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ANTIFUNGAL AND ANTIOXIDANT EFFECTS OF EXTRACTS OF SOME MEDICINAL PLANT SPECIES GROWING IN SOUTH JORDAN

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ABSTRACT

The antifungal and antioxidant effects of methanol (MeOH) and ethanol (EtOH) extracts of the following eleven plants selected from South Jordan : *Melilotus indicus, Paronchia argentea* , *Artemisia seiberi, Arum hygrophyllum, Achillea fragrantissima, Foeniculum vulgare* , *Sarcopterum spinosum*, *Citrullus colocynthis*, *Peganum harmala, Teucrium polium* and *Matricaria aurea* were tested against the growth of four fungi species: *Penicillium chrysogenum, Aspergillus niger, Aspergillus nidulans and Candida albicans* . The antifungal effect on the four fungi species was found with both MeOH and EtOH extracts of *S. spinosum, A. seiberi*, *and A. fragrantissima* .

The minimum fungicide concentration (MFC) of MeOH plant extracts against the growth of four fungi species ranged between 7-8.5 mg/ml for *S. spinosum*, 6.5-9 mg/ml for *A. fragrantissima* and 6-8mg/ml for *A. seiberi*. The (MFC) of EtOH plant extracts against the same fungi species was found between 6- 8 mg/ml for S. *spinosum*, 8.5-9 mg/ml for *A. fragrantissima* and 8-9 mg/ml for *A. seiberi*.

Two assays were used to test the antioxidant activity of the plant extracts, the 2-2-azinobis-3-ethylbenzothiazoline-sulfonic acid (ABTS) assay and the Ferric Reducing/Antioxidant Power (FRAP). S. *spinosum* extract showed the highest antioxidant activity by using both antioxidant assays. In the ABTS assay the IC_{50} was 3.1 µg/ml for EtOH and 7.6 µg/ml for MeOH and in the FRAP assay 4663.33µM ferrous/mg plant extract for EtOH extract and 4207.33µM ferrous/mg plant extract for MeOH extract .

Key words: *ABTS, antifungal, antioxidant, FRAPS. medicinal plants, MFC.*

1. INTRODUCTION

Herbal and natural material as alternative medicines were used throughout ancient times and represented the original sources of most drugs (Irobi and Draramola, 1993; Tsao and Zeltzer, 2005).The antibiotics properties of many medicinal plant crude extracts have been studied (Navarro *et al*., 1996). Jordan is rich in medicinal plants because the diverse topographic structure has a role of the country richness in natural resources and the Jordanian used the natural plants as a source of medicine (Lev and Amar, 2000). Studies were carried out on many of these plants which resulted in a development of natural antimicrobial and antioxidant formulations for food, cosmetic and other applications. However, scientific information on antioxidant properties of different plants, particularly those that are less widely used in cooking and medicine is still rather limited. Therefore, the assessment of such properties remains an interesting and useful task, particularly for finding new sources for natural antioxidants and functional foods (Rauha *et al*., 2001).

Plant materials have provided about 50% of western drugs (Rauha *et al*. 2001). The primary benefits of using plant derived medicines are that they are relatively safer than synthetic alternatives, offering profound therapeutic benefits and more affordable treatment (Iwu *et al*., 1999).

Plant based antimicrobials represent enormous available source for medicines and have different therapeutic potential. There are many side effects that are often associated with synthetic antimicrobials in the treatment of infectious diseases. Phytomedicines usually have multiple effects on the body and their actions often act beyond the symptomatic treatment of disease (Murray, 1995).

The biological inhibitory effects of diverse natural substances and plant extracts have been examined on fungal activities. The increased occurrence of fungal infections among immunocompromised persons and the development of antifungal resistance with prolonged treatment have generated substantial interest in the search for new therapeutic

antifungal agents (Holmberg and Meyer, 1986; Korting *et al.*, 1988; Bruatto *et al.*, 1991; FanHavard *et al.*,1991). It has been shown that plant products exhibited an antifungal effect, such as numerous latex and essential oils (Viollon and Chaumont, 1994).

Antioxidant compounds in food play an important role as a health-protecting factor. Scientific evidence suggested that antioxidants reduce risk for chronic diseases including cancer and heart disease. Most of the antioxidant compounds in a typical diet are derived from plant sources and belong to various classes of compounds with a wide variety of physical and chemical properties. Highly reactive free radicals and oxygen species are present in biological systems from a wide variety of sources. These free radicals may oxidize nucleic acids, proteins, lipids and can initiate degenerative disease. The free radical scavenging activity of antioxidants in foods has been substantially investigated (Miller *et al.*, 2000).

The antioxidant activity of several plant constituents in the form of crude extract or isolated compound has been put widely into consideration. Vegetables and fruits are also reported to decrease the risk of degenerative diseases and could have a protective effect against oxidative stress. Antioxidants are also important for food protection against deterioration reactions caused by atmospheric oxygen (Velioglu *et al.*, 1998). Naturally occurring antioxidants could be found in fruits, vegetables, nuts, seeds, leaves, flowers, roots and barks. Many investigators have found different types of antioxidants in various kinds of plants. One of the best approaches for discovering new antioxidants is the screening of plant extracts. This study was carried out as a part of a project to investigate the antioxidant activity of 11 selected plants growing in South Jordan by using ABTS free radical scavenging assay and determination of Ferric Reducing/Antioxidant Power (Vinson *et al.*, 1998).

2. MATERIALS AND METHODS

The 2-2-azinobis-3- ethylbenzothiazoline-sulfonic acid , Fe^{+2}-tripyridyltriazine, Dimethyl sulfoxide (DMSO) and sucrose were obtained from SIGMA. All media, reagents and chemicals were obtained from FLUKA.

2.1. Microorganisms

The fungi, *i.e.*, *Candida albicans (ATCC 36082)* and *Aspergillus niger (ATCC 16404) Penicillium chrysogenum (ATCC 11707),* and *Aspergillus nidulans (ATCC 16855)* were obtained from the Biological Department in Mutah University and used in this study.

2.2. Plants

Most of the plants used in this study were collected from Dana reserve in the south of Jordan during February and April 2007 and the used plant parts are shown in (Table, 1).

Table(1): Plants and the used plant parts in this study.

Scientific name	Family	Plant Part
Melilotus indicus L	*Leguminosae*	leaf
Paronchia argentea L	*Caryophyllaceae*	Aerial part
Artemisia seiberi L	*Compositae*	leaf
Achillea fragrantissima L	*Compositae*	leaf
Arum hygrophyllum L	*Apiaceae*	leaf
Foeniculum vulgare L.	*Apiaceae*	leaf + stem
Sarcopterum spinosum L.	*Rosaceae*	fruit
Citrullus colocynthis L.	*Cucurbitaceae*	fruit
Peganum harmala L	*Zygophyllaceae*	leaf + stem
Teucrium polium L.	*Labiatae*	leaf + stem
Matricaria aurea Loefl.	*Compositae*	flower

*According to Post (1932).

2.2.1. Preparation of crude plant extracts

The plants were air-dried in the dark at room temperature, ground by coffee blender into fine powder, then stored in plastic bags until extraction.

Twenty five grams of finely ground plants were put in 250ml of 80% methanol or ethanol and kept in the dark for three days with gentle shaking every 24 hours. The mixtures were then filtered under vacuum. The supernatants were centrifuged at 3000rpm for 10 minutes and concentrated by using rotary evaporator at 55°C to remove the solvent, then the extracts were kept at 4°C (Cichewicz and Thorpe, 1996).

2.2.2. Determination of dry weight and the % yield of plant extracts

To determine the dry weight, 1 ml of each plant extract was added to a sterile vial with a known constant weight then incubated in the oven at 100°C for 8 hrs, then the vial was removed from the oven and cooled down to room temperature. The dry weight of the plant extract was calculated as the difference between the weight of the vial with extract and the weight of the vial. The percentage (%) yield was then calculated according to the following equation (Meyer, 1982):

Yield of plant extract% = (dry weight (g) of crude extract / initial weight of plant sample) x 100

2.2.3. Antifungal test

The antifungal test was done according to the disc diffusion method (Rasooli and Mirmostafa, 2003). The same inoculum size was prepared and diluted in sterile yeast extract sucrose (YES) to 10^4 spores/ml. The spore population was counted using haemocytometer. The fungal suspension was streaked aseptically over the surface of the Mueller–Hinton agar using a sterile cotton swab in order to get a uniform microbial growth on both control and test plates. The discs (6mm Whatman no.1) were placed on the agar plates and then 10 µl from each of the crude plant extracts dilutions were loaded on the discs. 10 µl dilution solvent (95% methanol or ethanol and 10% DMSO) were added to the discs on the control plates. The plates were then incubated at 30°C for 48–72 h. Diameters of microbial inhibition zones were measured using Vernier calipers.

The Minimal Fungicidal Concentration (MFC) was assessed according to modified procedure (Rasooli and Mirmostafa, 2003). MFC was determined by a broth dilution method in test tubes as follows: 50 µl from each of various dilutions of the crude plant extracts were added to 5 ml of YES broth tubes containing 10^4spores/ml. The tubes were then incubated at 30°C in an incubator shaker for 24-48hrs. MFC was determined as the highest dilution at which no growth occurred on the plates.

2.2.4. Antioxidant test

To determine the *in vitro* antioxidant activities of medicinal plants in South Jordan, two assays were used, ABTS and the FRAP assays.

In the ABTS assay, the antioxidant capacity of the plant extract was determined according to (Re *et al*., 1999). ABTS was prepared in water as 7 mM solution. ABTS radical cation ($ABTS^{\bullet+}$) was produced by reacting ABTS stock solution with 2.45 mM potassium persulfate (final concentration) and allowing the mixture to stand in the dark at room temperature for 12–16 h before use. The radical was stable in this form for more than 2 days when stored in the dark at room temperature. Then generated ABTS• solution was diluted with ethanol to reach an absorbance of 0.70 (±0.02) at 734 nm. 20 µl of different concentrations of crude plant extract or solvent (control) were added to 2 ml of diluted $ABTS^{\bullet}$ solution. The decrease in absorbance at 734 nm was determined exactly 6 min after the initial mixing of each sample. All measurements were carried out at least three times. The percentage inhibition of ABTS• by the plant extract sample was measured at absorbance 734 nm and calculated according to the formula:

Inhibition %= (A_{blank} – A_{sample} / A_{blank}) * 100.

where A_{blank} is the absorbance of the control reaction and A_{sample} is the absorbance of the test compound. The values of the concentrations that gave 50% of antioxidant activity (IC_{50}) were calculated for each plant extract.

2.2.5.Determination of Ferric Reducing/ Antioxidant Power

In the FRAP, the total antioxidant potential of a sample was determined using a ferric reducing ability (Benzie *et al*., 1999). FRAP assay measures the change in absorbance at 593 nm due to the formation of a blue colored Fe^{+2}-tripyridyltriazine compound from colorless oxidized Fe^{+3} form by the action of electron donating antioxidants. All determinations were performed in triplicate. The FRAP assay is simple, speedy, cheap, and strong and does not require specialized equipment and it can be performed using automated, semiautomatic, or manual methods (Prior *et al*.,2005). 30µl of plant extract sample were added to 900µl FRAP reagent and 90µl water. The final dilution of the sample in the reaction mixture was 1/34. The mixture is incubated at 37 °C for 4 minutes then the absorbance at 593 nm is determined relative to the blank (Benzie *et al*., 1999).

3. RESULTS

3.1. Dry weight and yield percentage of plant extracts

The data presented in Table (2) show the dry weight and yield percentage of methanol and ethanol plant crude extracts of each tested plant species. Percentage yield of plant crude extracts differed according to the plant species and the solvent used.

The percentage yield of ethanol extracts for *P. argentea, A. hygrophyllum*, *A. fragrantissima*, *F. vulgare*, *S. spinosum*, *C. colocynthis* , *M. aurea* was higher than that for methanol extracts. On the other hand, the percentage yield of methanol extract for *M. indicus, A. seiberi*, *P.harmala*. was

higher than that of their reciprocal ethanol extracts.

Table(2): Percentage (%) yield and dry weight of plant crude extracts.

Plant species	%Yield of MeOH plant extract	Dry weight g/ml	%Yield of EtOH plant extract	Dry weight g/ml
Melilotus indicus L.	22	0.022	20	0.020
Paronchia argentea L.	14	0.014	16	0.016
Artemisia seiberi L.	24	0.024	22	0.022
Achillea fragrantissima L .	29	0.029	33	0.033
Arum hygrophyllum L.	26	0.026	32	0.032
Foeniculum vulgare L.	17	0.017	19	0.019
Sarcopterum spinosum L.	21	0.021	23	0.023
Citrullus colocynthis L.	8	0.008	12	0.012
Peganum harmala L.	24	0.024	23	0.023
Teucrium polium L.	21	0.021	19	0.019
Matricaria aurea Loefl.	14	0.014	23	0.023

3.2. Antifungal Effects

Screening of plant extracts for antifungal activities

The fresh plant crude extracts were tested by using the disc diffusion method, the antifungal activities of several plant extracts were assessed by detecting the presence or absence of clear zone around the filter disc then the diameter of inhibition zone was measured in (mm).

Data (Table 3) show the antifungal activities of methanol and ethanol plant extracts. Plant extracts were found to be different in their relative inhibitory effect on *Penicillium chrysogenum, Aspergillus niger, Aspergillus nidulans, Candida albicans* growth. The three most effective methanol and ethanol plant extracts that showed clear growth inhibition zones were those from each of *Artemisia seiberi , Sarcopterum spinosum* and *Achillea fragrantissima.*

Ethanol extract of *Sarcopterum spinosum* was more effective than methanol extracts against the growth of some fungal isolates used(Table,3). The antifungal activity of ethanol extracts of *Achillea fragrantissima* against *Penicillium chrysogenum, Aspergillus niger and Candida albicans* growth was higher than that of methanol extracts (Table,3). Ethanol and methanol extracts of *Artemisia seiberi* showed the same effect on the growth of *Penicillium chrysogenum, Aspergillus niger and Aspergillus nidulans,* while the effect of ethanol extracts of the same plant on *Candida albicans* was higher than that of methanol extracts (Table3).

3.3. MFC of methanol and ethanol plant extracts against fungi growth

The MFC's of methanol and ethanol plant extracts on growth of *Penicillium chrysogenum, Aspergillus niger, Aspergillus nidulans and Candida albicans* are shown in Table (4). It was found that as the concentration of methanol and ethanol plant extracts increased, the growth of the isolates was inhibited until it became invisible. The highest dilution at which no growth in plates was determined as the MFC. The value of MFC varied according to the plant and the solvent used (Table, 4). The MFC of *Sarcopterum spinosum* ethanol extracts is the lowest against all fungi, compared to the MFCs of other plants. This means that this plant extract has the highest antifungal activity (Table, 4).

3.4. Antioxidant activity

In ABTS assay, the results show that the ethanol extract of *Sarcopterum spinosum* was found to be the most potent (IC_{50} 3.1 µg/ml), followed by *Artemisia seiberi* (IC_{50} 12.1 µg/ml) and the antioxidant capacity for other plants ethanol and methanol extracts is shown in Table (5).

In the FRAP assay, the results also show that the ethanol extract of *Sarcopterum spinosum* (4663.33µM ferrous/mg plant extraction) was the most electron-donating antioxidants followed by *Artemisia seiberi* (1575.33 µM ferrous/mg plant extraction) as shown in Table (5).

4. DISCUSSION

The ethanol and methanol extracts of *Sarcopterum spinosum*, *A.fragrantissima* and *Artemisia seiberi* showed high antifungal activity against four fungi species, *i.e.*, *Penicillium chrysogenum, Aspergillus niger, Aspergillus nidulans* and *Candida albicans.* This is explained by the low MFC for these

Table(3): Effect of Methanol and Ethanol plant crude extracts on growth of *Penicillium chrysogenum, Aspergillus niger, Aspergillus nidulans* **and** *Candida albicans* using **Potato Dextrose Agar (PDA).**

Scientific name	Methanol extract				Ethanol extract			
	Candida albicans	*Aspergillus niger*	*Aspergillus nidulans*	*Penicillium chrysogenum*	*Candida albicans*	*Aspergillus niger*	*Aspergillus nidulans*	*Penicillium chrysogenum*
Control	-	-	-	-	-	-	-	-
Melilotus indicus	-	-	-	-	-	-	-	-
Paronchia argentea	-	-	-	-	-	-	-	-
Artemisia seiberi	+	+	+	+	++	+	+	+
Arum hygrophyllum	-	-	-	-	-	-	-	-
Achillea fragrantissima	+	+	+	++	++	++	+	+++
Foeniculum vulgare	-	-	-	-	-	-	-	-
Sarcopterum spinosum	++	+++	++	+++	+++	+++	+++	+++
Citrullus colocynthis	-	-	-	-	-	-	-	-
Peganum harmala	-	-	-	-	-	-	-	-
Teucrium polium	-	-	-	-	-	-	-	-
Matricaria aurea	-	-	-	-	-	-	-	-

+: Zone of inhibition = 6mm
++: Zone of inhibition = 7mm
+++: Zone of inhibition ≥ 8mm

Table (4): MFC of Methanol and Ethanol extracts of some plants in mg/ml on growth of the tested fungi.

Scientific name of the plants	Methanol extract				Ethanol extract			
	Candida albicans	*Aspergillus niger*	*Aspergillus nidulans*	*Penicillium chrysogenum*	*Candida albicans*	*Aspergillus niger*	*Aspergillus nidulans*	*Penicillium chrysogenum*
	MFC	MFC	MFC	MFC	MFC	MFC	MFC	MFC
A. seiberi	8±0.6	8±1.15	6±0.6	8±0.3	9±0.6	8.5±1.15	8±0.8	9±0.6
A. fragrantissima	8.5±0.8	8 ± 0.3	6.5±0.6	9± 0.3	9 ±0.8	8.5±0.3	9 ±0.3	8.5 ±0.3
S. spinosum	8.5±0.3	8±1.15	7±0.3	8 ±0.8	8 ±0.3	6 ±0.3	6±0.6	7 ±0.8

Each value is the mean of three replicates ± SD

plants and the high zone of inhibition of the growth of fungi tested. It was previously found that *A.fragrantissima* has less polar compounds that exerted antifungal activity on *Candida albicans*. One of these compounds was identified as terpinen-4-ol and the commercial form of it had a similar antimicrobial activity. It was also reported that oils from *A. fragrantissima* inhibited the growth of some mycotoxigenic fungi, *i.e.*, *Aspergillus flavus*, *A. parasiticus*, *A. ochraceus* and *Fusarium moniliforme* (Abbasoglu and Kusmenoglu 1994 and Soliman and Badeaa, 2002).

Both ethanol and methanol extracts of *Artemisia seiberi* showed antifungal activity against *Penicillium chrysogenum, Aspergillus niger, Aspergillus nidulans* ,and *Candida albicans*. *Artemisia sieberi* main compounds are Camphor, 1,8-cineole , bornyl acetate, trans-verbenol, lavandulol and 1,8-cineole. Camphor compound had an antioxidat and fungicide bioactivity (Cao & Prior, 1998).

Table (5): Antioxidant activity of different ethanol and methanol plant extracts using the ABTS and FRAP methods.

Plant Species	ABTS		FRAB	
	IC_{50} (µg/ml)		µM ferrous/mg plant extract	
	Methanol	**Ethanol**	**Methanol**	**Ethanol**
Melilotus indicus L.	59.4 ± 1.1	23.8 ± 1.4	300.33 ± 15.8	250.83 ± 14.1
Paronchia argentea L.	51.5 ± 1.5	15.8 ± 0.5	1122.33 ± 32.3	733.83 ± 18.8
Artemisia seiberi L.	19.1 ± 2.0	12.1 ± 0.8	1651.83 ± 38.3	1575.33 ± 33.1
Achillea fragrantissima L .	71.3 ± 0.8	34.7 ± 2.3	690.33 ± 27.8	652.83 ± 15.8
Arum hygrophyllum L.	51.5 ± 1.5	52.5 ± 1.1	709.83 ± 27.9	600.33 ± 15.8
Foeniculum vulgare L.	47.5 ± 0.9	20.8 ± 1.4	835.83 ± 31.6	654.33 ± 10.1
Sarcopterum spinosum L.	7.6 ± 1.8	3.1 ± 0.4	4207.33 ± 76.9	4663.33 ± 82.5
Citrullus colocynthis L.	116.8 ± 0.9	65.4 ± 1.1	430.83 ± 15.8	408.33 ± 9.6
Peganum harmala L	239.6 ± 1.1	188.2 ± 0.7	267.33 ± 11.3	235.83 ± 9.7
Teucrium polium L.	45.5 ± 0.8	19.8 ± 0.5	1003.83 ± 34.6	768.33 ± 15.9
Matricaria aurea Loefl.	51.5 ± 0.8	19.8 ± 0. 7	954.33 ± 25.4	814.83 ± 21.1

In ABTS method the antioxidant activity was expressed as IC_{50} (µg/ml) at 734 nm.
In the FRAP method the antioxidant activity was expressed as total reducing power (µM ferrous/mg plant extraction) at 593 nm
Each value is the mean of three replicates ± SD

The essential oils (EO) of many aromatic plants have been documented to have specific antifungal activity against *Candida albicans*. The phenolic major components of (EO) have been suggested to have a potent antifungal activity (Viollon and Chaumont, 1994). The leaves components of medicinal plants provide the plant defense mechanism against the attack of microorganisms, insects and herbivore (Cowan, 1999).

The total antioxidant capacity (FRAP) values for the selected medicinal plant extracts ranged from 250 to 4663 µM ferrous/mg plant extraction. There was a strong correlation between the methanol and ethanol plant extracts . The advantage of the FRAP assay was that the reaction is reproducible, quick, simple to perform and linearly related to the molar concentration of the antioxidant(s) present (Benzie *et al.*, 1999).

The antioxidant activity of a compound against a free radical does not necessarily match its reducing ability. However, a strong correlation between values was obtained with FRAP and ABTS assay, *e.g., M. indicus* plant extract is very low as antioxidant in FRAP assay, but moderate antioxidant effect in ABTS assay. This result is identical to differences in antioxidant capacity of rat tissues determined by ABTS and FRAP assays (Katalinica *et al.,* 2005). It was also reported that there was no correlation in the total antoxidant activity obtained with two different methods assessing the total antioxidant capacity of human serum (Cao and Prior, 1998). This distinction may be due to different samples and sample preparation and different antioxidant defenses in these plants (phenol and essential oil in plant cell , cellular antioxidants).

S. *spinosum* extract showed the highest antioxidant activity by using both antioxidant assays. In the ABTS assay the IC_{50} was 3.1 µg/ml for EtOH and 7.6 µg/ml for MeOH and in the FRAP assay4663.33 µM ferrous/mg plant extract for EtOH extract and 4207.33 µM ferrous/mg plant extract for MeOH extract .

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التاثيرات المضادة للفطريات والأكسدة لمستخلصات بعض النباتات الطبية التى تنمو فى جنوب الأردن

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ملخص

تم اختبار تأثير المستخلصات الميثانوليه والايثانولية لإحدى عشر نبتة تنمو في جنوب الأردن كمضادات للأكسدة وكمضادات للفطريات.

تمت دراسة الفعل المضاد للفطريات لمستخلصات النباتات التالية : حندقوق، رجل الحمام، شيح، لوف، القيصوم، شومر، البلان، حنضل، حرمل، جعدة، بابونج على اربع عزلات فطريه وهي :*Penicillium chrysogenum* ، و *Aspergillus niger*، و *Aspergillus nidulans* ، و *Candida albicans* . *تم ملاحظة مدى تاثر* عزلات الفطريات الأربعة بالمستخلصات النباتية التالية :البلان والقيصوم والشيح . كما لوحظ ان تثبيط نمو الفطر يزداد كلما زاد تركيز المستخلص.

قد تراوح اقل تركيز مميت للفطريات عند استخدام المستخلصات الميثانولية بين 7- 8.5 ملغ/ مل من مستخلص نبات البلان، 6.5 - 9 ملغ/ مل في مستخلص نبات القيصوم و 6-8 ملغ/ مل في مستخلص نبات الشيح، للعزلات الفطرية الأربع.*في حين* تراوح اقل تركيز مميت للفطربات عند استخدام المستخلصات الايثانولية بين 6-8 ملغ/ مل في مستخلص نبات البلان، 8.5- 9 ملغ/ مل في مستخلص نبات القيصوم، 8- 9 ملغ/ مل في مستخلص نبات الشيح للعزلات الفطرية الأربع.

ظهر اقوى مضاد للاكسدة باستخدام طريقتين هما طريقة (ABTS) لمستخلص نبات البلان (IC_{50} 3.1 ميكرغرام/ مل للمستخلصات الايثانولية و IC_{50} 7.6 ميكرغرام/مل للمستخلصات الميثانولية) وباستخدام طريقة FRAP assay (4663.33 ميكرمولر/ملغرام فى المستخلص الايثانولي و 4207.33 ميكرمولر / ملغرام فى المستخلص الميثانولي).

ومن ناحية اخرى ، ظهر ان مستخلصات نبات البلان الايثانولية و الميثانوليه تمتلك اثرا مضادا للفطريات والاكسدة من بين الاحدى عشر نبتة المختارة من جنوب الاردن والتي فحص اثرها كمضاد للفطريات والاكسدة .

المجلة العلمية لكلية الزراعة – جامعة القاهرة – المجلد (59) العدد الثالث (يوليو 2008):241-248.