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Phytochemical Study And Antioxidant Activity Of Some Flowering Plants Growing Wild In Al-Bahah In Saudi Arabia

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ABSTRACT

The work described in this paper has been undertaken with the object of contributing further studies of some selected plants wild in Al-Bahah area in the Kingdom of Saudi Arabia. Twelve flowering plants from different eight families were chosen according to their valuable medicinal importance, and many of them used as edible plants. The phytochemical screening of the natural constituents of the aerial parts of twelve selected aromatic flowering plants was performed. The phytosterol, hydrocarbon and fatty acid constituents in lipid contents were determined by GLC analysis. In addition study distribution of elements in all plant samples was carried out. The aerial parts of *Nepeta deflersiana*, *Ocimum basilicum*, *Achillea biebersteinii*, *Artemisia judaica, Dodonaea viscosa*, *Ruta chalepensis*, *Pandanus tectorius* assayed for antioxidant activities using DPPH radical scavenging and reducing power were assayed. Results revealed that all of them have good antioxidant activity. These results may have implications in use of the seven extracts as a therapeutic agent to prevent of oxidative stress related diseases.

Keywords: Flowering plants, phytochemical analysis, antioxidant activity.

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INTRODUCTION

Kingdom of Saudi Arabia "KSA" belongs to the dry region in the world and is diverse in terms of landscapes, including mountains, deserts and wadis. Moreover, traditional herbal medicine continues to play an important role in many parts of KSA, hence it has a great wealth of herbs and medicinal plants that was used in folk medicine for a long time. In Al-Bahah area, located on the southern part of the Hejaz region and on top of mountains, flora is significantly diverse and is characterized by moist moderate summer and cold rainy winter. This study aims to search for new sources of compounds with medicinal effectiveness in the local flora and specifically those available in Al-Bahah. (Newman and Cragg, 2007).

Over the last decade, the use of traditional medicine expanded and was recognized globally. In 2001, the World Health Organization (WHO) reported that herbal medicine satisfies health requirements of 80% of the world's population.

It is desirable to carry out the phytochemical screening of the aqueous methanolic extracts of the aerial part of the flowering aromatic plant scattered in Al-Bahah, in order to evaluate their potential medical and medicinal importance. In addition, study those plants subjected to phytochemical investigation to explore their constituents such as hydrocarbons, sterols, fatty acids and elements. Furthermore, seven of the investigated plants were evaluated for antioxidant activities.

As documented, most of the natural plants contain a large variety of phytochemical constituents, which represent a major source of antioxidant for their nutrition, which in turn decreases the potential stress caused by reactive oxygen species. The natural antioxidants may have free-radical scavengers, reducing agents, potential complexes of pro-oxidant metals, quenches of singlet oxygen, etc. (Ebadi, 2002). The antioxidants can interfere with the oxidation process by reacting with free radicals (Gupta *et al*., 2004). Recently, many studies have focused considerable on finding substitute natural antioxidants to use in medicinal materials, given the harms caused by artificial ones due to their side effects, such as carcinogenicity (Kumaran and Karunakaran, 2007). The antioxidant activities of the plant species were studied in light of available surveying resources in computer databases, and based on their traditional properties, including household uses.

MATERIALS AND METHODS

Plant Materials

The aerial parts (leaves and stems) of the twelve flowering aromatic wild plants from different eight families were collected from Al-Bahah, Saudi Arabia. They were kindly identified by Dr. Farag Abd- Allah El Ghamdy, Plant Taxonomy Department, King Abdul-Aziz University.

Definition of Flowering Plants Under Study

The flowering plants were collected from the forests and mountains of the courtyard, found in the southwest area of the Kingdom, Al-Bahah area. Table 1 shows the Latin names of the twelve flowering plants, which belonged to eight plant families, and the place and time of collection, which is mainly in the Spring.

Table 1: Identification of the selected plants

Nos.	Plants name	Family name	Place of collection	Time of collection
1	*Lavandula dentata*	Labiatae	Alzraab forest	22/3/2012
2	*Nepeta deflersiana*	Labiatae	Shahba forest	4/7/2012
3	*Ocimum basilicum L*	Labiatae	Tehama Mountains	17/2/2013
4	*Achillea biebersteinii*	Asteraceae	Luton Village	12/4/2012
5	*Artemisia judaica*	Asteraceae	Tehama Mountains	17/2/2013

6	*Conyza incana*	Asteraceae	Shahba forest	4/7/2012
7	*Dodonaea viscosa*	Sapindaceae	Garnet village	12/4/2012
8	*Ruta chalepensis*	Rutaceae	Shahba forest	4/7/2012
9	*Juniperus procera*	Cupressaceae	Raghadan forest	22/3/2012
10	*Pandanus tectorius*	Pandanaceae	Tehama Mountains	17/2/2013
11	*Reseda luteola*	Resedaceae	Abyssinian village	4/7/2012
12	*Foeniculum vulgare*	Apiaceae	Tehama Mountains	17/2/2013

Analytical Instruments

Gas liquid chromatography/ Pyeunicam PRO-GC, Conditions for unsaponifiable matters analysis: column OV-17 (methyl phenyl silicone), column dimensions (1.5 x 4 mm), column temperature, 70-270 °C with a rate of 35 °C /min. The operating conditions for fatty acid methyl ester analysis: column SP-2300, (1.5 x 4 mm); column temperature 70-190 °C with a rate of 8 °C /min. Generally, the injection temperature was 250 °C (N_2 gas) and the detector temperature was 300 °C (H_2 gas).

Phytochemical Screening of the Plant Samples

Fresh plant samples of the aerial parts (500 g) were separately digested with 90% methanol in a powerful mixer to give a homogenous mass which was refluxed for 30 min. After cooling, filtration and washing of the marc with methanol, the collected extracts of each plant sample made up to 500 ml with methanol. In case of dry samples, 50 g of ground material was reflux for 1hr with about 300 ml of 80% methanol, then processed as the wet samples but using 80% methanol for washing the marc. The methanolic extracts were screened for the different constituents according to the previous experiences (Elgamal *et al.*, 1989; Mahran *et al*., 1982; Trease and Evans,1989), and the results are summarized in Table 2.

Sterol, Hydrocarbon and Fatty Acid Constituents of Plant Samples

One hundred grams of the aerial parts of each sample were exhaustively extracted with 80 % methyl alcohols at room temperature to afford methanolic extracts. The methanolic extract of each sample was separately treated with 40 ml of 10% alcoholic potassium hydroxide and refluxed gently for 2 hrs. Each of the saponified solutions treated with 50 ml water, then exhaustively extracted with chloroform. The chloroform extracts was washed with water, dried and the solvent was distilled off to give the unsaponified fraction (AOCS, 1980).

Determination the hydrocarbon and sterol contents was carried out by GLC apparatus, and the identification was achieved by comparing the retention time of their peaks with those of authentic (Table 3).

Each one of the aqueous alkaline solution was acidified by 2N HCl. The liberated fatty acids were then exhaustively extracted with chloroform. The chloroform extracts was washed, dried and the solvent was distilled off to give fatty acid fractions. The isolated fatty acids were methylated by refluxing with absolute methanol (15ml) containing 5% H_2SO_4 (0.5 ml) for about 1hr according to the method described by Iverson and Sheppard (1975). After cooling, the solution was diluted with water and exhaustively extracted with chloroform. The chloroform layer was washed, dried and the solvent was distilled off to give the fatty acid methyl esters. Identification of the fatty acid methyl esters was achieved by comparing the retention time of their peaks with those of authentic by using GLC analysis (Tables 4, 5).

Determination of Elements in the Plant Samples

Phosphorus element was determined by using Spectrophotometer model Zeiss PM6**,** Calcium, sodium and potassium were determined by a flame photometer (Eppendorf, B 700E). In addition, magnesium, zinc, iron, manganese and copper were determined by Atomic Absorption Spectrophotometer, model Zeiss FMD3 (Champan and Pratt, 1978).

BIOLOGY

Preparation of Plant Samples

The fresh aerial parts of each sample (100 g) were subject to cold percolation with 80% aqueous methanol (3×2 L) at room temperature. After concentration under reduced pressure, the methanolic residue was stored in the refrigerator until use.

Antioxidant Assays

Chemicals

1.1-Diphenyl-2-picryl- hydrazil (DPPH), butylated hydroxyl toluene (BHT), potassium ferricyanide, and ferric chloride ($FeCl_3$) were purchased from Sigma Chemical Company (St. Louis, MO, USA).

Quantitative Analysis of Antioxidant Activity

The antioxidant activities of seven plants aerial parts were measured in terms of hydrogen donating or radical scavenging ability using the stable radical DPPH and reducing power capacity assay compared with BHT.

Antioxidant Activity (DPPH Assay)

The free-radical scavenging activity using the 1.1-diphenyl-2-picryl- hydrazil (DPPH) reagent was determined according to Brand-Williams *et al*. (1995). Each plant extract soluble with 85 % methanol: water. To 250 µg of each plant sample, 3 ml of freshly prepared methanolic DPPH solution (20 µg/ ml) added and stirred. The decolorizing processes were recorded after 5 min of reaction at 517 nm and compared with a blank control.

DPPH scavenging activity (%) = [(control absorbance − sample absorbance) ÷ control absorbance] ×100

Reducing Power Capacity Assay

The reducing power of the extracts was determined according to the method of Oyaizu (1986). Each plant extract (0.5 ml) was mixed with phosphate buffer (0.5 ml, 0.2 M, pH 6.6) and 1% potassium ferricyanide (0.5 ml). The mixture was incubated at 50°C for 20 min. Aliquots of trichloroacetic acid (0.5 ml, 10%) were added to the mixture, which was then centrifuged at 1000 rpm for 10 min. The upper layer of solution (0.5 ml) was mixed with distilled water (2.5 ml) and a freshly prepared $FeCl_3$ solution (0.5 ml, 0.1%). The absorbance was measured at 700 nm. Increased observance of their action mixture indicated increased, reducing power.

RESULTS AND DISCUSSION

The main aim of the present work is to investigate twelve plants belonging to eight families was chosen according to their valuable medicinal importance, and many of them used as edible plants.

Phytochemical Screening of the Plant Samples

The phytochemical screening of twelve plant samples was performed to test, for their alkaloid, flavonoid, tannin, anthraquinone, coumarin, cardiac glycoside and sterol (and/or terpenoid) contents. Primary, secondary and tertiary alkaloids were detected in ten samples, whereas quaternary alkaloids present in three samples. Leucoanthocyanidins and flavone aglycones were detected in six samples, whereas the flavone glycosides were found in four samples. The unsaturated sterols and / or triterpenoids were detected in all plant samples and coumarins in eight samples. The free anthraquinones was found in three samples and the derivative anthraquinones in five samples. Tannins and glycosides were present in all the plant samples. The cardiac glycosides were detected only in *Dodonaea viscosa* and *Ruta chalepensis* plant samples (Table 2).

In agree of our results, Cowan, (1999) recorded the phytochemical screening of the aerial parts of *Ruta chalepensis* which showed the presence of alkaloids, tannins, flavonoids, saponins, coumarins, sterols and / or triterpenes. Their antioxidant efficacy may related to their different mechanism of action, and a synergistic action of these constituents may be the main reason for this plant activity (Krishnaiah *et al*., 2011). In agree of our results, Purkayastha *et al*. (2012) recorded the phytochemical screening of *Foeniculum vulgare* in methanol to find tannins, saponins, flavonoids, alkaloids, terpenoids.

Sterol, Hydrocarbon and Fatty Acid Constituents of the Plant Samples

The sterol and hydrocarbon constituents of the unsaponifiable fraction of the oily extracts obtained from the different plant samples are recorded in Table 3. GLC of the sterols found that β-sitosterol was present in all plant samples except *Achillea biebersteinii*, however, stigmasterol was found only in *Conyza incana*.

In the present study, the analysis of *Foeniculum vulgare* revealed β-sitosterol in low amount (1.35%), while in another study (Nassar *et al*., 2010) found that β- sitosterol in higher amount (5.52%), besides presence of campesterol (3.33%) and stigmasterol (14.86%).

Investigation of the phytosterols in *Pandanus tectorius*, in this study; showed the absence of stigmasterol and the presence of β-sitosterol in a little amount (1.42 %). Although, in another study a mixture of the phytosterols stigmasterol and β-sitosterol were reported in the plant leaves collected from España (Tan *et al*., 2008).

It was observed that n-octacosane represented the major hydrocarbon and markedly higher than other hydrocarbons in all plant samples. n- Hexadecane, heneicosane, n-tricosane and n-hexacosane content was found in a reasonable amount in all plant samples.

Data obtained from Table 4, revealed presence of saturated fatty acid (96.79-76.45 %) in higher amounts than unsaturated fatty acids (23.54-3.21 %) in all plant samples, except *Pandanus tectorius* plant sample.

Fatty acids such as palmitic, oleic, stearic and docosanoic acids were the most abundant identified compounds in *Juniperus* species (Seca and Silva, 2008). In the present study, no one of these fatty acids detected. Three plants in the present study belong to the family Labiatae*; Lavandula dentata, Nepeta deflersiana*, *Ocimum basilicum L.* Many members of the family Labiatae are well-known for their pharmacological effects such as anticonvulsant, sedative, antispasmodic, analgesic, antioxidant, or local anesthetic activity (Ali *et al*. 2014).

Composition of lipoidal matter of *Foeniculum vulgare* has been the importance of several studies from which it can concluded that the plant shows a chemical variability (Ivanov *et al*., 1979;Vardavas *et al*., 2006). Composition of the investigated sample of *F. vulgare* growing in Saudi Arabia varying only quantitatively from the samples growing in Greece, Austria, Serbia, India, China, or Algeria. In the aerial parts of *F. vulgare*, saturated fatty acids represent 68.43 %, the major being: palimatic (31.51%), undecanoic (18.21%) and myristic (10.51%) acids, while the unsaturated acids represent 22.01 %, the major being pentadecadienoic (9.29%) and pentadecenoic (7.33%) acids (Nassar *et al*., 2010). On the other side, the present study showed that the fatty acids represent (92.43 %), and the major acids being: myristic (61.65%), Bytyric (15.19%) and coprylic (8.37%) acids, while the unsaturated acids 7.06 %, which represent only by linoleic acid.

Myristic acid was found in a markedly high amount in all twelve plant samples. Butyric acid was found in a markedly high amount in *Artemisia Judaica* (38.04%), *Dodonaea viscosa* (42.09%), *Ruta chalepensis* (35.39%) and *Juniperus procera* (35.96%) plant samples (Table 5).

One of the studies used the mono dimensional (GC-FID and GC-MS) and comprehensive two-dimensional gas chromatography to assess fatty acids from *Ruta chalepensis* aerial parts (Tedone*et al*., 2014). In this study, 65% of fats were polyunsaturated fatty acids (PUFA), followed by 30% saturated fatty acids (SFA), as opposed to our study that showed the percentage of SFA was higher (95.35 %) than that of PUFA (4.58 %).

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Table 2. Phytochemical screening of the studied plants

	Plants	Alk.		Leuco.	Flav.		St. & Terp.		Gly.	Card.Gly.			Tan.	Cou.	Anthra.	
		1,2,3 ry	Quart.		Ag.	Gly.	L-B	Sal.							Free Anthra	Anthra. Gly.
1	*Lavandula dentata*	+	–	–	–	–	+	+	+	–	–	–	+	+	–	–
2	*Nepeta deflersiana*	+++	–	–	–	–	+	+	+	–	–	–	+	+	–	–
3	*Ocimum basilicum*	+	+	+	+	–	+	+	+	+	–	–	+	+	–	–
4	*Achillea biebersteinii*	+	–	+	+	–	+	+	+	+	–	–	+	+	–	–
5	*Artemisia judaica*	+	–	+	+	–	+	+	+	–	–	–	+	+	+	+
6	*Conyza incana*	++	+	–	–	+	–	+	+	–	–	–	+	+	–	+
7	*Dodonaea viscosa*	–	–	+	+	+	+	+	+	+	+	–	+	–	–	–
8	*Ruta chalepensis*	++	–	–	–	+	–	+	+	+	+	–	+	+	–	+
9	*Juniperus procera*	–	–	+	–	+	+	+	+	–	–	–	+	+	+	–
10	*Pandanus tectorius*	+++	+	+	+	–	+	+	+	–	–	–	+	–	–	+
11	*Reseda luteola*	++	–	–	+	–	+	–	+	+	–	–	+	–	+	+
12	*Foeniculum vulgare*	+	–	–	–	+	–	+	+	–	–	–	+	+	–	–

Alk. (Alkaloids), Leuco.(Leucoanthocyanidins), Flav. (Flavonoids), Ag. (Aglycones), Gly. (Glycosides), L-B. (Liebermann), Sal. (Salkowski), St & Terp. (Sterols & Terpenoids), Card. Gly. (Cardiac Glycosides), Tan. (Tannins), Cou. (Coumarins), Anthra. (Anthraquinones).

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Table 3. Gas liquid chromatographic analysis of sterol and hydrocarbon constituents

No. of C	Hydrocarbons and Sterols	*Lavandula dentata*	*Nepeta deflersiana*	*Ocimum basilicum*	*Achillea biebersteinii*	*Artemisia judaica*	*Conyza incana*	*Dodonaea viscosa*	*Ruta chalepensis*	*Juniperus procera*	*Pandanus tectorius*	*Reseda luteola*	*Foeniculum vulgare*
C_8	n-Octane	-	-	-	-	6.15	1.58	-	-	4.10	-	-	-
C_{10}	n-Decane	1.92	2.28	1.54	1.97	1.65	1.99	-	1.62	1.99	1.41	2.10	0.98
C_{11}	n-Henedecane	1.70	2.04	1.47	1.78	1.02	2.03	2.30	1.54	1.76	1.38	1.96	1.06
C_{12}	n-Dodecane	1.49	1.90	1.37	1.56	0.72	1.82	2.10	1.40	1.54	1.24	1.77	0.98
C_{13}	n-Tridecane	2.04	3.00	1.92	2.14	9.90	2.73	2.62	1.88	2.51	1.70	2.71	1.48
C_{14}	n-Tetradecane	0.51	0.89	0.50	-	-	1.21	-	-	0.69	-	-	-
C_{15}	n-Pentadecane	1.25	1.68	1.17	1.23	15.06	2.40	2.47	0.54	2.91	1.60	2.70	0.88
C_{16}	n-Hexadecane	6.34	9.67	6.33	5.52	6.39	6.59	5.57	7.19	7.70	6.06	6.31	9.37
C_{17}	n-Heptadecane	2.08	2.60	2.01	1.71	1.86	1.58	-	1.07	2.16	1.87	2.30	2.65
C_{18}	n-Octadecane	1.19	0.53	0.86	1.09	1.53	1.80	-	1.08	1.84	-	0.95	1.65
C_{20}	n-Eicosane	1.01	0.84	0.89	1.22	2.61	0.76	-	2.85	1.24	0.57	0.87	1.39
C_{21}	Heneicosane	6.71	9.26	6.44	8.86	6.21	6.49	8.17	10.07	8.45	6.53	6.06	10.28
C_{22}	n-Docosane	0.39	-	0.89	5.77	-	-	-	-	0.67	0.80	-	-
C_{23}	n-Tricosane	5.37	7.86	6.21	7.31	5.22	5.04	7.06	8.11	7.00	6.08	5.59	8.86
C_{26}	n-Hexacosane	3.60	5.17	4.57	4.62	4.11	3.71	3.40	5.38	5.59	5.31	4.43	6.90
C_{28}	n-Octacosane	43.47	48.21	59.20	50.08	31.44	51.43	59.76	51.23	39.99	60.71	55.48	45.09
C_{29}	n-Nonacosane	2.71	2.60	2.78	2.25	3.09	2.20	3.38	2.90	5.36	2.91	2.51	4.48
C_{30}	n-Triacontane	1.36	1.19	1.25	0.89	1.92	2.53	2.67	1.50	2.43	1.84	0.59	2.58
C_{29}	Stigmasterol	-	-	-	-	-	1.97	-	-	-	-	-	-
C_{29}	β-Sitosterol	16.84	0.24	0.57	-	1.11	2.13	0.84	1.64	2.04	1.42	3.63	1.35

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Table 4. Saturated and unsaturated fatty acid contents

Fatty acids	*Lavandula dentata*	*Nepeta deflersiana*	*Ocimum basilicum*	*Achillea biebersteinii*	*Artemisia judaica*	*Conyza incana*	*Dodonaea viscosa*	*Ruta chalepensis*	*Juniperus procera*	*Pandanus tectorius*	*Reseda luteola*	*Foeniculum vulgare*
Saturated Fatty acids	90.97	76.45	92.38	80.94	96.79	84.94	89.71	95.35	89.82	48.21	87.84	92.93
Unsaturated Fatty acids	8.98	23.54	7.61	19.06	3.21	15.05	10.28	4.58	10.18	51.78	12.16	7.06

Table 5. GLC analysis of fatty acid costituents

No. of C	Fatty acids	*Lavandula dentata*	*Nepeta deflersiana*	*Ocimum basilicum*	*Achillea biebersteinii*	*Artemisia judaica*	*Conyza incana*	*Dodonaea viscosa*	*Ruta chalepensis*	*Juniperus procera*	*Pandanus tectorius*	*Reseda luteola*	*Foeniculum vulgare*
$C_{4:0}$	Buturic	15.79	-	8.43	8.09	38.04	6.00	42.09	35.39	35.96	-	2.55	15.19
$C_{6:0}$	Caproic	1.33	5.49	-	-	-	-	2.10	2.14	-	1.82	3.24	8.37
$C_{8:0}$	Coprylic	-	-	4.42	1.37	3.15	2.23	-	3.10	7.04	-	-	-
$C_{10:0}$	Capric	-	7.35	-	0.66	-	0.91	1.90	0.71	-	1.69	-	2.39
$C_{12:0}$	Lauric	1.39	-	35.05	31.80	26.12	32.09	-	21.28	20.45	-	1.77	-
$C_{14:0}$	Myristic	71.84	24.90	33.35	21.86	23.27	24.08	26.96	24.71	21.68	21.63	80.28	61.65
$C_{14:1}$	Myristoleic	2.70	11.48	-	1.21	-	-	2.21	-	-	12.02	-	-
$C_{16:0}$	Palmitic	-	-	11.13	14.98	6.21	15.16	-	7.33	4.69	-	-	-
$C_{17:0}$	Margaric	-	3.88	-	-	-	-	1.18	-	-	1.07	-	-
$C_{18:0}$	Stearic	-	9.25	-	-	-	-	-	0.69	-	11.36	-	-
$C_{18:1}$	Oleic	-	4.37	-	1.23	-	-	-	-	-	30.23	-	-
$C_{18:2}$	Linoleic	6.28	2.06	3.72	9.02	2.13	8.73	4.74	2.34	1.31	4.12	12.16	7.06
$C_{18:3}$	Linolenic	-	5.63	3.89	7.60	1.08	6.32	3.34	2.24	8.87	5.41	-	-
$C_{20:0}$	Arachidic	0.62	2.20	-	1.02	-	1.33	2.30	-	-	-	-	5.33
$C_{24:0}$	Lignoceric	-	23.38	-	1.16	-	3.14	13.18	-	-	10.64	-	-

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Minerals Analysis of the Plant Samples

Table 6 shows data on mineral concentrations for the investigated twelve plants. The dried Fennels (*Foeniculum vulgare* L.), are one of the highest plant sources of potassium (414 mg), sodium (52 mg), phosphorus (50 mg), and calcium (49 mg) (Badgujar *et al*., 2014), this result was in contrast with the current study. Fennels also contain mineral and trace elements like aluminum, barium, calcium, cadmium, cobalt, chromium, copper, iron, magnesium, manganese, nickel, lead, strontium, and zinc (Xue *et al*., 2006).

The potassium K contents of all the twelve plants found higher than the other elements except three plants, *Artemisia judaica, Conyza incana* and *Juniperus procera*. *Ocimum basilicum* had significant the highest value (95.0 mg/g) of K. The K contents were higher than the values reported for *Ruta chalepensis* (52.0 mg/g) (Ereifej *et al*., 2015), *Foeniculum vulgara* (20.1 mg/g) and *Ocimum basilicum* (24.8 mg/g) (Özcan, 2004).

Calcium Ca contents varied significant among all plants. *Nepeta deflersiana* had the highest value (17.2 mg/g). This result was in contrast to Ereifej *et al*. (2015),who reported that *Ruta chalepensis* had significant higher Ca contents (122.9 mg/g). In another study, *Foeniculum vulgare* L and *Ocimum basilicum* L calcium contents found be to greater than those in our study, which reported to have 20.1 mg/g, and 24.8 mg/g, respectively (Özcan, 2004). Magnesium, Mg contents differed significant among the investigated plants and ranged between 5.2 mg/g (*Lavandula dentata*) and 20.8 mg/g (*Artemisia judaica*) as shown in Table 6. The sodium Na contents of plant samples varied significantly, ranging from 2.5 (*Lavandula dentata*) to 35.5 mg/g (*Pandanus tectorius*). *Ruta chalepensis* sodium contents found to be greater than that reported by Ereifej *et al*. (2015), which had 9.4 mg/g.

Micronutrients, manganese, copper, iron, zinc and phosphorus were found to contain as trace elements in most plant samples. In the current study, the manganese (Mn) was recorded as 33 ppm in *Pandanus tectorius*. Another study revealed extremely high levels of Mn in foliar tissue of the monocot tree *P. tectorius* from southern Guam with values exceeding 10,000 µg/g dry weight in some wetland representatives (Denton *et al*., 2009).

Phosphorus content showed significant variation among plants. *Achillea biebersteinia, Ocimum basilicum* L and *Ruta chalepensis* had the highest P contents (1.135, 1.083 and 1.048 mg/g, respectively). In another study by Ereifej *et al*. (2015), *Ruta chalepensis* phosphorus contents (2.9 mg/g) found to be greater than those in our study. The Fe contents were found in low amounts in all the investigated plants, ranging from 0.0139 mg/g (*Artemisia judaica*) to 0.410 mg/g (*Ocimum basilicum*).

Sweet basil (*Ocimum basilicum* L.) is cultivated as edible herbs in many countries. The status of macronutrients content of *O. basilicum* could be changed by the promotive effect of cobalt element (Gad *et al*., 2013). In the current study, the heavy-metal Cu in vegetable as sweet basil recorded 0.125 mg/g. A study in Sanandaj, Iran, investigated the contributions of the vegetables to the daily intake of Cu from *O. basilicum* (Maleki and Zarasvand, 2008).

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Table 6: Minerals analysis of the plant samples

Plants mg/g	*Lavandula dentata*	*Nepeta deflersiana*	*Ocimum basilicum*	*Achillea bieberstenii*	*Artemisia judaica*	*Conyza incana*	*Dodonaea viscosa*	*Ruta chalepensis*	*Juniperus procera*	*Pandanus tectorius*	*Reseda luteola*	*Foeniculum vulgare*
K	7.3	26.4	95.0	81.6	9.1	19.7	20.6	65.3	10.6	81.6	21.6	55.7
Na	2.5	18.8	19.3	19.7	17.4	31.5	17.9	26.9	16.9	35.5	19.3	32.0
Ca	0.8	17.2	4.3	10.4	1.00	15.5	13.5	1.8	1.1	1.00	0.8	1.1
Mg	5.2	18.2	20.6	17.1	20.8	19.0	19.3	17.5	19.3	20.1	19.9	20.6
P	0.221	0.494	1.083	1.135	0.244	0.203	0.254	1.048	0.165	0.853	0.245	0.605
Fe	0.242	0.071	0.410	0.204	0.013	0.115	0.151	0.073	0.161	0.078	0.020	0.056
Mn	0.017	0.122	0.103	0.032	0.030	0.027	0.041	0.066	0.020	0.033	0.024	0.036
Zn	0.069	0.365	0.242	0.389	0.101	0.186	0.070	0.162	0.078	0.169	0.304	0.182
Cu	0.046	0.031	0.125	0.102	0.023	0.058	0.028	0.047	0.019	0.205	0.012	0.022

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DPPH Radical Scavenging Activity of Plant Extracts

DPPH; common abbreviation for an organic chemical compound, is a dark-colored crystalline powder composed of stable free radical molecules. DPPH assay measures the hydrogen atom (or one electron) donating activity DPPH, which is reduced into diphenylpicrylhydrazine (yellow colored compound), then measured spectrophotometrically. Decreasing DPPH solution absorbance indicates an increase in DPPH radical scavenging activity. In our results revealed that all the choose seven plant extracts exhibited high antioxidant activity. *Achillea biebersteinii, Pandanus tectorius* and *Dodonaea viscosa* extracts recorded significant antioxidant activity (76.05, 73.73 and 76.05%, respectively). *Ruta chalepensis, Ocimum basilicum* L. and *Nepeta deflersiana* exhibited a moderate antioxidant activity (68.23±0.89, 51.86±1.67 and 41.87±0.99 %, respectively), while *Artemisia Judaica* has the lowest antioxidant activity (26.29 %). Moreover, the decrease in DPPH radical absorption caused by antioxidants may be attributed to the reaction between the antioxidant molecules and radical progresses. That resulted in the scavenging of the radical by hydrogen donation. Discoloration from purple to yellow is visually noticeable. Plants' antioxidant activity is mainly contributed to the active compounds present in them. Plants produce diverse arrays of phytochemicals, which are useful in the development of new drugs. These phytochemicals are mostly secondary metabolites constantly synthesized plants for defensive purposes (Chew *et al*., 2009). For instance, antioxidants are biologically produced as a defensive mechanism to prevent tissue destruction caused by highly reactive chemical species, which are formed from various biochemical reaction **Figure (1)**

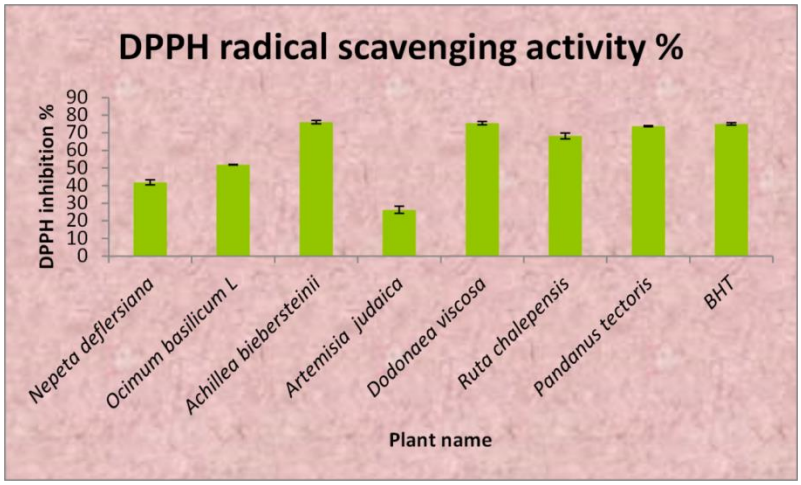

Fig. 1 DPPH Radical scavenging activity of selected plants. each value represents the mean of 3 replicates (mean ±SD).

Reducing Power Capacity of Plant Extracts

Reducing power refers to measuring the reduced capability of antioxidant, then measuring it by transformation of Fe (III) to Fe (II) in the sample extracts (Gülçin *et al*., 2003). Reducing power of the methanolic plant extracts is summarized in Fig. 2. The data showed that all the plant extracts had good ability to reduce Fe (III). The methanolic extract of *Dodonaea viscosa* (1 mg /ml) was found to have the highest reducing power (1.17±0.02) among the other plant extracts, its activity is as near to the synthetic antioxidant BHT at the same concentration *Pandanus tectorius, Achillea biebersteinii,* and *Ocimum basilicum*, recorded similar results (0.885±0.03, 0.851±0.01and 0.839±0.02, respectively). Reducing capacity of the selected plants may be attributed to the presence of secondary metabolites that may serve as a significant indicator of its potent antioxidant activity. Ilhami *et al*., reported that flavonoids and phenolic compounds, some of the alkaloids, saponins and triterpenoids have antioxidant activities. Antioxidant compound activities has been attributed to various mechanisms, among which is prevention of chain initiation, binding of transition metal ion catalysts, decomposition of peroxides, prevention of continued hydrogen abstraction, reductive capacity and radical scavenging (Ilhami *et al*., 2005). These results revealed that all the investigated seven plants were free radical inhibitor or scavenger acting possibly as primary antioxidants.

Many antioxidants can be obtained from the diet, such as polyphenol metabolites, flavonoids, carotenoids, tocopherols, ascorbic acid. These compounds showed oxygen free radical quenching and inhibition of lipid peroxidation (Shalaby *et al*., 2012; Awad *et al*., 2014).

In the current study, the phytochemical analyses of *Pandanus tectorius, Achillea biebersteinii,* and *Ocimum basilicum* have demonstrated the presence of many bioactive compounds, especially the terpenes, flavonoids and volatile constituents, which may be are responsible for the recorded good antioxidant activity (Awad *et al*., 2014, Abd-Alla *et al*. 2014).

Pandanus tectorius is one of the medicinal plants used to treat different livestock ailments in India. It is used for estrus regulation/preparation for breeding (Kumar and Bharati, 2013). There was a great range of provitamin A carotenoid level many *Pandanus* cultivars (Englberger *et al*., 2006). Provitamin A carotenoid may be related to the antioxidant activity (Palace *et al*., 1999).

In the current study, Saudi Arabian *N. deflersiana* plant showed moderate antioxidant activity. These results are in harmony with those obtained by previous studies on Yemeni *N. deflersiana* plant (Chhetri *et al*., 2015). Due to little reports about *N. deflersiana*, the phytochemical investigations of its leaves reported presence of terpenes (Mothana, 2012), so the moderate reducing power capacity could be attributed to presence of the group of terpenes or other constituents.

Our earlier work showed that the constituents of *Achillea biebersteini* are mainly sesquiterpene lactones of the germacranolide and the guaianolide types, and methoxy flavones (Abd-Alla *et al*., 2016). In addition other reported bioactive agents of terpenes (essential oil) (Sökmen *et al*., 2004) and flavonoids (Saeidnia *et al*., 2011), methoxy flavones have been found to be free radical scavengers.

The interesting reducing power capacity activity of *Dodonaea viscosa* reported here could be attributed to its content of flavanones and flavones, furthermore, many methyl ethers, known as a group of rare, naturally occurring compounds, showed good antioxidant activity (Shalaby *et al*., 2012).

Chemically, *Foeniculum* species are characterized by the presence of many bioactive antioxidant agents as coumarins and phenolic acids, and flavonoids (Ivanov *et al*., 1979; Ruberto *et al*., 2000; Nassar *et al*., 2010; Badgujar *et al*., 2014).

The structural diversities of secondary metabolites, in many medicinal plants, results in the presence of many natural antioxidants and appearance of other distinct biological activities. In addition, traditional medicinal plants and herbs studies, we aspire that future researches will provide more insights on pharmacological activities of unexplored KSA flora (Awad *et al*., 2014).

Many international cultivars of *Ocimum basilicum* showed quantitative difference of carotenes, phenolics, flavonoids and tannins content in their leaves extract and antioxidant activities ranged from 75.8% to 93.3% (Dzida, 2010; Elansary and Mahmoud, 2015).

Leucoanthocyanidins considered a part of the plants defense system (Krishnaiah *et al*., 2011). In the current phytochemical screening, leucoanthocyanins can be found in two wild Saudi Arabian Asteraceae plants; *Achillea biebersteinii* and *Artemisia judaica*. Previously, the antioxidant activity of some other wild Saudi Arabian Asteraceae plants was related to presence of polyphenolic content as leucoanthocyanidins (Shahat *et al*., 2014). These plants showed powerful antioxidant properties as radical scavenger, reducing agent and superoxide anion radical scavenger. Additionally, *Ocimum basilicum*, *Dodonaea viscosa* and *Pandanus tectorius* have leucoanthocyanidins content.

Many mono and diterpenes were effectively protected biological systems and functions against various oxidative stresses. *Juniperus* species are characterized by a high content of monoterpenes, diterpenes and sesquiterpenes (Abdel Ghany and Hakamy, 2014). The antioxidant feature of *Juniperus procera* may due to these varied groups of bioactive terpenes.

Ruta chalepensis is an ancient medicinal herb still used in traditional medicine (Mansour *et al*., 1990). In our study, a phytochemical screening of the aerial parts of the plant exhibited the presence of alkaloids,

flavonoids, coumarins, tannins, anthraquinones glycosides, sterols and/or triterpenes. Their antioxidant efficacy may related to their different mechanism of action, and a synergistic action of these constituents may be was the main reason for this plant activity (Krishnaiah *et al*., 2011).

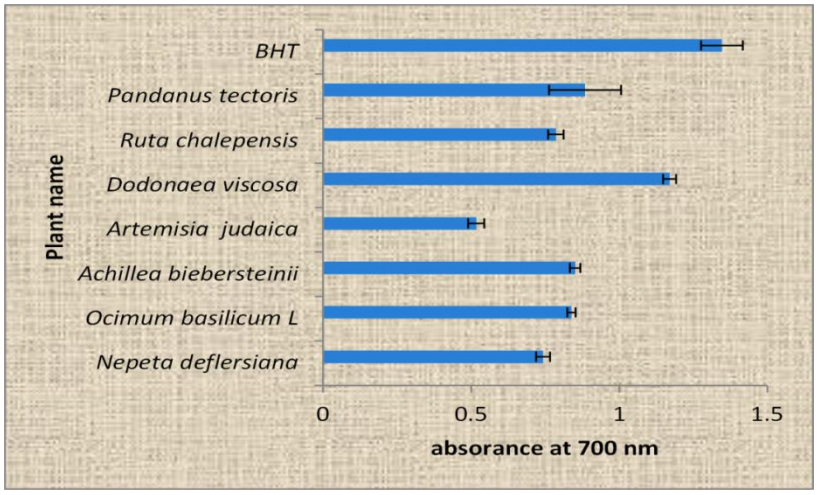

Fig. 2 Reducing power capacity of selected plants. each value represents the mean of 3 replicates (mean ±SD).

CONCULSION

In the present study, twelve of the aerial parts of flowering plants from different eight families chosen according to their valuable medicinal importance. Phytochemical screening showed that most of these plants contain alkaloids, leucoanthocyanidins, glycosides, flavonoids, anthraquinones, coumarins, cardiac glycosides, tannins, steroids and triterpenes. In addition phytosterols, hydrocarbons and fatty acids were detected. These active principles can be exploited and used as drug base in pharmaceutical industries. An appreciable amount of mineral elements was also found to be present in all plants. significant antioxidant activity, while *Ruta chalepensis, Ocimum basilicum* L. and *Nepeta deflersiana* exhibited a moderate antioxidant activity. *Artemisia* The aerial parts of seven plants assayed for antioxidant activities using DPPH radical scavenging and reducing power assays. *Achillea biebersteinii, Pandanus tectorius* and *Dodonaea viscosa* extracts recorded *Judaica* has the lowest antioxidant activity.

Our results revealed that all the investigated seven plants were free radical inhibitor or scavenger acting possibly as primary antioxidants. These results may have implications in use of the seven extracts as a therapeutic agent to prevent of oxidative stress related diseases.

REFERENCES

Abad JM, Bedoya LM, Apaza L, Bermejo P. The *Artemisia* L. genus: A review of bioactive essential oils. Molecules, 2012; 17: 2542–2566.

Abd-Alla HI, Aly HF, Shalaby NMM, Albalawy MA, Aboutabl EA. Hunting for renal protective phytoconstituents in *Artemisia judaica* L. and *Chrysanthemum coronarium* L. (Asteraceae). Egy Pharmaceut J, 2014; 13(1): 46-57.

Abd-Alla, HI, Shalaby MMS, Hamed MA, El-Rigal NS, Al-Ghamdi SN, Bouajila J. Phytochemical composition, protective and therapeutic effect on gastric ulcer and α-amylase inhibitory activity of *Achillea biebersteinii* Afan. Arch Pharm Res, 2016; 39: 10–20.

Abdalla SS, Abu-Zagra MH. Effects of cirsimaritin, a flavone isolated from *Artemisia judaica*, on isolate guinea-pig ileum. Planta Med, 1987; 53: 322–324.

Abdel-Ghany TM, Hakamy OM. *Juniperus procera* as food safe additive, their antioxidant, anticancer and antimicrobial activity against some food-borne bacteria. J Biol Chem Res, 2014; 31(2): 668-677.

Acquaviva R, Iauk L, Sorrenti V, Lanteri R, Santangelo R, Licata A. Oxidative profile in patients with colon cancer: effects of *Ruta chalepensis* L. Eur Rev Med Pharmacol Sci, 2011; 15: 181–191.

Adkar PP. Bhaskar VH. *Pandanus odoratissimus* (Kewda): A review on ethnopharmacology, phytochemistry and nutritional aspects. Adv Pharmacol Sci, 2014; 7(1): 1-19.

Ali MA, Abul Farah M, Al-Hemaid FM, Abou-Tarboush FM. *In vitro* cytotoxicity screening of wild plant extracts from Saudi Arabia on human breast adenocarcinoma cells. Genet Mol Res, 2014; 13(2): 3981-3990.

American Oil Constituents Society (AOCS) 1980. Official and tentative methods of the American Oil Chemists Society, 3rd Ed., AOCS, USA.

Awad, HM, Abd-Alla HI, Mahmoud KH, El-Toumy SA. *In vitro* anti-nitrosative, antioxidant, and cytotoxicity activities of plant flavonoids: A comparative study. Med Chem Res, 2014; 23(7): 3298-3307.

Badgujar SB, Patel VV, Bandivdekar AH. *Foeniculum vulgare* Mill: A review of its botany, phytochemistry, pharmacology, contemporary application and toxicology. Biomed Res Int, 2014; 2014:842674. doi: 10.1155/2014/842674. Epub 2014 Aug 3.

Brand-Williams W, M.E. Cuvelier ME, Berset C. Use of a free radical method to evaluate antioxidant activity. Lebensmittel Wissenschaften und Technologi, 1995; 28: 25-30.

Browner CH. Plants used for reproductive health in Oaxaca Mexico. Econ Bot, 1985; 39(4): 482-504.

Champan HD, Pratt PF. 1978. Methods of analysis for soils, plants and water. University of California, Div Agric Sci, Priced Publication 4034, USA.

Chew YL, Goh JK, Lim YY. Assessment of *in vitro* antioxidant capacity and polyphenolic composition of selected medicinal herbs from Leguminosae family in Peninsular Malaysia. Food Chem, 2009; 119: 373-378.

Chhetri BK, Ali NAA, Setzer WN. A Survey of Chemical Compositions and Biological Activities of Yemeni Aromatic Medicinal Plants. Medicines, 2015; 2(2): 67-92.

Cowan MM. Plant products as antimicrobial agents. Clin Microbiol Rev,1999; 12(4): 564–582.

Denton GR, Siegrist HG, Jano-Edwards JP. Trace elements in *Pandanus* (*Pandanus tectorius*) from a manganese-enriched wetland in Southern Guam: a possible Lytico-Bodig connection?. J Toxicol Environ Health A, 2009; 72(9): 574-576.

Dzida K. Nutrients contents in sweet basil (*Ocimum basilicum* L.) Herb depending on calcium carbonate dose and cultivar. Acta Sci Pol Hortorum Cultus, 2010; 9(4): 143-151.

Ebadi M. 2002. Pharmacodynamic basis of herbal medicines, CRC Press, Washington DC, pp. 86.

Elansary HO, Mahmoud EA. *In vitro* antioxidant and antiproliferative activities of six international basil cultivars. Nat Prod Res, 2015; 2: 1-6.

Elgamal MHA, Abdel-Wahab S, Duddeck H. Constituents of *Achillea fragrantissima*. Fitoterapia, 1991; 62: 362.

Elgamal MHA, Shalaby MMS, Abdel-Hady FK. Constituent of local plants. XXIX. Phytochemical screening of some Cruceferaeous plants. Bull NRC, Egypt, 1989; 14: 191-199.

Englberger L, Aalbersberg W, Dolodolotawake U, Schierle J, Humphries J, Iuta T, Marks GC, Fitzgerald MH, Rimon B, Kaiririete M. Carotenoid content of *Pandanus* fruit cultivars and other foods of the Republic of Kiribati. Public Health Nutr, 2006; 9(5): 631-643.

Ereifej KI, Feng H, Rababah T, Almajwal A, Alu'datt M, Gammoh SI, Oweis LI. Chemical composition, phenolics, anthocyanins concentration and antioxidant activity of ten wild edible plants. Food and Nutrition Sciences, 2015; 6: 581-590.

Gad N, Aziz EE, Bekbayeva LK, Surif M. Role of cobalt in sweet basil (*Ocimum basilicum* L.) plants B. Endogenous hormones, chemical and nutritional contents. American-Eurasian J Agric Environ Sci, 2013; 13(1): 16-21.

Ghazanfar SA. 1994. Handbook of Arabian Medicinal Plants; CRC Press: Boca Raton, FL, USA.

Gülçin İ, Oktay M, Kireçci E, Küfrevioğlu Öİ 2003. Screening of antioxidant and antimicrobial activities of anise (*Pimpinella anisum*) seed extracts. Food Chem, 83(3): 371-382.

Gupta M, Mazumdar UK, Gomathi, Kumar RS. Antioxidant and free radical scavenging activities of *Ervatamia coronaria* Stapf. Leaves. Iranian Journal of Pharmaceutical Research, 2004; 2: 119-126.

Hudaib MM, Tawaha, KA, Mohammad, MK, Assaf, AM, Issa, AY, Alali, FQ, Aburjai TA, Bustanji YK. Xanthine oxidase inhibitory activity of the methanolic extracts of selected Jordanian medicinal plants. Pharmacognosy Magazine, 2011; 7: 320–324.

Ilhami G, Haci AA, Mehmet C. Determination of *in vitro* antioxidant and radical scavenging activities of propofol. Chem Pharm Bull, 2005; 53: 281–285.

Ivanov S, Seher A, Schiller H. Natural antioxdants. IV: Antioxidants in the fatty oil of *Foeniculum vulgare* Miller 2. Fette Seifen Anstrichmittel, 1979; 81(3): 105-107.

Iverson JL, Sheppard AJ. Temperature gas chromatographic analysis of esters of fatty acids. J Chromatogr Sci, 1975; 13: 505-508.

Khafagy SM, El-Din AA, Jakupovic J, Zdero C, Bohlmann F. Glaucolide-like sesquiterpene lactones from *Artemisia judaica*. Phytochem, 1988; 27: 1125–1128.

Khare CP. 2007. Indian medicinal plants: An illustrated dictionary, Springer-Verlag, New York. 461.

Krishnaiah D Sarbatly, R, Nithyanandam R. A review of the antioxidant potential of medicinal plant species. Food and Bioproducts Processing, 2011; 89(3): 217-233.

Kumar R, Bharati KA. New claims in folk veterinary medicines from Uttar Pradesh, India. J Ethnopharmacol, 2013; 146(2): 581-593.

Kumaran A, Karunakaran JR. *In-vitro* antioxidant activities of methanol extracts of five *Phyllanthus* species from India. LWT-Food Science and Technology, 2007; 40(2): 344-352.

Mahran GH, Elgamal MHA, Ahmed MS, Abou Mustafa EA, Abdel-Hady FK, Shalaby MMS. Phytochemical screening of some Cucurbitaceous plants. Bull Fac Pharm, Cairo University, 1982; XXI: 181-192.

Maleki A, Zarasvand MA. Heavy metals in selected edible vegetables and estimation of their daily intake in Sanandaj, Iran. Southeast Asian J Trop Med Public Health, 2008; 39(2): 335-340.

Mansour S, Al-Said M, Tarique MA, Al-Yahya S, Rafatullah O, Ginnawi T, Ageel AM. Studies on *Ruta chalepensis*, an ancient medicinal herb still used in traditional medicine. J Ethnopharmacol, 1990; 28: 305–312.

Meenu J, Sunil S, Manoj K. Evaluation of antihyperglycemic activity of *Dodonaea viscosa* leaves in normal and STZ-diabetic rats. Int J Pharm Pharmaceut Sci, 2011; 3: 69-74.

Meilleur BA, Maigret MB, Manshardt R. Hala, Wauke in Hawai'i. Bishop Mus Bull Anthropol, 1997; 7: 1–55.

Menut B, Lechat C, Bessiere M. Isoprene related esters, significant components of *Pandanus tectorius*. Phytochem, 1996; 43: 1277-1279.

Mossa JS, Al-Yahya MA, Al-Meshal IA. 2000. Medicinal plants of Saudi Arabia. Riyadh: King Saud University Press.

Mothana RA. Chemical composition, antimicrobial and antioxidant activities of the essential oil of *Nepeta deflersiana* growing in Yemen. Rec Nat Prod, 2012; 6(2): 189-193.

Mothana RA, Gruenert R, Bednarski PJ, Lindequist U. Evaluation of the *in vitro* anticancer, antimicrobial and antioxidant activities of some Yemeni plants used in folk medicine. Pharmazie, 2009; 64(4): 260-268.

Nassar MI, Aboutabl EA, Makled YA, El-Khrisy EA, Osman AS. Secondary metabolites and pharmacology of *Foeniculum vulgare* Mill. Subsp. *Piperitum*, Rev latinoam Quím, 2010; 38(2): 103-112.

Newman DA, Cragg G. Natural products as sources of new drugs over the last 25 years. J Nat Prod, 2007; 70: 461–477.

Oyaizu M. Studies on the product of browning reaction prepared from glucosamine. Jpn J Nutrition, 1986; 44: 307- 315.

Özcan M. Mineral contents of some plants used as condiments in Turkey. Food Chem, 2004; 84: 437-440.

Palace VP, Khaper N, Qin Q, Singal PK. Antioxidant potentials of vitamin A and carotenoids and their relevance to heart disease. Free Radic Biol Med, 1999; 26(5-6): 746-761.

Purkayastha S, Narain R, Dahiya P. Evaluation of antimicrobial and phytochemical screening of Fennel, Juniper and Kalonji essential oils against multi drug resistance in clinical isolates. Asian Pacific Journal of Tropical Biomedicine, 2012; 2(3): S1625-S1629.

Rani MS, Rao, SP, Mohan K. "*Dodonaea viscosa* Linn" An overview. J Pharmaceut Res Health Care, 2009; 1: 97–112.

Ruberto G, Baratta MT, Deans SG, Dorman HJD. Antioxidant and antimicrobial activity of *Foeniculum vulgare* and *Crithmum maritimum* essential oils. Planta Medica, 2000; 66: 687-693.

Saeidnia S, Gohari AR, Mokhber-Dezfuli N, Kiuchi F. A review on phytochemistry and medicinal properties of the genus *Achillea*. Daru, 2011; 19: 173-186.

Seca AM, Silva AM. The chemical composition of hexane extract from bark of *Juniperus brevifolia*. Nat Prod Res, 2008; 22(11): 975-983.

Shahat AA, Ibrahim AY, Elsaid MS. Polyphenolic content and antioxidant activity of some wild Saudi Arabian Asteraceae plants. Asian Pac J Trop Med, 2014; 7(7): 545-551.

Shalaby MMS, Abd-Alla HI, Hamed MA, Al-Ghamdi SN, Jambi SMS. Flavones Composition and therapeutic potential of *Dodonaea viscosa* against liver fibrosis. Int J Phytomed, 2012; 4(1): 27-39.

Shanmugavasana A, Ramachandran T. Investigation of the extraction process and phytochemical composition of preparations of *Dodonaea viscosa* (L.) Jacq. J Ethnopharmacol, 2011; 137: 1172-1176.

Sökmen A, Sökmen M, Daferera D, Polissiou M, Candan F, Unlü M, Akpulat HA. The *in vitro* antioxidant and antimicrobial activities of the essential oil and methanol extracts of *Achillea biebersteini* Afan. (Asteraceae). Phytother Res, 2004; 18(6): 451-456.

Tan MA, Takayama H, Aimi N, Franzblau SG, Nonato MG. Antitubercular triterpenes and phytosterols from *Pandanus tectorius* Soland. var. laevis. J Nat Med, 2008; 62(2): 232-235.

Tedone L, Costa R, De Grazia S, Ragusa S, Mondello L. Monodimensional (GC-FID and GC-MS) and comprehensive two-dimensional gas chromatography for the assessment of volatiles and fatty acids from *Ruta chalepensis* aerial parts. Phytochem Anal, 2014; 25(5): 468-475.

Tilebeni HG. Review to Basil Medicinal Plant. International journal of Agronomy and Plant Production, 2011; 2(1): 5-9.

Trease GE, Evans WC. 1989. Textbook of pharmacognosy 13nd ed. Bailliere, Tindal and Cox London.

Vardavas CI, Majchrzak D, Wagner KH, Elmadfa I, Kafatos A. Lipid concentrations of wild edible greens in Crete. Food Chem, 2006; 99 (4): 822–834.

Veerapur VP, Prabhakar KR, Parihar VK, Bansal P, Srinivasan KK, Priyadarsini KI, Unnikrishnan MK. Antidiabetic, hypolipidaemic and antioxidant activity of *Dodonaea viscosa* aerial parts in streptozotocin induced diabetic rats. Int J Phytomed, 2010; 2: 59–70.

World Health Organization (WHO) 2001.General guidelines for methodologies on research and evaluation of traditional medicine. WHO, Geneva, p. 1.

Xue GQ, Liu Q, Han YQ, Wei HG, Dong T. . Determination of thirteen metal elements in the plant *Foeniculum vulgare* Mill. by flame atomic absorption spectrophotometry. Guang Pu Xue Yu Guang Pu Fen Xi, 2006; 26(10): 1935–1938.