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RESEARCH ARTICLE

Evaluation of antioxidant and antimicrobial activities of ethanolic extracts of Parsley (*Petroselinum erispum*) and Coriander (*Coriandrum sativum*) plants grown in Saudi Arabia

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Abstract

Antioxidant and antimicrobial activities of the ethanolic extract of both seeds and green parts of parsley (*Petroselinum erispum*) and coriander (*Coriandrum sativum*) were examined in addition to their content of phenolic compounds. Several methods were used in studying the antioxidant activity such as peroxide value, p-anisidine test – malonaldhyde and DPPH (antiradical activity). Antimicrobial activity of the extracts towards six microbial strains; two bacterial strains (*Salmonella typhi* and *Staphylococcus aureus*), one yeast (*Candida tropicals*) and three fungal strains (*Aspergillus flavus*, *Mucor sp* and *Emericella nidulans*) was assessed by determination of inhibition zone and count of bacteria, yeast and spares of fungus. The results revealed that the leaves extracts have high levels of phenolics than the seeds extracts. Concerning antioxidant activity, significant decreases ($p<0.001$) were observed in peroxide, P- anisidine and TBA values as compared to control oil. On the other hand, scavenging activity % of the four extracts on DPPH radical were higher than that of butylated hydroxyl toluene (BHT) especially with high concentration (1000 µg/ ml). Regarding antimicrobial activity, the results showed that the extract of parsley seeds has the highest reduction percent in growth of all the examined microorganisms. The result also revealed that *Mucor sp* was resistant to the action of parsley extracts while *Aspergillus flavus* has the highest resistance against coriander extracts. In conclusion, utilization of parsley and coriander or their components as food additives will increase the antioxidant and the antimicrobial potential of the food which prevent food deterioration and improve the shelf-life of food beside its nutritional value.

1- Introduction

Many of the medicinal plants display antioxidant and antimicrobial properties which can protect the human body against both cellular oxidation reactions and pathogens. Thus it is important to characterize different types of medicinal plants for their antioxidant and antimicrobial potential (Mothana&Lindequist, 2005; Bajpai et al., 2005; Wojdylo et al., 2007). Medicinal plants are known to produce certain bioactive molecules which are responsible for their antimicrobial properties (Rios &Recio, 2005; Kuete et al., 2008; Sonibare et al., 2009; Kuete, 2010). The substances that can inhibit pathogens and have little toxicity to host cells are considered candidates for developing new antimicrobial drugs. On the other hand, indiscriminate use of commercial antimicrobial drugs in the treatment of infectious diseases has resulted in Multiple-drug resistance to many human pathogenic microorganisms.

Lipid peroxidation is an important deteriorate reaction in food during storage and processing. It not only causes a loss in food quality but also is believed to be associated with some diseases such as carcinogenesis, mutagenesis, ageing, and arteriosclerosis. The role of active oxygen and free radicals in tissue damage in such diseases, are

becoming increasingly recognized (Halliwell and Gutteridge, 1985). Cancer, emphysema, cirrhosis, arteriosclerosis, and arthritis have all been correlated with oxidative damage. Many antioxidant compounds, naturally occurring from plant sources, have been identified as free radical or active oxygen scavengers. Recently, interest has increased considerably in finding naturally occurring antioxidant for use in foods or medicinal materials to replace synthetic antioxidants, which are being restricted due to their effects such as carcinogenicity. Natural antioxidants can protect the human body from free radicals and retard the progress of many chronic diseases as well as retard lipid oxidative rancidity in foods .(Lai and choi, 2001).

The antioxidant properties of plant extracts have been attributed to their polyphenol contents .So plants containing high- level of polyphenols have a great importance as natural antioxidants. Many by products and wastes generated by agro-industries contain polyphenols with potential application as food antioxidants and preventive agents against some diseases (Torres et al., 2002). This situation has necessitated a more radical approach in the search for new antioxidant and antimicrobial substances from various sources which could be used as novel antioxidant and antimicrobial chemotherapeutic agents.

Parsley (*Petroselinum crispum*) as a spice is produced in vegetable garden ,it is a very rich source of vitamins C and E, carotene, thiamin and organic minerals, because of its high water content (78-82%,w\w.) parsley is ordinarily dried for market, in order to inhibit microorganisms growth and prevent degradation caused by biochemical reactions (Soysal, 2004).Wong and Kitts (2006) investigated that in vitro antioxidant effects prepared from different vegetative organs of parsley and observed that the essential oil plays a significant role in the scavenging effect.

The fixed oil of parsley contains petroseline plus oleic, linoleic, palmatic, and other fatty acids. Zheng et al. (1992) found that the major volatile aroma constituent of parsley essential oil, myristicin may be an effective as cancer chemopreventive agent. They also found that parsley showed weak antioxidant activity in groundnut oil under various heating conditions.

Coriander (*Coriandrum sativum* L.; Umbelliferae) is widely distributed and mainly cultivated for the seeds. The seeds contain an essential oil (up to 1%) and the monoterpenoid, linalool, is the main component (Wichtl, 1994). Coriander seed is a popular spice and finely ground seed is a major ingredient of curry powder. The seeds are mainly responsible for the medical use of coriander and have been used as a drug for indigestion, against worms, rheumatism and pain in the joints (Wichtl, 1994). Recent studies have also demonstrated hypoglycaemic action and effects on carbohydrate metabolism (Chithra&Leelamma, 2000; Gray & Flatt, 1999). Volatile components in essential oil, from both seeds and leaves, have been reported to inhibit growth of a range of micro-organisms (Delaquis et al., 2002), and inhibition of lipid peroxidation is reported as well (Anilakumar et al., 2001; Tanabe et al., 2002). Coriander leaves showed stronger antioxidant activity than the seeds, and in both parts of coriander, the ethyl acetate extract contributed to the strongest activity (Wangensteen et al., (2004). Coriander and basil were also highly inhibitors to E. coli and other bacteria and fungi tested. The phenolic compounds or polyphenols, secondary vegetal metabolites, constitute a wide and complex array of phytochemicals that exhibit antioxidant action and consequently a beneficial physiological effect (Martinez- Valverdeet al., 2000). Phenolic substances with an antioxidant activity, including phenolic acids and flavonoids, have been isolated from a variety of sources such as rosemary, sage (Lu & Foo, 2001) oregano, thyme and pepper (Nakatani, 1992). Briefly, these compounds are ubiquitously distributed throughout the plant kingdom (Naczk&Shahidi, 2004).

The objective of our study was to evaluate the phenolic compounds and to study both the antioxidant and the antimicrobial activities of extracts obtained from green parts and seeds of coriander and parsley plants grown in Taif region.

2- Materials and methods

2. 1-Plant Samples:

Seeds and green parts of Parsely and Coriander were purchased from Taif region, KSA.

2. 2- Chemicals:

All the chemicals used were of analytical grade which were purchased from Sigma Chemical Co.

2. 3- Microorganisms used:

Six microbial strains were used in this investigation. These microbes were two bacterial strains, *Salmonella typhi* (*Enterobacteriaceae*) and *Staphylococcus aureus (Micrococcaceae)*, one yeast strain called *Candida tropicalis* and three fungal strains namely *Aspergillusfalvus (Trichocomaceae), Mucorsp (Mucoraceae)* and *Emericella nidulans*

(Trichocomaceae). These microorganisms were kindly taken from Prof. Husain El-Fadaly, Prof. and Head of Microbiology Dept., Faculty of Agric., Dameitta Univ., Dameitta, Egypt.

2.4- Samples preparation.

Leaves and seeds of both parsley and coriander plants were dried and grinded in a blender. The powder of each sample was kept in a polyethylene bags and preserved in deep freezer until use.

2.5- Extraction of the ethanolic extract:

About 250 grams of each milled plant samples were macerated in 500 ml of methanol overnight at room temperature, then filtered and the ethanolic crude extract was collected. Another portion of 500 ml of ethanol were added to the plant residue and homogenized in a blender for five minutes and filtered. The filtrate was collected to the previous crude extract. The residue was subjected to additional 500 ml of ethanol and left at room temperature overnight, then filtered. The filtrate was added to the previous crude extract to form the ethanolic extract. The solvent was evaporated under vacuum using rotary evaporator. The crude extract was obtained, kept in dark bottles and stored in a deep freezer until use.

2.6- Total phenolic contents of the seeds and green parts of both parsley and coriander extracts.

The FolinCiocalteu procedure (Ghafoor& Choi, 2009) was used to measure the total phenolic contents of the seeds and green parts of both parsley and coriander extracts. This method depends on the reduction of Folin's reagent by phenols to a mixture of blue oxides which have a maximal absorption in the region of 765 nm. A 200 µL properly diluted sample or a standard solution of varying concentrations were mixed with 400 µLFolinCiocalteu reagent. The deionized water was used for dilution and control. The solution was diluted to a total volume of 4.6 mL using deionized water then thoroughly mixed. After incubation for 10 minutes at room temperature, 1 mL of 20% Na_2CO_3 solution was added then immediately mixed and incubated for 2 h. The absorbance was read at 765 nm on a spectrophotometer. Measurements were recorded in triplicates.

Gallic acid of 1 mg/ml was used as the standard and the total phenolic compounds of the samples were expressed in grams gallic acid equivalent (GAE) per 100 g extract (g GAE/100 g).

2.7- Antioxidant activity:

The antioxidant is system dependent and according to the method adopted and lipid system used as substrate. Hence, different methods have been adopted to assess anti-oxidative potential of the plant extract, which are as follows.

2.7.1-Evaluation of antioxidant activity for sunflower oil:

To assess the antioxidant activities of the ethanolic extracts, crude sunflower oil obtained from local market, having initial peroxide value of 2.5meq/kg was taken for present investigation. This oil is the most frequently used edible oil. The antioxidant activities of the extracts were examined by comparing the activity of known antioxidants such as BHT by peroxide, thiobarbituric acid, P-anisidine, and total carbonyl values.

2.7.1.1- Peroxidevalue:

The peroxide value was determined according to AOAC (2000) with a modified oven test (Bandoniene et al., 2002). The antioxidant activities of parsley and coriander extracts were compared with synthetic antioxidant (BHA). The calculated quantities of the extracts (100ppm) were added to 9g sunflower oil in open –mouthed beaker. The mixtures were thoroughly homogenized and placed into thermostat at 80 C. The peroxide values (meq/kg-1) were measured every 7days, and test was replicated for 3 times. A control sample was prepared under similar conditions without any additives.

2.7.1.2- Thiobarbituric acid value (TBA):

The test was performed according to the methods previously described by (Sidwell et al. (1954) as follow: The same samples as prepared for the peroxide value method were used. To 3gsample, ten ml from 0.67% aqueous thiobarbituric acid reagent, which prepared by mixing a volume of glacial acetic acid with an equal volume of the TBA solution, were pipetted into the flask and shaken for 4 minutes using a mechanical shaker . After 2 h, the supernatant was taken and placed in a boiling water bath for 30 min. After cooling, absorbance of the supernatant was measured at 530 nm with Hitachi- U 2000 spectrophotometer .TBA value was expressed as mg. malonaldhyde /kg sample using the following equation:

TBA=7.8 x O.D.

O.D. is the absorbance at 530 nm.

2.7.1.3- P-Anisidine value :

The test was performed according to the methods of AOAC (2000). The same samples as prepared for the peroxide value method were used. In a 25- mL volumetric flask, 0.6g sample (m) was taken, and the volume was made using iso-octane solution .The absorbance (Ab) of the solution was measured at 350 nm against the solvent as a blank. Exactly 5 ml of the fat solution was pipetted into one test tube and exactly 5ml from the solvent into a second test tube. One ml of the P-anisidine reagent (0.25% in glacial acetic acid) was added to each tube and shaken, kept in dark for 10 min, then the absorbance (As) was measured at 350 nm against the solution from the second test tube as a blank using a UV-VIS spectrophotometer.

The P-anisidine value (P-A.V.) is given by the formula:

$$\text{P-A.V.} = \frac{25 \times (1.2As - Ab)}{m}$$

2.7.2- Scavenging effect on DPPH:

The DPPH assay constitutes a quick and low cost method, which has frequently been used for the evaluation of the antioxidant potential of various natural products (Cotelle et al, 1996; Silva et al, 2000). Due to its odd electron, DPPH gives a strong absorption band at 516 nm (deep violet color). In the presence of a free radical scavenger, this electron becomes paired, resulting in the absorption loss and consecutive stoichiometric decolorization with respect to the number of electron acquired. The absorbance change produced by this reaction is assessed to evaluate the antioxidant potential of the test sample. Scavenging effect on DPPH radical was determined by the method reported earlier by some authors (Miller et al., 1997, Sanchez, M. and Calixto, F., 1998) with minor modifications. The extracts (100, 200, 250, 500 and1000µg) in methanol (1 mL) was mixed with 4 mL of 0.004% methanolic solution of DPPH . The mixture was shaken vigorously and left to stand for 30 min in dark at 30 C, and the absorbance was then measured at 517 nm in a UV – VIS spectrophotometer. The percent of radical scavenging was calculated according to the formula

Antiradical activity % = 100 x {absorbance of control- absorbance of sample} / {absorbance of control.}

2.8- Microbiological tests of plant extracts:

2.8.1-Count of bacteria and yeast:

Total bacterial and yeast count were determined according to APHA (1998) by plating suitable dilution (10^5) in triplicates using nutrient agar medium (Difco, 2009). pH was adjusted to 6-8 for bacteria and 5 for yeast. The plates were incubated at 30^o for 48 h, and then counting of developed colonies was performed.

2.8.2-Fungal spores count:

Suitable dilution (108) of fungal spores' suspension was inoculated into PDA medium in triplicates. After solidification, plates were incubated at 28^o C for 10 days. After incubation period, developed fungal colonies were counted per each plate and the mean value was recorded according to APHA (1998).

2.8.3-Assessment of antimicrobial activities:

The antimicrobial activities of the tested plant extracts were examined using agar well diffusion method as described by Kacaniova et al. (2009). Petri dishes containing 20 ml of nutrient agar in case of bacteria and yeast. In case of fungi, petri dishes containing 20 ml PDA. All petri dishes were seeded with a fixed count of yeast and bacterial count and fungal spores as well. Wells of 6.0 mm in diameter were done by a sterilized cork borer. Each well was filled up with 50 ul of each tested plant extract after being sterilized by micro filter (Flowpore D 0.2um, Germany made). All plates were incubated at 30^o C for bacteria and yeast and at 28^o C for fungi. Then appeared inhibition zones were carefully measured after 48 h in case of bacteria and yeast while in case of fungi obtained inhibition zones were measured after 10 days. The mean values of three replicates were recorded.

2.9- Statistical analysis (SAS, 2001):

All the analyses were carried out in triplicates and the experimental results were expressed as the mean ±S.D. Student t-test and Pearson correlation coefficients were from Excel program (SPSS Series). Differences were considered significant at $p < 0.05$.

3- Results and Discussion

3.1-Total phenolic contents of the seeds and green parts of both parsley and coriander extracts.

The total phenolic contents in extracts obtained from the seeds and leaves of coriander and parsley are shown in Table (1). The highest content (0.92 g GAE/100g) was observed in extract of parley leaves followed by coriander leaves (0.83g GAE/100g). It was noticed that the leaves have higher amounts of phenolic compounds than the seeds. However, the coriander seeds extract contains 0.72g GAE/100g while the extract of parsley seeds contains 0.62g GAE/100g). These results are consistent with that obtained by Al-Juhaimiand Ghafoor (2011.)

Table (1): The total phenolic contents in extracts obtained from the seeds and leaves of coriander and parsley in g GAE/100 g extract.

Extract	**Phenolic contents** (g GAE /100g)
Coriander leaves	0.83 ± 0.02
Coriander seeds	0.72± 0.01
Parsley leaves	0.92 ± 0.4
Parsley seeds	0.62± 0.01

Each value is the Mean ± SD

3.2- Antioxidant activities:

3.2.1- Inhibitory effect of parsley and coriander extracts on the primary oxidation of sunflower oil as measured by means of peroxide value

Table (2) illustrates peroxide value changes in sunflower oil of all investigated samples at 60 C. Peroxide value is a widely used measure of the primary lipid oxidation, indicating the amount of peroxides formed in the fats and oils during oxidation. Sunflower oil oxidation was measured at time intervals of 7 days during 28 days of storage. The results revealed that the extracts of parsley seeds, coriander seeds and green parsley reduced peroxide value significantly after 7 days of storage. On the other hand, all the extracts decreased peroxide value significantly (at $P<0.001$) as compared to control after 14, 21 and 28 days of storage. The maximum reduction which reached 7.5 after 28 days was noticed in the sample treated with extract of parsley seeds followed by green parsley, coriander seeds and green coriander where their values were 7.9, 9.4 and11.0 while BHT reached 9.2. It is obvious that the parsley extracts have an antioxidant potential better than that of the artificial antioxidant, BHT.

Table (2): Inhibitory effect of parsley and coriander extracts on the primary oxidation of sunflower oil asmeasured by using peroxide value compared to BHT.

	Zero Time	**7 days**	**14 days**	**21 days**	**28 days**
Oil control	2.53 ± 0.45	5.94± 0.11	11.44 ± 0.49	13.42 ± 2.09	19.8 ± 0.27
Oil + BHT	2.53 ± 0. 45	3.74± 0.39 *	4.6 ± 0.66***	6.6 ± 0.27***	9.2 ± 0.39***
Extract of Parsley seeds	2.53 ± 0. 45	3.63 ± 1.43*	6.66 ± 2.2***	7.04 ±1.65***	7.59 ± 0.05***
Extract of coriander seeds	2.53 ± 0. 45	3.52 ± 0.57**	6.05 ± 0.99***	7.92 ± 1.43***	9.46 ± 0.35***
Extract of green parsley	2.53 ± 0. 45	3.85± 1.15**	4.84± 1.15***	7.48± 1.13***	7.9± 0.33***
Extract of greencoriander	2.53 ± 0. 45	4.73 ± 1.32	5.17 ± 1.65***	7.26 ± 1.15***	11 ± 0.88***

Each value is the Mean ± SD

Significant with control group* $P < 0.05$ ** $P < 0.01$ *** $P< 0.001$.

3.2.2- Inhibitory effect of parsley and coriander extracts on the formation of 2-Alkenes on sunflower oil during heating as measured by P-anisidine method.

P-anisidine values which reflect the inhibitory effect of the ethanolic extracts of the plants under study on the formation of 2-Alkenes in sunflower oil were recorded in Table (3). P-anisidine was determined every 7 days; the effects of extracts under study on alkenes formation in sunflower oil were carried out. The results revealed that all the extracts significantly decreased p-anisidine values during all the periods of the experiment as compared to control. After 7 days, the p-anisidine value of the oil treated by green parsleyextract reached (28.7) followed by parsley seeds, coriander seeds and green coriander where their p-anisidine values were 29.26, 33.06 and 33.3 respectively while BHT was (25.08). It is clear that the green parts extracts of both parsley and coriander exhibit the most inhibitory effect towards 2-alkenes formation in the treated oil where their values being, 34.1 and 35.64 at the end of the experiment, respectively in comparing with control (112.5).

Table (3): Inhibitory effect of parsley and coriander extracts on the formation of 2-Alkenes on sunflower oil as measured by P-anisidine method.

	Zero Time	**7 days**	**14 days**	**21 days**	**28 days**
Oil control	14.9 ± 0.12	41.09 ±0.90	51.8 ± 2.8	91.74± 5.39	112.5 ±0.11
Oil + BHT	14.9 ± 0.12	25.08 ±0.39***	25.1 ± 0.27***	30.03 ± 1.59***	37.46 ± 0.55***
Extract of Parsley seeds	14.9 ±0.12	29.26 ±0.44***	24.86 ± 0.22***	32.23 ±0.66***	38.9 ±0.1.01***
Extract of coriander seeds	14.9 ± 0.12	33.06 ± 0.44***	28.04 ± 1.88***	39.45 ± 0.60***	43.89 ± 1.54***
Extract of green parsley	14.9 ± 0.12	28.7 ± 0.68***	23.27 ± 1.54***	30.69 ± 0.66***	34.1 ± 1.87***
Extract of green coriander	14.9 ± 0.12	33.3 ± 0.28***	27.28 ± 1.43***	31.57 ± 1.21***	35.64 ± 1.1***

Each value is the Mean ± SD
Significant with control group* P < 0.05 ** P < 0.01 *** P< 0.001.

3.2.3- Inhibitory effect of parsley and coriander extracts on malonaldehyde formation in sunflower oil measured by using TBA value method.

Malonaldehyde formation was determined every 7 days, the effects of ethanolic extracts of samples under study on malonaldehyde formation insunflower oil in terms of incubation times versus TBA value at 60C was shown in Table (4). After 7 days the reductions in TBA values caused by all the extracts were significant as compared to control oil, the highest reduction (0.48) was caused by extract of coriander seeds followed by parsley seeds (0.51), green parsley (0.76), and green coriander (1.13) while BHT was (0.46) mg/kg.

After 28 days, the reductions in the malonaldehyde formation were significant as compared to control oil which increased to 12.65 with storage time; the highest reduction (3.41) was caused by the extract of parsley seeds, followed by green parsley (3.96), green coriander (4.84) and coriander seeds (5.01). However BHT reduction was (4.18). It was noticed that parsley seed and green parsley are better than that of BHT. Our results agreed with Gurdip et al. (2005) who studied the effects of volatile oil and acetone extract of dill on malonaldehyde formation for rapeseed oil in terms of incubation time versus TBA value at 80C. They stated that the malonaldehyde formation increases in rapeseed oil with storage time.

Table (4): Inhibitory effect of parsley and coriander extracts on the formation of malonaldehyde in sunflower oil as measured by using TBA

	Zero Time	**7 days**	**14 days**	**21 days**	**28 days**
Oil control	0.48 ± 0.01	1.87 ± 0.02	5.28 ± 0.22	7.37 ± 0.22	12.65 ± 0.22
Oil + BHT	0. 48 ± 0.01	0.46 ± 0.09 ***	2.8 ± 0.22***	3.19 ± 0.11***	4.18 ± 0. 11***
Extract of Parsley seeds	0.48 ± 0.01	0.51 ± 0.01***	3.1 ± 0.41***	3.32 ± 0.11***	3.41 ± 0.06***
Extract of coriander seeds	0.48 ± 0.01	0.48 ± 0.01***	3.9 ± 0.05***	4.07 ± 0.11***	5.01 ± 0.25 ***
Extract of green parsley	0.48 ± 0.01	0.76 ± 0.05***	3.45 ± 0.05***	3.36 ± 0.16***	3.96 ± 0.286***
Extract of green coriander	0.48 ±0.01	1.13 ± 0.03***	3.5 ± 0.07***	3.74 ± 0.05***	4.84 ± 0.16***

Each value is the Mean ± SD
Significant with control group* P < 0.05 ** P < 0.01 *** P< 0.001.

3.2.4- Scavenging effect (%) of parsley and coriander extracts on 1,1-diphenyl-2-picrylhydrazyl radical (DPPH).

The 1,1-diphenyl-2-picrylhydrazyl radical (DPPH) is a stable radical with a maximum absorbance at 517 nm that can readily undergo reduction by an antioxidant. Because of the ease and convenience of this reaction, it now has widespread use in the free radical scavenging activity assessment (Brand Williams 1995). The results in Table (5) showed that the seeds extracts of parsley and coriander have high scavenging activity on DPPH which is more than that of BHT especially with the concentrations of 250, 500 and 1000 µg/ml. The scavenging effect of the four extracts (1000µg/ml) was as follows; 91.97% for parsley seeds, 89.52 % for Coriander seeds, 88.91% for parsley green parts and 89.82% for green parts of coriander while it was 90.73% for BHT.Although the results revealed that the concentration of 1000 µg/mlwas the best, it is preferable to use the concentration of 500ug/ml because the differences in the results were not too much. At 500µg/ml, the extract of parsley seeds was the best radical scavenger with (88.23%) followed by coriander seeds, green coriander and green parsley where their scavenging effects were 87.9, 83.64 and 77.79 % respectively in comparing with BHT (83.2 %).
The highest antioxidant activity of the seeds isdue to their content of phenolic compounds in addition to their content of volatileand fixed oils.

Table (5): Scavenging effect (%) of parsley and coriander extracts on 1,1-dipheny-l-2-picrylhydrazyl radical (DPPH).

	1000µg/ml	500 ug /ml	250 ug /ml	200 ug /ml	100 ug /ml
BHT	90.73 ± 2.69	83.20.1±2.01	70.67 ± 2.23	67.79 ± 4.67	45.34 ± 1.16
Extract of Parsley seeds	91.97 ± 4.38	88.23 ± 1.65	86.05 ± 4.49	84.97 ± 0.86	84.13 ± 0.83
Extract of coriander seeds	89.52 ± 2.03	87.9 ± 1.65	72.67 ± 1.30	66.15 ± 0.52	39.44 ± 0.58
Extract of green parsley	88.91 ± 1.41	77.79 ± 2.17	69.75 ± 0.72	63.39 ± 0.51	50.18 ± 0.46
Extract of green coriander	89.82 ± 1.9	83.64 ± 0.48	79.82 ± 2.27	37.30 ± 0.89	27.21 ± 0.67

* Each value is the Mean ± SD

Simon et al. (1984) reported that parsley is a rich source of vitamin C and yields a fixed oil, an essential oil, and tannins. The seeds contain both a fixed and volatile oil, the latter being comprised of apiol, myristicin, tetramethoxybenzene, pinene, and other compounds. The leaf or herb oil is considered superior to seed oil, as the volatile characteristics are more similar to parsley leaves.

Our results did not agree with that of Wangensteen et al. (2004) who stated that the ethyl acetate extract of Coriander leaves showed stronger antioxidant activity than the seeds. In our work we used ethanol in extraction which extracts a variety of compounds rather than ethyl acetate.

Yung et al. (2009) studied the antioxidant activities of ethanolic extract of dill flower and its various fractions by evaluation the 2,2-diphenyl-1-picrylhydrazyl radical scavenging, Trolox equivalent antioxidant capacity, reducing power, chelating power, and β-carotene bleaching assays. They reported that the flower extract showed higher antioxidant activity than the leaf and seed extracts.

3.3- Antimicrobial results:

Results in Table (6) indicate that parsley had the most inhibitory action on the tested microorganisms. The highest inhibition zone was noticed in *Candida tropicals* (25 mm) followed by *S. typhi* and *Staph. aureus* to be 23 and 22 mm, respectively.

Green parts of parsley exhibited a remarkable inhibition zone less than that of parsley seeds but more than the extracts of coriander either seeds or green parts. However, the extract of coriander seeds showed inhibition zone more than that of its green parts.

Regarding the reduction percent of the microorganisms' growth as affected by parsley and coriander extracts (Table 7), it is clear that the extract of parsley seeds showed the highest reduction percent in growth of all the examined microorganisms. The highest reduction percent (60%) was noticed in *S. typhi* followed by *Asp. flavus* (47%) and *Emricella nidulais* (36%). The extract of parsley green parts revealed a reduction percent of about 40% in the growth of *S. typhi* and 33% in the growth of *A. flavus* whereas the least reduction was noticed in *Mucor sp* (11%). On the other hand, the extract of coriander seeds revealed a reduction percent of 44% in the growth of *S.typhi* followed by *Mucor sp.* (28%), *Emericella nidulais* (27%), and *Candida tropicals* (25%). The extract of coriander green parts has the lowest effect among the four extracts on the growth of the microorganisms under study. The highest activity of the seeds extracts is due to their high content of volatile oils, in addition to their content of phenolic compounds. The results also revealed that *Mucor sp*. was resistant to the action of parsley extracts while *Asp. flavus* has the highest resistance against coriander extracts.

Table (6): Zone of inhibition (mm) of parsley and coriander extracts against some pathogenic bacteria and some food-born fungi

Microorganism used / Plant extract	Pathogenic bacteria		Yeast	Food-borne fungi		
	S.Typhi	*Staph. aureus*	*Candida tropicals*	*Asp.flavus*	*Mucorsp*	*Emericella nidulais*
Parsley seeds	23	22	25	18	19	17
Green parts parsley	20	18	22	16	18	15
Coriander Seeds	16	14	19	12	14	12
Green parts coriander	12	9	16	10	12	14

* Each value is the mean of three replicates

The antimicrobial activity of the four extracts under study is attributable to their content of phenolic compounds. Farag et al. (1989) stated that the microbial activity of herbs is due to the presence of phenolic

compounds. Many flavonoids such as furocoumarins and furanocoumarins have been isolated from parsley leaves which are known by their antibacterial activities against Listeria and Micrococcus species (Gram positive) and Escherichia and Erwinia species (Gram negative) (as reported by Manderfield et al, (1997) and Ulate-Rodriguez et al, (1997). Furoisocoumarins was also isolated from coriander leaf (Ceska et al., 1988).
Jeongmok et al. (1995) explained the role of plant extracts in inhibition the growth of bacterial strains by interference with the phospholipids bilayer of the cell membrane causing increasing permeability and less of cellular constituents or by impairment of a variety of enzymatic systems including those involved in the production of cellular energy and synthesis of structural components.

Table (7): Reduction (%) of the microbial and fungal growth as affected by parsley and coriander extracts after 48 hrs. incubation at 30° C for bacteria and yeast and 10 days at 28° C for fungus

Microorganism used / Plant extract	Pathogenic bacteria		Yeast	Food-borne fungi		
	S.Typhi	*Staph. aureus*	*Candida tropicals*	*Asp.flavus*	*Mucorsp*	*Emericella nidulais*
Parsley seeds	60	33	20	47	28	36
Green parts parsley	40	28	13	33	11	23
Coriander Seeds	44	22	25	13	28	27
Green parts coriander	28	11	23	7	17	18

* Each value is the mean of three replicates

4- Conclusion:

It was concluded that the ethanolic extracts of seeds and green parts of parsley and coriander plants grown in Taif region, KSA exhibited antioxidant and antimicrobial activities; this is attributed to their content of phenolic compounds. These observations encourage using the two plants or their extracts as natural preservatives agents which prevent food deterioration and improve the shelf-life of food. These extracts can be used in pharmaceuticals as antioxidant drugs for cardiovascular and cancer diseases. Further studies are required to separate and identify the active components of these extracts.

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