Antibacterial and antioxidant activities of essential oils extracted from Iraqi coriander (*Coriandrum sativum* L.) seeds

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Abstract— This study focuses on extraction of essential oils from Iraqi seeds of Coriander plant (Coriandrum sativum L.). The yield of essential oils was 2 % (V: W) of seed, analyzed by the GC- mass technique. The essential oil contained 35 varieties of compounds, with Linalool (59.14 %) compound prevailing in the essential oils extract. The essential oils of Coriander have antibacterial activity against G^+ and G^- bacteria. *Leuconostoc mesenteroides* had the most inhibition while *E. coli* ATCC 25922 had the lowest inhibition after the addition of essential oils concentrations. After the end storage period which is 25 days, peroxide values and fatty acids % of fat milk samples were decreased when increase the concentrations of essential oil added compared with the BHA sample

Index Terms— Coriander plant; essential oils; antibacterial; antioxidant.

1 Introduction

Essential oils from plants and plant parts, which are secondary metabolic products of plants, have many applications food preservatives, perfume, ethnomedicine and pharmaceutical industries [1]. It also has antimicrobial and antifungal properties [2], along with antioxidant properties [3].

Coriander plant (*Coriandrum sativum* L.) is an annual herb, which is the member of the Apiaceae or Umbelliferae family [4]. It is a medicinal plant that grows in wide areas across the world. Coriander seeds are composed of 7.3 % water, 21.83 % protein, 4.76 fat, 14.02 % ash and 52.1 % carbohydrates. The fat content includes petroselinic acid 68.6%, linoleic acid 16.6%, oleic acid 7.3% and palmitic acid 3.8 %. The seeds also have distinct essential oils. Linalool is the main compound of essential oil extracted from coriander seeds [5,6]. It is a well-known herb, and is used as a spice extensively and also in folk medicine, pharmacy and food industries [7]. The essential oil of Coriander is known for its inhibition activity against Gram positive and negative bacteria [8], molds and yeasts [9].

The various compound extracts and essential oil from coriander have been proven to possess antibacterial, anti-oxidant, free radical, antidiabetic, anticancerous, antimutagenic and higher activities [10,11]. The essential oil of coriander has antioxidant activity when added to salami product in order to lead reduction in lipid oxidation and increasing the shelf life of the product [12].

The aim of the study is the extraction of essential oils from Coriander (Coriandrum sativum L.), cultivated in Basra city, and identification, composition and determination of antimicrobial and antioxidant activity.

2 Materials and Methods

2.1 Coriander seeds

One (kg) of coriander seeds was purchased from the market in Basra city, and transferred to the Biotechnology Lab., Food Science Department, Agriculture College, Basra University..

2.2 Extraction of essential oil

Essential oil was extracted from coriander seed using Clevenger apparatus. 250 g of seeds with 500 ml of distilled water was transferred into oil distillation for 1-2 hours at 90℃. The essential oil was then collected and determined by calibrated tube. It was kept in the freezer [13].

2.3 Gas Chromatography-Mass Spectrum Analysis (GC-MS)

GC-MS technique was used in this study to identify the essential oils extracted from coriander (*Coriandrum sativum* L.) seeds. GC-MS technique was carried out at the GC-mass Lab, Agriculture College, Basra University, Basra City, Iraq. GC-MS analysis of this essential oils extract was performed using GC SHIMADZU QP2010 Ultra and gas chromatograph, interfaced to a Mass Spectrometer (GC-MS) equipped with DbB5ms capillary column.

The relative percentage amount of each component was calculated by comparing its average peak area to the total areas. Software adopted to handle mass spectra and chromatograms was a GC-MS solution ver.2.53 [14] .

2.4 Bacterial isolates

Seven isolates bacteria: Bacillus subtilis, *E. coli* ATCC 25922,

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Enterobacter aerogenes ATCC 35029, *Leuconostoc mesenteroides*, *Listeria monocytogenes* ATCC 9525, *Pseudomonas erogenous* ATCC 10145 and *Staphylococcus aureus* ATCC 25923 were obtained from Food Science department, Agriculture college, Basra University, and grown on Nutrient broth (Hi-media, India) at 37℃ for 18 hours. 1ml of bacteria growth was adjusted to correspond with the turbidity standard of 0.5 McFarland units. This was prepared by mixing 0.7 mL of 1.75% (w/v) barium chloride dehydrate with 99.3 ml 0.5 % (v/v) sulfuric acid. The turbidity was roughly equivalent to 1×106 cfu / mL.

2.5 Antibacterial activity essay

Agar diffusion method was determined by the antibacterial activity of essential oil extract from Coriander. 1 mL of bacteria test was streaked on Mueller-Hinton agar (Hi-media, India) and worked on 3 walls (6 mm) in agar. 3, 5 and 7 µL of essential oil extract were transferred to walls and kept in the refrigerator for 1 hour. After the Petri dishes were incubated at37℃ for 24-48 hours, effective inhibitory was estimated by measuring diameters of clear zones [15].

2.6 Antioxidant activity essay

The fat extract from buffalo milk was centrifuged at 6000×g / min for 15 minutes. 100 g of fat extraction was mixed with 0.2, 0.4, 0.6, 0.8 and 1 mL(V: W), respectively, which was stored at 4℃. The analyses are described in the following paragraphs. Evaluation of oxidation was done periodically by measuring the peroxide value and Free fatty acid at 1, 5, 10, 15 and 25 days of storage according to [16]. These samples were compared with a sample contain 0.2% Butylated hydroxyanisole (BHA) (Sigma Company).

3 Results and Discussion

3.1 GC-MS of *Coriandrum sativum* L. oil

The essential oil yield of Coriandrum sativum L. was 2% (V:W) from seeds. The essential oil was studied for composition study, analyzed by GC-MS (Figure 1 and Table1). It contained 35 compounds, mostly of phenolic compounds and aromatic acids. The main compound is Linalool (59.14 %), which has other names such as 1,6-Octadien-3-ol, 3,7-dimethyl, Linalyl alcohol, beta.-Linalool, 2,6-Dimethyl-2, 7-octadien-6-ol and p-Linalool. Linalool is a naturally occurring terpene alcohol chemical found in many flowers and spice plants with many commercial applications [17]. There are many studies that indicate that Linalool is the main compound in essential oil extract from coriander plant 37.7 % [5], 76.33 % [18], 58.0 - 80.3 % [19] and 72.5 % [20].The other major compounds were gamma-Terpinen (8.92 %), α-Pinene (5.86.10 %), Geraniol (3.74%), Nerol (3.51%), P-propenylanisole (3.41 %), Bicyclo-heptan-2-one (3.09 %) and D-Limonene (1.99 %). The aliphatic aldehydes compounds were few in essential oils of Coriander and its contents linalool, phytol and oleic acid [21]. The essential oil distilled from the coriander, containing linalool compound, as the main component, elucidates antifungal activity. Whereas, oleoresin that is rich in oleic and linolenic acids, is suggested as an alternative source of natural resources antioxidants [22].

Table 1. The composition of essential oils extract from *Coriandrum sativum* L. seeds analyzed by GC-MS

Peak	R.time	Name of compound
1	5.139	α.-Pinene
2	5.444	Bicyclo[2.2.1]heptane,
3	5.933	β-Phellandrene
4	5.997	L-β-pinene
5	6.773	(+)-4-Carene
6	6.914	m-Isopropyltoluene
7	6.999	D-Limonene
8	7.528	gamma.-Terpinen
9	7.737	α.-Methylα-[4-methyl-3-pentenyl
10	7.991	2-Carene
11	8.314	Linalool
12	8.492	1,3,5-ris(trimethylsilyl)
13	8.994	Bicyclo-heptan-2-one
14	9.103	Rhodinal
15	9.392	Linderol,
16	9.522	L-4-terpineneol
17	9.755	α-Terpineol
18	9.939	Capric aldehyde
19	10.258	Elenol
20	10.402	Pulegone
21	10.470	Cuminal
22	10.608	Nerol
23	10.761	(2E)-2-Tridecenal
24	10.861	6,11-Dimethyl-2,6,10-dodecatrien-1-ol
25	10.925	Caprinic alcohol
26	11.113	P-propenylanisole
27	11.409	Hendecanal
28	11.614	Myrtenyl acetate
29	12.017	3-Allyl-6-methoxyphenol
30	12.365	Geraniol
31	12.706	o-Isoeugenol
32	12.775	Tetradecanal
33	12.895	Caryophyllene
34	13.270	trans-Isoeugenol
35	13.510	2-Dodecenal

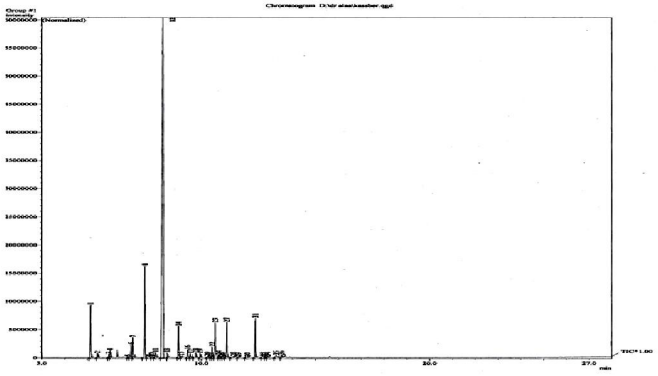

Figure 1. The chromatogram of essential oils extract from *Coriandrum sativum* L. seeds

3.2 Bacterial inhibition

Table 2 shows the results of bacterial inhibition by three concentrations of essential oil from coriander. High concentration of essential oil from coriander led to increase in zones inhibition for all strains test. The G^- bacteria was less affected, as compared to the G^+ bacteria. The inhibition zone of *Leuconostoc mesenteroides* was 28.76 mm when 7 µL of essential oils from coriander was used. The inhibition zone of *Enterobacter aerogenes* ATCC 35029 was 10.00 mm when 3 µL of essential oil from coriander was used.

The results were in synchronous with my studies about the ability of essential oil from coriander regarding inhibition of G^+ and G^- bacteria [23-25] The G^+ bacteria as *Bacillus cereus* showed high inhibition as compared with the G+ bacteria as *Enterococcus faecalis* [8]. The essential oil from coriander have more effective molecules that act as antibacterial agents [5].

Table 2. Diameters of bacterial zones inhibition by concentrations of essential oils Coriander

Bacteria isolates	Concentrations of essential oil Coriander		
	3 µl	5 µl	7 µl
B. subtilis	16.00±0.50	21.20±0.34	28.23±0.30
E. coli ATCC 25922	11.00±0.00	15.10±0.43	21.20±0.36
E. aerogenes ATCC 35029	10.00±0.20	15.46±0.15	23.00±0.00
L. mesenteroides	17.00±0.00	20.23±0.35	28.76±0.15
L. monocytogenes ATCC 9525	16.30±0.35	19.70±0.50	26.86±0.60
P. erogenous	11.00±0.00	14.23±0.30	22.56±0.11
S. aureus ATCC 25923	16.50± 0.23	21.03±0.20	27.30±0.86

3.3 Antioxidant activity

As shown in Figure 2, after end storage time the peroxide value increased in all samples. But in case of the sample without essential oil from coriander, there was a high increase in peroxide value. With the addition of essential oil from coriander, concentrations were reduced in the peroxide values during storage time. Increase of the essential oil from coriander concentrations, reduced the peroxide values. The sample with 0.8 % of essential oil from coriander overtook the sample with BHA during the storage time. The peroxide value of fat milk simple with 0.8 % of essential oil from coriander was 0.49 meq/ kg in fat milk, while it was 0.55 meq/ kg fat milk in sample with BHA after end storage time.

The essential oil from coriander was extracted from seeds that were cultivated in southern Iraq. It showed best antioxidant activity. These results agreed with other researches as well [27-30].

Effects of adding essential oil from coriander to fatty acid values of fat milk were showed in Fig.3. Adding 0.6, 0.8 and 1 % of essential oil from coriander were best during the reduction of fatty acids values to 1.62, 1.43 and 1.16 % respectively, than with the BHA sample that gave 1.75 % of fatty acids after 25 days of storage time. The formation of free fatty acids is also a measure of rancidity in foods. Fatty acids are formed due to the decomposition of triglycerides by native lipase enzymes and enzymatic activity of microbial growth in [31]. Inhibition activity of essential oil against microbial led to reduction of fatty acid % [32].

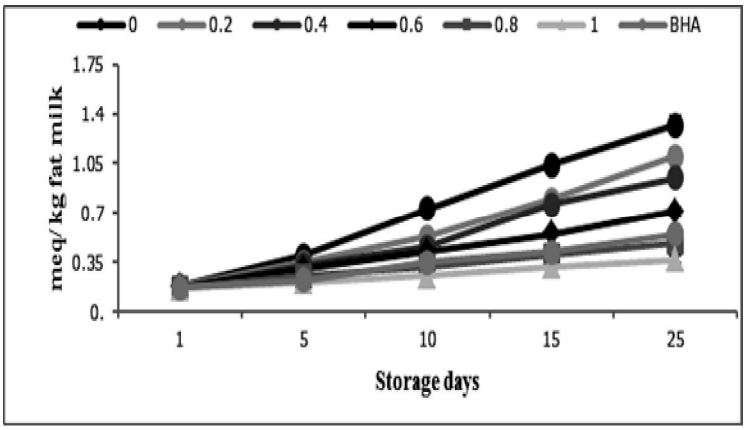

Figure2. Effect of essential oil Coriander on peroxide value of samples during storage time at 4℃

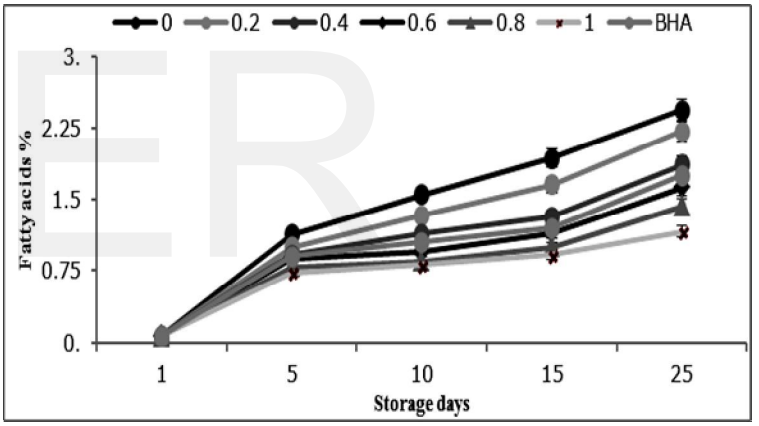

Figure:3 Effect of essential oil Coriander on fatty acids % of samples during storage time at 4℃

4 Conclusion

Essential oil extracted from the seeds of Iraqi coriander contained 35 compounds after GC-MS analysis. Linalool is the dominant compound. Essential oil from coriander have bacterial inhibition activity and effect on G^+ and G^- strains growth. G^+ bacteria showed more inhibition as compared to G^- bacteria. Antioxidant activity of essential oils from coriander estimated through peroxide value and fatty acids tests in fat milk samples than with BHA sample. The essential oils of Coriander extract were able to reduce the peroxide values and fatty acids in samples.

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