cactus fruits that are geographically distributed in Mexico, Latin America, South Africa, and Mediterranean countries (Butera *et al*., 2002). *O. dillenii* plants have a high environmental adaptivity and adapt to all climatic conditions due to their remarkable genetic (Moßhammer *et al*., 2006). *Opuntia* fruit is a berry with a delicately flavored juicy pulp that contains many hard seeds and has a thick pericarp (peel) of 30-40% of the fruit (Duru &Turker, 2005). Cactus pear acidity is 0.03-0.12%, while the pH range from 6.0 to 6.6, and total soluble solids was 12-17% (Sharma *et al*., 2015). Fruit peels contain high amounts of flavonoids, polyphenols, betacyanins, and dyes, offering several health benefits (Koubaa *et al*., 2015). Current studies have shown that pear fruit contains many special chemical components that provide this fruit multiple functionalities and increased nutritional value, attracting scientist's research interest in recent years (Piga, 2004). Cactus pear fruit

and peel extracts have important properties, such as anticancer and, anti-inflammatory effects (Madrigal-Santillán *et al*., 2013). Cactus pear fruits contain vitamin E, ascorbic acid, amino acids, carotenoids, and fibres enriched in carbohydrates like fructose and glucose, which provide the body strength and health (Valente *et al*., 2010; Osorio-Esquivel *et al*., 2011). Cactus peels contain liposoluble compounds and essential fatty acids used as antioxidants (Ramadan & Mörsel, 2003). Antioxidants could inhibit the oxidation of lipid and cactus extracts utilise as natural food additives for anti-rancidity (Alsaad *et al*., 2019). Antioxidants compounds, such as phenolic compounds, could delay oxidative effects in DNA, lipids, and proteins by producing astable radicals (Shahidi *et al*., 1992). Some chemically synthesised antioxidants, such as Butylated Hydroxytoluene (BHT) and Butylated Hydroxyanisole (BHA) have toxic effects (Zhang *et al*., 2009); therefore, natural antioxidants from plant resources are of great interest among researchers (Buyukokuroglu *et al*., 2001; Gulcin *et al*., 2003). To our information, this study is the first study in Iraq that analyses the active compounds and other properties of prickly pear. Therefore, the objectives of this study are to (i) identify the bioactive compounds of cactus (OD) fruit (pulp and peels) extracts by using GC-MS to describe the nutraceutical compounds which are useful for human health and (ii) quantify their physicochemical properties and antioxidant activity.

Materials & Methods

Materials and reagents

Butylated Hydroxytoluene (BHT), 2,2-diphenyl-1picrylhydrazyl (DPPH), a double-beam UV-VIS spectrophotometer to measure intensity of light beam. All solvents used for partition and extraction were purchased from Sigma-Aldrich (St.Louis, MO, USA).

Plant materials

Cactus fruit *Opuntia dellienii* (OD) grows in abundance in the southern part of Iraq, Basrah. The temperature ranges between 48°F and 108°F with small amounts of rain during the year. Sandy and silt soils are predominant. Fruits were harvested at their full maturity in August 2019. Only fresh, clean, free of defects, uniform-sized, good-textured fruits were procured for the experiments. One local genotype (purple) was selected for the test. Fifty fruits were used for the experiments. Seeds were manually separated from the pulp and the peels. Then, the fruit pulp and peels were briefly homogenised in a kitchen-type blender. The juice was centrifuged at (4000 x g, 30 min at 4°C), and then the supernatant juice was immediately used to measure physicochemical parameters.

Physicochemical parameters

Based on the procedures described in AOAC (2010), the moisture of fresh Cactus pulp and peels and total sugars of their juices were determined. The total soluble solids (TSS) (°Brix) was determined using a refractometer (DBR95, G. Bormac, Carpi, Italy). The pH was measured using a pH meter (Model 430, Corning, NY, USA). Total acidity was measured by mixing 10 ml of juice with 0.1 N NaOH solution until reaching a pH 8.1, which was observed potentiometrically. The results were expressed as % citric acid (Matias *et al*., 2014). All parameters were carried out in triplicates.

Preparation of extracts

100 g of cactus (OD) fruit pulp and peels without seeds were dried at 45-50 °C for 48

h, ground in an electric grinder to transform it into powder form. Polar and nonpolar compounds were extracted by adding 150 ml of ethanol and hexane solution to 5 g of each pulp and peel powders and leaving the solution soaked for two days. Filter paper No1 was used to filter extract solutions. The extract was then concentrated using a rotary evaporator at 45 °C, and dry extracts were obtained, Fig. (1). The extracts were kept in a glass container away from light and stored at 4 °C until further use. The extracts carried the symbols: hexane pulp extract (HPuE), hexane peels extract (HPeE), ethanolic pulp extract (EPuE), and ethanolic peels extract (EPeE). All analyses were carried out in triplicates. Extracts yield was determined on a dry basis (DW) according to the following equation:

$$\%\text{Yield} = \frac{W1 \times 100}{W2}$$

where W1 =extract weight after evaporation of the solvent and W2 = weight of dried fruits.

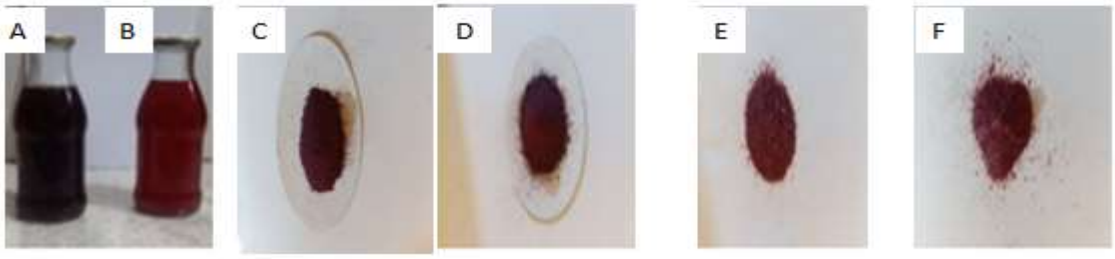

Fig.(1): Iraqi cactus *Opuntia dellienii* (OD) fruit extracts studied in this research, pulp juice (A), peels juice (B), ethanolic peels extract (C), hexane peels extract (D), ethanolic pulp extract (E), hexane pulp extract (F).

Identification of organic compounds

The organic compounds of Cactus extracts were analysed using Gas Chromatography-Mass Spectrometer (GC-MS) technique (Shimadzu QP2010). A sample of 1 microliter was placed into the capillary column (intercut DB5MS, Japan). The initial column temperature was 50 °C which rising at the rate of 5 C° per min to a final temperature of 250 °C. The system provides a carbowax (ID 30 m × 0.25 mm; film thickness 0.25µm. As a carrier gas, Helium gas was used. Split mode (1:30) was carried out for injection. The temperatures of the detector and injector were adjusted at 250 °C. Organic compounds were isolated at stable pressure (90 kPa). The identification of chemical compounds in various extracts was based on GC retention time. The mass spectra were computer matched with those of standards available in mass spectrum libraries (2008NIST Library).

Determination of (DPPH) free radical

The scavenging activity of 1,1-diphenyl-2 picrylhydrazyl (DPPH) of all extracts of cactus (OD) pulp and peels was measured using DPPH assay following the described procedure by Morales & ´Enez-Perez (2001). Each extract was dissolved in methanol at concentrations of 20, 40, 60, and 80 µg.ml^{-1}. The reaction mixture contained 375 µl solvent (methanol), 125 µl of 1 mM of DPPH prepared in methanol, and 500 µl of extract. After incubation for 30 min at 25 °C, when the reaction mixture changed its colour from deep violet to light yellow, the absorbance

was read at 517 nm. As a comparative sample, BHT was used. The inhibition ratio (%) was determined from the equation:

$$\%\text{DPPH} = \frac{\text{Abs control} - \text{Abs sample}}{\text{Abs control}} \times 100$$

Where Abs control is control absorbance, and Abs sample is sample absorbance.

Statistical analysis

The data of triplicate measurements were expressed as the mean ± standard deviation (SD). The SPSS version 17.0 software (SPSS Inc., Chicago, IL, USA) was used for statistical analyses of the data. One-way analysis of variance (ANDVA) was used to sanalyse the results. Tukey test for multiple comparisons was conducted to show the differences between the means at $p = 0.05$.

Results & Discussion

Physicochemical parameters

The physicochemical parameters results of cactus fruit juices (pulp and peels) are given in table (1). Fresh fruit pulp and peels contain 84.9% and 71.4% of water, respectively. The pulp had significantly ($p< 0.05$) higher water content than peels. Each cultivar of the fruit has special physicochemical properties and the environment has a major impact on these properties (Parish & Felker, 1997). Our results are consistent with Gurrier *et al*. (2000), who found that cactus fruit pulp contains 85% water. Anwar & Sallam (2016) studied prickly pear (*Opuutia ficus-indica*) and found that peels contain 75.8% water. The fruits with high water content, such as prickly pears, are prone to rapid spoilage at room temperature **(**Bouzoubaâ *et al*., 2016). The moisture content of other fruit peels, such as pitaya peels (93%), carrot (91.05%), red apple (81.68%), and white grape (75.28%) was different from that of cactus peels (Makris *et al*., 2007).

The values of TSS (°Brix) of cactus fruit juice were 14.30 and 14.20 for pulp and peels, respectively. There was no significant difference ($p>0.05$) between the TSS of pulp and peels. TSS increased during ripening and varied at different maturity and fruit metabolism stages during ripening (Albano *et al*., 2015). Our results were in accordance with Bouzoubaâ *et al*. (2016), who found TSS (°Brix) of prickly pears ranging 13.15 - 15.87.

The average pH values obtained for pulp and peels in our study were 5.01 and 5.63, respectively. The pH of pulp was lower than that of peels. There was a significant difference ($p< 0.05$) between the pH of pulp and peels. The pH value of the prickly pear juice was low because of the presence of extremely high content of organic acids, such as acetic acid, citric acid, and n-hexadecanoic acid. In contrast, the acidity of the pulp was found to be 0.15%; this value is higher compared to the acids content of the peels 0.06%. It is assumed that these fruits were fully mature and low acidic food. Our results are consistent with the results of Sáenz (2000) who revealed that the acidity of cactus fruit ranged from 0.05 to 0.18%. Gurrieri *et al*. (2000) found the pH value of peels ranging from 6.4 to 6.5 with acidity ranging between 0.11-0.14. Other fruit juices acidity values, such as orange (0.94%), Green grapes (1.06%), Apple (0.48%) Lemon (9.65%) (Yadav & Chakravarty, 2013)

Our study found that cactus (OD) fruits contain a high amount of total sugar (39.6, 21.9%), alsorepresented by reducing sugar (34.4 and 18.9%) and non-reducing sugar (5.2, 3.0%) of fruit pulp and peels juices, respectively. In general, pulps taste sweeter than peels. There is a significant difference ($p< 0.05$) between pulp and peels. Our analysis confirmed these results that pulp contained large amounts of carbohydrate represented by d-glycerol-d-galactoheptose, fructose, and lactose. Usually, the fruits of dry soils are sweeter than wetland soil (Jacobo, 2001). The total sugar of prickly pear peels was 60.58% (Anwar & Sallam, 2016). Fructose and glucose were the main sugar content of prickly pear juice (11−12%) (Gurrieri *et al*., 2000).

Table (1): Physicochemical parameters of cactus *O. dillenii* (OD) fruit juice.

Samples	Moisture %	TSS˚(Brix)	pH	Acidity%	Total sugar%
Pulp juice	84.9±0.05^{a}	14.30±0.11^{a}	5.01±1.0^{a}	0.15±1.01^{a}	39.6±0.40^{a}
Peels juice	74.40±0.01^{b}	14.20±0.21^{a}	5.63±0.1^{b}	0.06±0.01^{b}	21.9±0.03^{b}

- Mean with the different letters in the same column is significantly different ($p \leq 0.05$), Each value is the means ± standard deviation ($n = 3$)

Yield

The yield of extracts obtained from cactus (OD) peels, and pulp was given in table (2). The yield of extracts ranged between1.2-4.1%. Among all extracts, EPeE has the highest yield (4.1%) followed by EPuE (3.9%). The yields of HPeE and HPuE were 1.4 and 1.2%, respectively. There is asignificant ($p> 0.05$) difference in the yield between the ethanolic extracts and hexane extracts. The yield of extraction depends on the type of extraction solvents; hexane produced the lowest volume of extracts, whereas ethanol produced the highest amount of extracts. Our results confirmed that the highest extraction occurred for a high polar solvent. Fernández-López *et al*. (2010) showed that the yield of ethanolic peels extracts of *O. ficus indica* had 64.745 µg.100g^{-1}, methanolic extracts 50.75µg.100g^{-1}, while chloroform and acetone extracts were recorded the lowest values, 4.8 and 2.5µg.100g^{-1}. Koubaa *et al*. (2015) studied two varieties of *O.acanthocarpa* and found that their extraction yields were 0.05% and 0.07%.

Table (2): %yield of cactus *O. dillenii* (OD) fruits extracts.

Samples	Ethanolic extracts	Hexane extracts
Peels	4.1±0.01^{aA}	1.4±0.04^{bB}
Pulp	3.9±0.10^{aA}	1.2±0.05^{bB}

- The same small letters in the same row are not significantly different ($p > 0.05$). The mean with the same capital letters in the same column is not significantly different ($p > 0.05$). Each value is the means ± standard deviation (n = 3)

Organic compounds identification

GC-MS is an effective technique for finding the composition of volatile components of plant origin (Butera *et al*., 2002). Figs. (2 and 3) of GC-MS chromatogram of cactus (OD) extracts (pulp and peels) clearly show 20 peaks for each extract of HPuE and HPeE, indicating the presence of 20 compounds of various classes of bioactive chemical constituents. At the same time, each EPuE and EPeE had 30 compounds (Figs. 4 and 5). Tables (3 and 6) show the extracts compounds with the retention time (RT), peak area, molecular weight (MW), and formula for HPuE, HPeE, EPuE, and EPeE, respectively. The chemical compositions of the four extracts varied quantitatively and qualitatively. Tables (3 and 4) show that 37.94% of HPuE compounds were Hexanedioic acid dioctyl ester, Decanoic acid, 2-propenyl ester 9.15%. The compound 1-Decanol cover 10.69%, phenolic compounds represented by (Z)-3-(pentadic-8-en-1-yl) phenol with levels containing up to 4.29%. The extract HPeE contains Eicosanoic acid (Arachidic acid) in a percentage of 18.04%, n-Fatty alcohol: Z, Z-8, 10-Hexadecadien-1-ol with levels containing up to 19.25% and Pentalene, octahedron-2-[(2-octyl) decyl]-11.15%, phenolic compounds: (Z)-3-(pentadic-8-en-1yl) phenol comprised 6.01%. Our results were in agreement with those reported by Zito *et al*. (2013) who showed that (14.0%) of volatile compounds were present in *O. ficus indica* fruits. These results also are agreement with data reported by Bergaoui *et al*. (2007) who found that the most important compounds in cladodes, flowers, and fruits of *Opuntia lindheimeri* were saturated fatty acids represented by hexadecanoic acid (8.5-17.3%), tetradecanoic acid (3.2-13.6%), and butyl tetradecanoate (8.1-21.5%), contributing antioxidant and anti-bacterial properties (Rajeswari *et al*., 2012; Aghajani *et al*., 2015). Ethanolic pulp and peels extracts (EPuE and EPeE) contained the same compounds (Tables 5 and 6) represented by d-Glycerol-d-galactoheptose 29.27 and 19.58%, Butoxyacetic acids 23.59 and 11.39%, 7Tetradecenal,(Z)- 13.54 and 22.08%, 2-Methoxy-4-vinyl phenol 6.11 and 10.84% respectively. In comparison, citric acid 4.23% presented in EPeE only. Our results agree with Flath & Takahashi (1978), who found that *O. ficus-indica* peels contain numerous esters and carbonyl compounds. Jaiswal *et al*. (2009) isolated polysaccharides derived from *Opuntia* spp. by using an ultrasonic extraction method and showed that it contained various compounds of sugars represented by arabinose, xylose, fructose, glucose, galacturonic acid, and rhamnose units.

It is evident that the extracts found in this study have different biological compounds, such as phenolic compounds, fatty acid aster and citric acid which acts as chelators and synergists of antioxidant systems (Sarkadei & Howell, 2007).

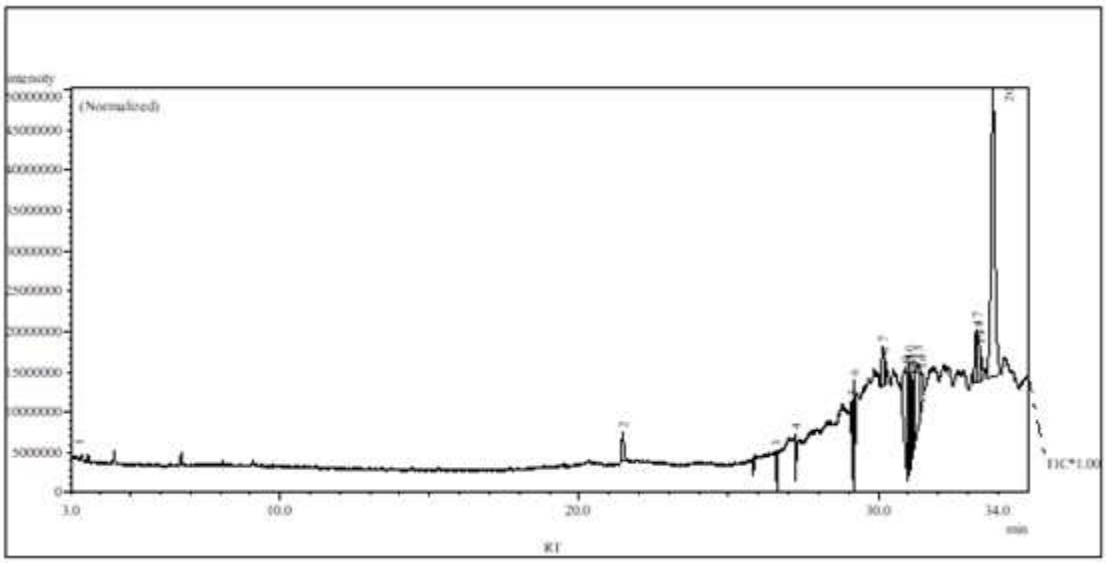

Fig. (2): GC-MS chromatogram of HPuE of cactus *O. dillenii* (OD) fruit.

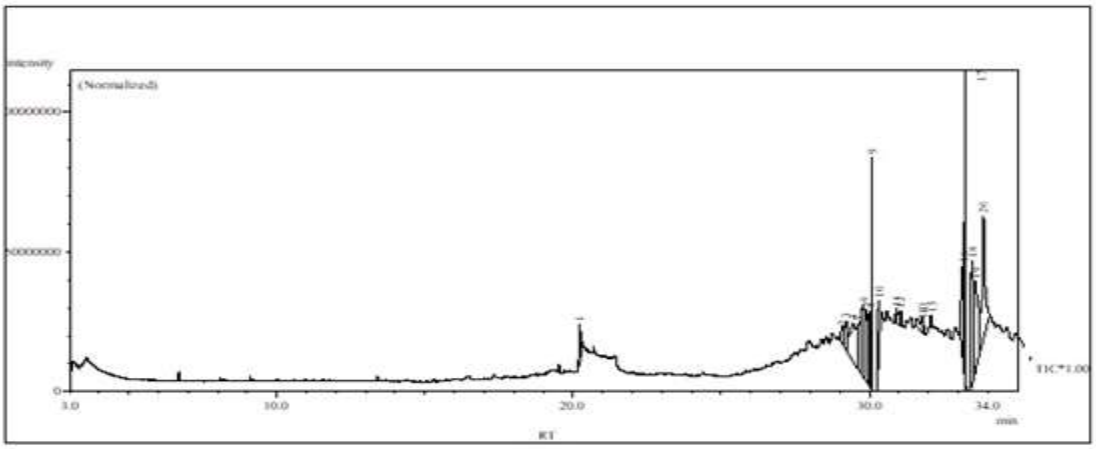

Fig. (3): GC-MS chromatogram of HPeE of cactus *O. dillenii* (OD) fruit.

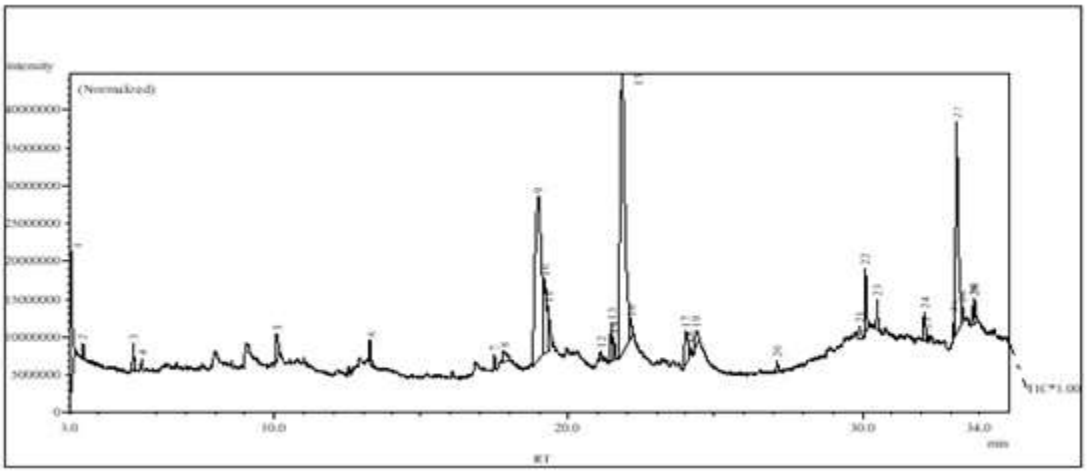

Fig. (4): GC-MS chromatogram of EPuE of cactus *O. dillenii* (OD) fruit.

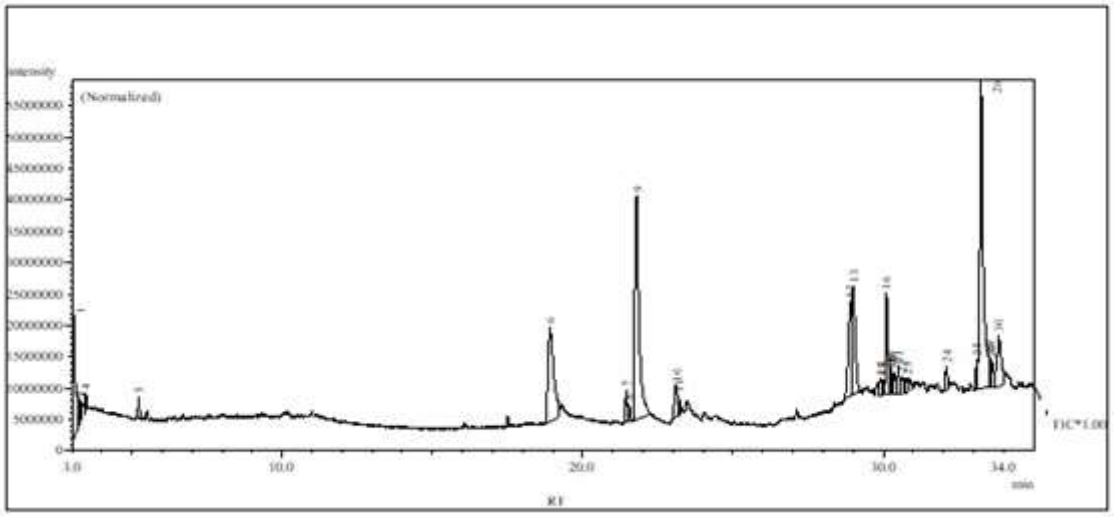

Fig. (5): GC-MS chromatogram of EPeE of cactus *O. dillenii* (OD) fruit.

Table (3): GC-MS analysis of HPuE of cactus *O. dillenii* (OD) fruit.

Pk	RT(min)	%Area	Formula	MW.	Compounds name
1	3.023	0.32	C4H6N2O	98	1H-Pyrrole, 2,5-dihydro-1-nitroso-
2	21.466	2.23	C12H14O4	222	Diethyl Phthalate
3	26.603	0.79	C22H40O4	368	Oxalic acid, cyclobutylhexadecyl ester
4	27.249	0.57	C21H34O	302	(Z)-3-(pentadec-8-en-1-yl)phenol
5	29.144	3.72	C21H34O	302	(Z)-3-(pentadec-8-en-1-yl)phenol
6	29.207	2.85	C14H30O	214	2-Hexyl-1-octanol
7	30.151	3.27	C16H32O2	256	n-Hexadecanoic acid
8	30.233	0.9	C35H72O	508	1-Pentatriacontanol
9	30.911	10.69	C16H34O	242	1-Decanol
10	31.028	3.47	C41H84O	592	1-Hentetracontanol
11	31.06	2.79	C7H11NO	125	2-Propionyl-1-pyrroline
12	31.087	1.53	C39H76O3	592	Oleic acid, 3-(octadecyloxy)propyl ester
13	31.127	3.22	C19H34O	278	1,9,12-Octadecatriene, 1-methoxy-
14	31.2	3.98	C6H11NO	113	N-Allyl-N-ethylformamide
15	31.347	9.15	C13H24O2	212	Decanoic acid, 2-propenyl ester
16	31.48	3.85	C26H52	364	1-Hexacosene
17	33.293	4.21	C14H24O	208	13-Tetradece-11-yn-1-ol

18	33.36	2.53	10H18O	154	2-Isopropyl-5-methylhex-2-enal
19	33.413	1.99	C25H50	350	Heptadecane, 9-(2-cyclohexylethyl)-
20	33.843	37.94	C22H42O4	370	Hexanedioic acid, dioctyl ester

Table (4): GC-MS analysis of HPeE of cactus *O. dillenii* (OD) fruit.

PK	RT(min)	%Area	Formula	MW	Compounds name
1	20.228	2.16	C12H14O4	222	Diethyl Phthalate
2	29.06	1.49	C43H88	604	Tetracontane, 3,5,24-trimethyl-
3	29.223	2.38	C40H77F3O2	646	Octatriacontyltrifluoroacetate
4	29.433	8.56	C38H69F7O2	690	Tetratriacontylheptafluorobutyrate
5	29.633	4.17	C26H50	362	Cyclopentane, 1,1'-hexadecylidenebis-
6	29.793	6.02	C20H38O2	310	cis-11-Eicosenoic acid
7	29.9	5.44	C16H22O4	278	Dibutyl phthalate
8	30.007	6.48	C17H36O3S	320	Sulfurous acid, dodecyl pentyl ester
9	30.094	5.83	C20H40O2	312	Eicosanoic acid
10	30.303	3.14	C34H68O2	508	Heptadecanoic acid, heptadecyl ester
11	30.913	1.41	C29H58	406	Cyclopentane, 1-(2-decyldodecyl)-2,4-dimethyl-
12	31.067	0.73	C21H44	296	Heptadecane, 2,6,10,15-tetramethyl-
13	31.786	1.86	C14H30O	214	2-Hexyl-1-octanol
14	31.827	1.26	C22H37NO4	379	2-Nitro-1,3-bis-octyloxy-benzene
15	32.078	0.46	C16H32O	240	Hexadecen-1-ol, trans-9-
16	33.153	6.0	C21H34O	302	(Z)-3-(pentadec-8-en-1-yl)phenol
17	33.245	12.03	C16H30O	238	Z,Z-8,10-Hexadecadien-1-ol
18	33.456	7.22	C16H30O	238	Z,Z-8,10-Hexadecadien-1-ol
19	33.567	11.15	C26H50	362	Pentalene, octahydro-2-[(2-octyl)decyl]-
20	33.861	12.21	C20H40O2	312	Eicosanoic acid

Table (5): GC-MS analysis of EPuE of cactus *O. dillenii* (OD) fruit.

Pk	RT(min)	%Area	Formula	MW	Compounds name
1	3.078	5.25	C7H14O2	130	Acetic acid, 3-methylbutyl ester
2	3.471	0.34	C6H14O	102	Propane, 1-(1-methylethoxy)-
3	5.232	0.78	C9H20O2	160	Butane, 1,1-diethoxy-3-methyl-
4	5.517	0.22	C8H18O3	162	Ethyl orthoacetate
5	10.077	1.63	C9H10O2	150	2-Methoxy-4-vinylphenol
6	13.235	0.77	C7H12O3	144	4-Pentanoic acid, 2-methoxy-, methyl ester
7	17.503	0.36	C14H28	196	1-Tetradecene
8	17.814	1	C11H24O2	188	Butane, 1,1'-[methylenebis(oxy)]bis[3-methyl-
9	18.975	23.59	C6H12O3	132	Butoxyacetic acid
10	19.21	4.23	C6H8O7	192	Citric Acid
11	19.327	1.97	C9H10O2	150	2-Methoxy-4-vinylphenol
12	21.092	0.64	C11H22O2	186	Undecanoic acid
13	21.457	1.39	C12H14O4	222	Diethyl Phthalate
14	21.541	0.8	C13H28O	200	n-Tridecan-1-ol
15	21.806	29.72	C7H14O7	210	d-Glycero-d-galactoheptose
16	22.127	1.19	C12H22O11	342	Lactose,
17	24.03	2.51	C9H10O2	150	2-Methoxy-4-vinylphenol
18	24.167	0.25	C14H30O5S	310	:d-Mannitol, 1-thiooctyl-1-deoxy
19	24.384	0.77	C5H10O5	150	Pentose
20	27.111	0.43	C18H33Cl3O2	386	Trichloroacetic acid, hexadecyl ester
21	29.913	0.67	C34H58O4	530	Phthalic acid, ditridecyl ester
22	30.106	2.35	C16H32O2	256	n-Hexadecanoic acid
23	30.5	0.93	C24H48O2	368	Docosanoic acid, ethyl ester
24	32.094	1.31	C20H40	280	9-Eicosene, (E)-
25	32.193	0.13	C11H20O	168	6-Nonenal, 3,7-dimethyl-
26	33.12	1.09	C12H22O2	198	Acetic acid 9-decenyl ester

27	33.248	13.54	C14H26O	210	7-Tetradecenal
28	33.447	0.38	C10H18O	154	5-Ethoxy-cyclooctene
29	33.82	0.97	C14H28O	212	cis-11-Tetradecen-1-ol
30	33.855	0.79	C8H13NO4	187	Acetic acid, 2-(2-buten-1-yl)-2-nitro-, ethyl ester

Table (6): GC-MS analysis of EPeE of cactus *O. dillenii* (OD) fruit.

Pk	RT(min)	%Area	Formula	MW	Compounds name
1	3.077	6.57	C7H14O2	130	Acetic acid, pentyl ester
2	3.267	0.93	C2H4O2	60	Acetic acid
3	3.307	0.35	C2H4O2	60	Acetic acid
4	3.473	0.48	C6H14O	102	Propane, 1-(1-methylethoxy)-
5	5.23	0.57	C9H20O2	160	Butane, 1,1-diethoxy-3-methyl-
6	18.912	11.39	C6H12O3	132	Butoxyacetic acid
7	21.459	1.3	C12H14O4	222	Phthalic acid, diethyl ester
8	21.538	0.59	C13H26	182	1-Tridecene
9	21.792	19.58	C7H14O7	210	d-Glycero-d-galacto-heptose
10	23.106	1.87	C6H12O6	180	Fructose
11	23.18	0.81	C7H12O5	176	alpha.-D-Mannopyranoside, methyl 3,6-anhydrous-
12	28.921	6.05	C9H10O2	150	2-Methoxy-4-vinylphenol
13	28.995	7.38	C22H42O4	370	Hexanedioic acid, dioctyl ester
14	29.908	0.62	C34H58O4	530	Phthalic acid, ditridecyl ester
15	29.968	0.53	C13H28	184	Nonane, 5- (1-methylpropyl
16	30.11	4.79	C21H34O	150	2-Methoxy-4-vinylphenol
17	30.227	0.29	C14H26O4	258	Oxalic acid, 6-ethyloct-3-yl ethyl ester
18	30.253	0.52	C10H18	138	Naphthalene, decahedron
19	30.287	0.3	C8H14O2	142	9-Oxabicyclo[4.2.1]nonan-2-ol
20	30.368	1.33	C21H40O5	372	Glycerylmonoricinoleate

21	30.498	1.04	C24H48O2	368	Docosanoic acid, ethyl ester
22	30.633	0.76	C22H39F5O2	430	Nonadecylpentafluoropropionate
23	30.83	0.6	C10H22	142	Nonane, 2-methyl
24	32.096	1.16	C20H40	280	3-Eicosene, (E)-
25	33.127	1.03	C13H24	180	6-Tridecane
26	33.257	22.08	C14H26O	210	7-Tetradecenal, (Z)-
27	33.52	0.43	C16H30O2	254	E-6-Tetradecen-1-ol acetate
28	33.547	0.58	C12H20	164	Cyclohexane, 1,5-dimethyl-2,3-divinyl-
29	33.607	1.53	C23H42O2	350	Methyl 5,9-docosadienoate
30	33.851	4.54	C20H40O2	312	Eicosanoic acid

Determination of (DPPH) free radical

The scavenging of the DPPH assay depends on the decrease in absorbance as the DPPH radical received hydrogen radical or an electron from an antioxidant compound like phenols to become a stable molecule. This process can evaluate the ability of materials to donate electrons or hydrogen atoms to the reactive species (Paixao *et al*., 2007).

Results of free radical scavenging activity are given in table (7). Data in the figure indicated that DPPH free radical scavenging values increased proportionally and significantly to the sample concentration 20-80 µg.ml^{-1}. The highest scavenging activity was for EPeE, ranging from 34.8 to 90.3%, followed by EPuE 32.9-89.9%. All extracts were significantly different (p<0.05), which means that free radicals react with the extracts considered effective electron donors, which completes the reaction by forming stable compounds. There are no significant differences (p>0.05) between BHT and ethanolic extracts at a 60 and 80 µg/ml concentration. Extracts obtained using hexane (HPeE and HPuE) had significant differences, and the lowest scavenging activity ranged between 24.9-78.9 and 20.7-73.3%, respectively. All extracts exhibited an appreciable scavenging effect, which could be because the extracts contain a high amount of antioxidant compounds, such as phenolic compounds and saturated fatty acid.

The scavenging activity of EPeE is in agreement with Faten & Ali (2014), who found that the DPPH scavenging activity of *O. ficus indica peels extracts* by ethanol/water ranged from 62.72 to 90.4%. Koubaa *et al*. (2015) studied three varieties of cactus. They showed that antioxidant activity by the DPPH method of *O. undulata* fruits was four times lower than that in *O. ficus-indica* and *O. stricta* fruits. In a study performed by Bakari *et al*. (2017), there is a positive relationship between the sample concentration and DPPH free radicals scavenging. Prior *et al*. (2005)

showed that the ability to scavenge the DPPH free radicals increased with a high content of total phenols.

Table (7): DPPH scavenging activity of cactus *O. dillenii* (OD) extracts at different concentrations and comparative with Butylated Hydroxytoluene (BHT).

Conc. µg.ml^{-1}	DPPH scavenging activity%				
	HPuE	HPeE	EPuE	EPeE	BHT
20	20.7±0.05^{aA}	24.9± 0.03^{aB}	32.9± 0.02^{aC}	34.8± 0.01^{aD}	38.5± 0.06^{aE}
40	32.0±0.02^{bA}	35.0± 0.01^{bB}	57.6±0.08^{bC}	58.2± 0.01^{bC}	67.6± 0.01^{bD}
60	56.0 ±0.01^{cA}	62.7± 0.06^{cB}	71.8± 0.06^{cC}	75.0± 0.09^{cD}	81.1± 0.08^{cD}
80	73.3±0.15^{dA}	78.9± 0.11^{dA}	89.9± 0.02^{cB}	90.3± 0.03^{dD}	93.0± 0.07^{dD}

The same small letters in the same row is not significantly different ($p \leq 0.05$), Mean with the same capital letters in the same column is not significantly different ($p \leq 0.05$) each value is the means ± standard deviation (n = 3)

Conclusion

The chemical composition of the Iraqi cactus (OD) was identified for the first time by the GC-MS technique. The moisture, acidity, TSS, and sugar values inpulp were higher than those in peels. The study confirms that pulp and peels of cactus pear fruit extracts are rich in natural antioxidants and are an important source of bioactive compounds, such as carbohydrate compounds, saturated fatty acids, and phenolic compounds, which may effectively scavenge the DPPH free radicals by ethanolic peels and pulp extracts in arang of 34.8 - 90.3% and 32.9 - 89.9% respectively. Hexane extracts scavenging ranges from 24.9-78.9% and 20.7-73.3%, respectively. These are good attributes to reduce the risk of several diseases due to their antioxidant activity.

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دراسة الفعالية المضادة للاكسدة لفاكهة الصبار *Opuntia dellienii* (اللب والقشور) وتشخيص مركباته الفعالة بواسطة GC-MS

عاليه جميل علي السعد* و لينا سمير محمد

قسم علوم الاغذية ,كلية الزراعة,جامعة البصرة , العراق

المستخلص: هدفت الدراسة الحالية إلى تحديد وتشخيص المركبات الكيميائية الموجودة في مستخلصات فاكهة الصبار *Opuntia dillenii* (OD) التي تنمو في جنوب العراق وذات فوائد صحية مختلفة. تم دراسة الخواص الفيزيوكيميائية لعصير الفاكهة (اللب والقشور). حملت مستخلصات لب الفاكهة وقشورها الرموز: مستخلص لب الهكسان (HPuE) ، مستخلص قشور الهكسان (HPeE) ، مستخلص اللب الإيثانولي (EPuE) ومستخلص القشور الإيثانولي (EPeE). فحصت المركبات الفعالة بواسطة مقياس الطيف الكتلي اللوني للغاز (GC–MS). احتوى HPuE و HPeE على 40 مركبًا حيويًا وتم اكتشاف 60 مركبًا حيويًا في EPuE و EPeE. سجل نشاط اقتناص الجذور الحرة DPPH مستوى عالٍ من التثبيط تراوح من 34.8 إلى 90.3٪ لـ EPeE ومن 32.9 إلى 89.9٪ لـ EPuE ، بينما كان نشاط اقتناص مستخلصات الهكسان HPeE و HPuE 24.9–78.9% و 20.7–73.3٪ على التوالي بتراكيز تراوحت بين 20–80 ميكروغرام مل$^{-1}$. حظي هذا النشاط باهتمام كبير بسبب وظائفه الفسيولوجية.

الكلمات المفتاحية: الصبار ، طريقة DPPH ، فواكه ، GC–MS ، القياسات الفيزيوكيميائية.