J. Agric. Sci. Mansoura Univ., 32 (2): 1521 - 1535, 2007

EFFECT OF MICROWAVE HEATING AND CONVENTIONAL ROASTING ON VOLATILE COMPOUNDS IN OREGANO LEAVES, CORIANDER AND CUMIN SEEDS.

Abd El-Mageed, Magda A.
Chemistry of Flavour and Aromatic, Dept., NRC., Dokki, Cairo, Egypt.

ABSTRACT

Processing of spices using microwaves is a newer dimension. This alternative methodology is preferred due to the convenience and ease of handling. In the present study, oregano leaves (*Origanum vulgare* L.), coriander (*Coriandrum sativum* L.) and cumin seeds (*Cuminum cyminum* L.) were subjected to conventional roasting and microwave heating to study their effects on the volatile components of each spice. Hydrodistilled oil of each spice was subjected to GC and GC- Ms analysis. A comparison study was done between the two methods of roasting and with raw sample of each spice. Twenty three volatile components were identified in essential oil of oregano leaves, 17 components in essential oil of coriander seeds and 16 components in essential oil of cumin seeds. In general, the effect of heating on the three spices caused reduction in their essential oil concentrations compared with the raw samples. This reduction was due to the formation of lipid degradation products, hexanal and (E)-2-hexenal in all cases. However the sum of their total percentages in microwave treated samples were always smaller than that in conventional roasted samples, which revealed that the microwave heating is more preferable. Moreover, the higher total percentages of thymol and carvacrol (the two major isomeric monoterpene phenols) in microwave treated sample (25.82%) of oregano leaves than that in conventional roasting sample (20.44%) make the microwave heating sample of higher quality, since these two monoterpene phenols are responsible for the potent odorant compounds and used as the quality index for this herb. Also, the higher percentage of linalool in microwave heated coriander seeds (57.26%) than that in conventional roasted coriander seeds (55.53%) make the microwave method more preferable due to the fact that linalool increases quality and add fruity and minty aroma to this spice. On the other hand, the total concentration of monoterpene aldehydes in microwave heated cumin are higher than that in conventional roasting sample (35.68% and 34.17%, respectively). These aldehydes (cuminaldehyde; ρ-mentha-1,3-dien-7-al; ρ-mentha-1,4-dien-7-al and myrtenal) contribute to the pleasant characteristic flavour of cumin seeds. Besides, microwave heated sample showed a decrease in concentrations of γ-terpinene, p-cymene and β- pinene in comparison with those in conventional roasted sample, these compounds thought to reduce the quality of this spice. Therefore microwave treatment was more retentive of the flavour impact compounds than conventional roasting treatment and considered the best choice as an alternative- heating medium for processing.

Keywords: Microwaves, Conventional roasting, Oregano leaves, Coriander seeds, cumin seeds, Volatile compounds.

INTRODUCTION

In the last years, the use of microwaves for the sanitization of food acquired an ever increasing importance. In particular, this treatment is very efficient for the sanitization of herbs and spices *(Emam et al. 1995; Legnani* *et al. 2001)*. Cannamela SpA* had developed an original system for the treatment of pepper, origanum, sage, basil and chili. This new process, improved by Cannamela SpA consists of the continuous supply of spices and herbs in the pasteurization chamber, where microwave oscillators allow sanitizastion with drastic reduction of the microbial contamination and maximum control of all relevant physical parameters. The treatment conditions are between 30 and 80 W/kg of spices for about 15 min depending on the kind of material.

The effectiveness of the microwave treatment for spices depends on the high penetration power of radiations in these products, that have a low water content, usually 80-150g/kg; this causes a moderate and uniform heating, while the higher humidity content of polluting agents leads to a higher heating, which is lethal *(Emam et al. 1995; Legnani et al. 2001)***.**

Herbs and spices are particularly characterized by their flavours, therefore it is fundamental to know the influence on volatile compounds of each technological treatment they are submitted to. This is particularly true for treatments that involve the heating of material such as for microwaves treatment.

Origanum (*Origanum vulgare* L.) is well known as the "pizza herb" and is widely used in Italian and Mediterranean cooking as fresh and dried material. The dried herb is also used by the food industry in flavouring of processed foods: vegetables, meat products, and condiments in particular. The most important component of origanum is the essential oil which can be isolated by steam distillation. Essential oil contains up to 60-75% of volatile phenols particularly thymol and carvacrol. Chemical composition of origanum oil is very variable, due principally to the wide range of plant material from which it is distilled and the origanum species of origin. Origanum can be considered as a natural food preservative; in fact thymol and carvacrol and other; volatile or non-volatile; phenolic compounds present in herbs. Besides, their importance for flavouring, have also demonstrated high antibacterial and antioxidant activities *(Dorman et al. 2000; Lambert et al. 2001)***.** Volatile components in essential oil of origanum have been investigated by many authors *(Russo et al. 1998; Bertelli et al. 2003; Kokkini et al. 2004; Siatis et al. 2005 and Yang et al. 2006)*.

Coriander (*Coriandrum sativum* L.) 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. The 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 *(Wangensteen et al. 2004)*. The coriander seeds have a pleasant flavour owing to the particular composition of the essential oil. The fruits are used in the preparation of fish and meat, and also for baking. The extracted essential oil is used in the flavouring of a number of food products and in soap manufacturing. Among its major components are the monoterpene

---

*** Information about the company Cannamela SpA- Via S. Lazzaro, 6-40064 Ozzano dell'Emilia (Bologna, Italy) [E-mail:cannamela@cannamela.it-http://www.cannamela.it]**

hydrocarbons (γ-terpinene, limonene, p-cymene), the monoterpene alcohols (linalool, borneol, geraniol), the monoterpene esters (geranyl acetate, linalyl acetate, bornyl acetate), the monoterpene ketones (carvone, camphor) and the coumarins *(Anon 1993; Frank et al. 1995; Zheljazkov and Zhalnov, 1995; Pino et al. 1996; Arganosa et al. 1998; Bandoni et al. 1998; Carrubba and la Torre, 2002; Msaada et al. 2007; Eikani et al. 2007)*. It is principally used as a flavouring agent in the liquor, cocoa and chocolate industries. Like the fruits, the coriander seed oil is also employed in medicine as a carminative or as a flavouring agent. It has the advantage of being more stable and of retaining its agreeable odour longer than any other oil of its class *(Diederichsen, 1996)*. Moreover, the essential oils and various extracts from coriander have been shown to possess antibacterial *(Burt, 2004)* antioxidant *(Wangensteen et al. 2004),* antidiabetic *(Gallagher et al. 2003)*, anticancerous and antimutagenic *(Chithra and Leelamma, 2000)* activities.

Cuminm cyminum L. is one widely used spice. Crushed cumin seeds are used as a condiment in a variety of dishes. Cumin seeds contain volatile oil (2%-5%) that imparts the characteristic aroma to the seeds. Volatile oil of cumin is employed advantageously, instead of the seeds, in many types of flavouring compounds. The essential oil present in cumin seeds prevents butter from deterioration and improves its acid value. It has an antihydrolytic effect and is better than conventional synthetic antioxidants *(The Wealth of India, 2001)*. The oil is used in perfumery and for flavouring liquors and cordials. It is also used as a varminative. Cumin seeds possess an aromatic odour and have a spicy and bitter taste. They are used as an essential ingredient in mixed soups, sausages, pickles, cheese and meat dishes, and for seasoning breads, cakes and candies. In indigenous medicine, cumin seeds have long been considered as a stimulant, carminative and are used for medicines *(Varo and Heinz, 1970)*. The chief constituent of the volatile oil is cuminaldehyde (p-isopropyl benzaldehyde). The comparative chemical composition of cumin seed oil produced in different ways, has been reported, and steam distillation results in good retention of character impact flavour constituents. Also, the cumin oil, shows fungi-toxic activity, which could be linked to the cuminaldehyde content *(Lawrence, 1992)*. The ovicidal activity of cumin essential oil, against insects, has been reported *(Tunc et al. 2000)*. Volatile components of cumin seeds were previously studied by *Behera et al. 2004; Pourmortazavi et al. 2005 and heravi et al. 2007*. The composition of Indian cumin oil has been reported. It showed significant flavour components, such as cuminaldehyde 18.3% and perillaldehyde 8.17%, in addition to the terpenic hydrocarbons, whereas Egyptian cumin oil contains 39.2% cuminaldehyde *(Srinivas, 1986)*.

Generally, some spices are processed, for their microbial stability and removal of extraneous matter. Roasting is one of the important phases in the cooking process to release characteristic flavour volatiles and undesirable constituents *(Susheela, 2000)*. Hence, roasting of spices affects flavour quality, this study aimed to reveal the effect of microwave heating and conventional roasting on volatile components of oregano leaves, coriander and cumin seeds compared with raw samples of each.

MATERIALS AND METHODS

Plant materials and chemicals:

Dry clean oregano leaves (*Origanum vulgare* L.), coriander (*Coriandrum sativum* L.) and cumin (*Cuminum cyminum* L.) seeds were purchased from the same local market, authentic and standard n-paraffin (C_8 - C_{22}) were purchased from Sigma-Aldrich Co,s (St. Louis, MN, USA), and Merck (Darmstadt, Germany). All other chemicals were of analytical grade.

Processing of raw material:

Two samples (50g each) of dry oregano leaves, coriander and cumin seeds were separately roasted in a conventional electric oven at 140°C for 15 min.

The three samples under investigation were subjected to microwave heating (Daewoo DE Microwave, Mod: KoG-181G, 200-240 V 50 Hz Microwave input power was 1400 W, Korea) as follows 15 samples (6 gm each) of oregano for 3 min, 4 sample (25g each) of coriander 2 min and 50 sec. and 4 sample (25g each) of cumin 2 min and 20 sec. The treated samples were separately ground in a spice mix grinder.

Isolation of volatile compounds:

The raw and heated samples of oregano leaves, coriander and cumin seeds were separately subjected to hydro distillation for 3 hours using, Clevenger type apparatus. The obtained oil was dried over anhydrous sodium sulfate. The collected essential oils were immediately analyzed using GC and GC-MS.

Gas chromatographic (GC) analysis:

GC analysis was performed by using Hewlett-Packard model 5890 equipped with a flame ionization detector (FID). A fused silica capillary column DB5 (60m x 0.32 mm id) was used. The oven temperature was maintained initially at 50°C for 5 min, then programmed from 50 to 250°C at a rate of 4°C/min. Helium was used as the carrier gas, at flow rate of 1.1 ml/min. The injector and detector temperatures were 220 and 250°C, respectively. The retention indices (Kovats index) of the separated volatile components were calculated using hydrocarbons (C_8-C_{22}, Aldrich Co.) as references.

Gas chromatographic-mass spectrometric (GC-MS) analysis:

The analysis was carried out by using a coupled gas chromatography Hewlett-Packard model (5890)/mass spectrometry Hewlett-Packard-MS (5970). The ionization voltage was 70 eV, mass range m/z 39-400 amu. The GC condition was carried out as mentioned above. The isolated peaks were identified by matching with data from the library of mass spectra (National Institute of Standard and Technology) and compared with those of authentic compounds and published data *(Adams,2001)*. The quantitative determination was carried out based on peak area integration.

RESULTS AND DISCUSSION

Volatile components in the hydrodistilled oil of raw, conventionally roasted and microwave heated oregano leaves.

Oregano leaves subjected to conventional roasting and microwave heating were analyzed and a comparison was done between these two methods. In the case of raw sample, the volatile oil recovered after 3h of distillation was 2.7%. But when the samples were roasted conventionally in an electric roaster at 140ºC for 15 min., the volatile oil yield decreased to 1.8.%, whereas the yield of volatile oil in the sample subjected to microwave heating was 2.0.%

The typical gas chromatograms of the volatiles in the hydrodistilled oil of raw, conventionally roasted and microwave heated oregano leaves are shown in [Fig. 1].

Twenty three compounds were identified and listed with their area percentages in [Table, 1]. All these compounds were identified by Kovats index values and MS spectra *(Adams, 2001)*.

As shown in [Table, 1] the heating caused a reduction in essential oil concentration from 99.99% of raw sample to 65.27% in conventionally roasted sample and 79.96% for microwave treated sample. This reduction was due to the formation of two components which are hexanal and (E) -2-hexenal with concentration of 24.96% and 9.77% in conventional roasted sample and 14.04% and 6.00% in microwave treated sample, respectively. Hexanal and 2- hexenal were reported to be derived from oxidation and isomerization of linoleic and linolenic fatty acids *(Ullrich and Grosch, 1987).*

The volatile profile of raw hydrodistilled oil of oregano consisted mainly of thymol (30.51%) followed by ρ-cymene (10.55%), linalyl acetate (8.59%), carvacrol (6.47%), β- caryophyllene (6.31%), 1,8-cineole (6.12%), and γ- terpinene (4.68%), [Table, 1]. These results are in accordance with those of *Kokkini et al. 2004; Siatis et al. 2005 and Yang et al. 2006*.

Although the effect of heat on the two roasted samples caused a decrease in the yield of thymol and carvacrol (the two major isomeric monterpene phenols) compared to their percentages in raw sample (36.98%) [Table, 1]. It was found that the sum of their percentages is higher in essential oil of microwave treated sample than that in conventionally roasted sample (25.82% and 20.44%, respectively). This parameter is usually used as the quality index for this herb *(Bertelli et al. 2003)*. Therefore the microwave treated sample has higher quality than that of conventional roasted sample. Also, heat caused a decrease in percentage of ρ-cymene to 4.38% and 6.37% in conventional roasted sample and microwave treated sample, respectively, compared to raw sample (10.55%) [Table, 1]. γ-Terpinene showed an increase in its percentage from 4.68% in raw sample to 2 folds in conventional roasted sample (8.88%) and 3folds in microwave treaed sample (12.30%) [Table, 1] .ρ-Cymene and γ-terpinene are considered as biosynthetic precursors for thymol and carvacrol and the sum of these four compounds constituted the bulk of oregano essential oil in the range of 72.08-82.86% *(Russo et al. 1998)*.

Yang et al. (2006) reported that terpene stability decreased with increasing temperature. β- Caryophyllene, the sesquiterpene hydrocarbon showed a high increase in its concentration from 6.31% in essential oil of raw sample to12.24% in essential oil of conventional roasted sample and to 10.45% in microwave treated sample. These results are in agreement with *Bertelli et al. (2003)* who reported that microwave treatment may induce a reduction of percentages of volatile compounds at higher retention time and an increase at lower retention time but this behaviour is not very evident.

Table (1): Volatile components in the hydrodistilled oil of Raw, Conventionally roasted and Microwave heated oregano leaves (*Values expressed as relative area percentages to total identified components)

Peak No	KI[a]	Components	Raw Oregano	Conventional Rosting 140°C for 15 min	Microwave heating	Methods of Identification[b]
1	801	Hexanal	-	24.96	14.04	ST,MS,KI
2	848	(E)-2- Hexenal	-	9.77	6.00	MS,KI
3	929	α- Thujene	*1.63	0.54	0.97	MS,KI
4	939	α- Pinene	0.56	0.34	0.33	ST,MS,KI
5	977	Sabinene	3.56	0.48	1.08	MS,KI
6	982	β- Pinene	0.50	0.13	0.48	MS,KI
7	992	Myrecene	0.79	0.31	0.42	ST,MS,KI
8	1009	α- Phellandrene	0.93	0.95	0.72	MS,KI
9	1026	P-Cymene	10.55	4.38	6.37	MS,KI
10	1033	Limonene	3.49	3.97	2.28	ST,MS,KI
11	1036	1,8-Cineole	6.12	2.79	2.28	MS,KI
12	1064	γ- Terpinene	4.68	8.88	12.30	ST,MS,KI
13	1085	Terpinolene	2.77	1.90	1.97	MS,KI
14	1097	Linalool	4.24	0.21	2.26	ST,MS,KI
15	1197	α- Terpineol	2.49	3.43	1.33	MS,KI
16	1257	Linaly acetate	8.59	0.79	5.46	MS,KI
17	1290	Thymol	30.51	15.23	20.93	MS,KI
18	1299	Carvacrol	6.47	5.21	4.89	MS,KI
19	1337	Carvacryl acetate	0.96	0.64	0.99	MS,KI
20	1365	Eugenol	0.28	0.61	0.68	ST,MS,KI
21	1370	α- copaene	0.73	0.43	0.72	MS,KI
22	1437	β- Caryophyllene	6.31	12.24	10.45	ST,MS,KI
23	1454	α- Humulene	3.82	1.53	2.85	MS,KI

-: not detected compounds listed according to their elution on DB5 column
a: Kovats index
b: Compounds identified by GC-MS(MS) and/or by comparison of MS and KI of standard compound run under similar conditions

Volatile components in the hydrodistilled oil of raw, conventionally roasted and microwave heated of coriander seeds:

Coriander seeds *(Coriandrum sativum* L.*)* subjected to conventional roasting and microwave heating were analyzed and a comparison was made between these two methods. In the case of raw sample, the volatile oil recovered after 3h of distillation was 2.1%, which decreased to 1.5% in case of conventional roasting at 140°C for 15 min, however the yield decreased to 1.7% in microwave heated sample.

Fig (1): Gas Chromatograms of volatiles in the hydrodistilled oil of raw, conventionally roasted and microwave heated oregano leaves

Fig (2): Gas Chromatograms of volatiles in the hydrodistilled oil of raw, conventionally roasted and microwave heated coriander seeds

Fig (3): Gas Chromatograms of volatiles in the hydrodistilled oil of raw, conventionally roasted and microwave heated cumin seeds

Table (2): Volatile components in the hydrodistilled oil of raw, conventionally roasted and microwave heated coriander Seeds. (*Values expressed as relative area percentages to total identified components)

Peak No	KI[a]	Components	Raw Coriander	Conventional Roasting 140°C for 15 min	Microwave heating	Methods of Identification[b]
1	801	Hexanal	-	11.54	10.88	ST,MS,KI
2	848	(E)2-Hexenal	*0.19	6.06	5.30	MS,KI
3	939	α- Pinene	5.54	5.87	5.88	ST,MS,KI
4	952	Camphene	0.64	0.70	0.70	MS,KI
5	977	Sabinene	0.25	0.19	0.20	MS,KI
6	982	β- Pinene	0.53	0.53	0.49	MS,KI
7	992	Myrecene	1.08	0.77	0.77	ST,MS,KI
8	1016	α- Terpinene	0.16	0.14	0.22	MS,KI
9	1026	P-Cymene	1.51	1.64	1.42	MS,KI
10	1033	Limonene	2.30	2.48	2.51	ST,MS,KI
11	1038	(z)-β -Ocimene	0.20	0.21	0.24	MS,KI
12	1064	γ- Terpinene	8.78	7.81	7.88	ST,MS,KI
13	1085	Terpinolene	0.26	0.39	0.43	MS,KI
14	1097	Linalool	72.69	55.53	57.26	ST,MS,KI
15	1146	Camphor	3.73	3.28	2.97	MS,KI
16	1168	Borneol	0.20	0.22	0.33	MS,KI
17	1387	Geranyl acetate	1.94	2.63	2.51	MS,KI

-: not detected compounds listed according to their elution on DB5 column
a: Kovats index
b: Compounds identified by GC-MS(MS) and/or by comparison of MS and KI of standard compound run under similar conditions

As shown in [Table, 2], heating caused a reduction in essential oil from 99.99% in raw sample to 82.39% in conventional roasting sample and 83.81% in microwave heated sample. This reduction, as metioned before; is due to the appearance of hexanal and (E) -2- hexenal with concentrations of 11.54% and 6.06% respectively in conventional roasted sample; and 10.88 % and 5.30%, respectively in microwave treated sample.

The volatile profile of hydrodistilled oil of raw coriander consistsed mainly of linalool (72.69%) followed by γ-terpinene (8.78%), ∝-pinene (5.54%), camphor (3.73%), limonene (2.30%), geranyl acetate (1.94%) and ρ-cymene (1.51%) Table (2). These results are in accordance with those found by *Carrubba and la Torre (2002)* and with the recently published data by *Eikani et al. (2007)* who reported that the main component of *C. Sativum* was linalool with concentration between 78% and 83%, it was chosen as the key component to find the best subcritical water extraction (SCWE) operating conditions. Also, *Msaada et al. (2007)* found that the, essential oil at the final stage of maturity of coriander fruits consists mainly of linalool (87.54%) and this related to the increase in quality which add fruity and minty aroma.

From [Table, 2] by comparing the volatile compounds in conventional roasted and microwave heated samples with those of raw sample, no significant difference was found in concentrations of most terpenic compounds except for linalool which decreased from 72.69% in raw sample to 55.53% and 57.26% in conventional roasted and microwave heated samples, respectively. This illustrated that the two compounds, hexanal and (E) -2- hexenal with concentrations of 17.60% in conventional roasting and 16.18% in microwave heating, formed on the expense of linalool reduction (17.16% and 15.43%, respectively). This result was confirmed by *Eikani et al. (2007)* who reported that, the linalool extraction yield increased generally with the increase in temperature up to 125°C. At 150 and 175°C, it decreased and an extract with burning smell was produced.

Volatile componenets in the hydrodistilled oil of raw, conventionally roasted and microwave heated of cumin seeds:

Cumin seeds *(Cuminum cyminum* L.*)* subjected to conventional roasting and microwave heating were analyzed and a comparison was made between these two methods and raw sample. The volatile oil recovered after 3 h of distillation was 6.7% which decreased to 3.2% in hydrodistilled oil of conventional roasting, 4.3% in hydrodistilled oil of microwave heated sample. A typical gas chromatogram of the volatiles in the hydrodistilled oil of raw, conventional roasting and microwave heating of cumin seeds are shown in [Fig. 3]. Sixteen compounds were identified and listed with their area percentages in [Table, 3]. As shown from [Table, 3], heating caused a reduction of essential oil from 99.99% in raw sample to 80.79% in conventional roasted sample and 82.71% in microwave heating sample. As mentioned before, this reduction was due to formation of lipid degradation products of unsaturated fatty acids (hexanal and (E) -2-hexenal) with concentrations of 13.22% and 5.80% in conventional roasted; and 12.33% and 4.95% in microwave heated samples, respectively.

The volatile profile of hydrodistilled oil of raw cumin consisted mainly of cuminaldehyde (26.45%) followed by γ-terpinene (20.95%), β-pinene (20.93%), ρ-mentha 1,4-dien-7-al (12.31%), ρ-cymene (7.69%) and ρ-mentha - 1,3-dien -7-al (3.99%). These results are in accordance with the previously published data by *Heravi et al. (2007); Pourmortazavi et al. (2005) and Behera et al. (2004)*.

The hydrodistilled oil of black cumin seeds was reported to be rich in monoterpene aldehydes; the main components are cuminaldehyde, ρ-mentha-1,3- dien-7-al and ρ-mentha-1,4-dien-7-al; terpene hydrocarbons are γ-terpinene, ρ-cymene and β-pinene. These terpene hydrocarbons are thought to reduce the quality of the spice *(Agarwal et al. 1991; Abduganiew et al. 1997; Foroumadi et al. 2002)*.

As shown in [Table, 3] the decrease in concentrations of the major components are the same in both conventionally roasted and microwave heated samples, compared with raw sample. However, the microwave heated sample showed slight increase in the yield of the monoterpene aldehydes (35.68%) which contribute to the characteristic flavour of cumin seeds *(Boelens, 1991)*, compared with that in conventionally heated sample (34.17%) [Table, 3]. Also, the total concentration of hexanal and (E) -2- hexenal in microwave heated sample is lower than that of conventional roasted sample (17.28% and 19.02%, respectively). For these reasons one can conclude that, the microwave treatment was more retentive of the flavour impact compounds than conventional roasting treatment and making microwave the best choice as an alternative-heating medium for processing.

Table (3): Volatile components isolated in the hydrodistilled oil of raw, conventionally roasted and microwave heated cumin seeds (*Values expressed as relative area percentages to total identified components)

Peak No	KI[a]	Components	Raw Cumin	Conventional Roasting 140°C for 15 min	Microwave heating	Methods of Identification[b]
1	801	Hexanal	-	13.22	12.33	ST,MS,KI
2	858	(E)2-Hexenal	*0.13	5.80	4.95	MS,KI
3	929	α- Thujene	0.32	0.34	0.27	MS,KI
4	939	α -Pinene	1.22	1.12	1.53	ST,MS,KI
5	977	Sabinene	0.87	0.54	0.59	MS,KI
6	982	β- Pinene	20.93	17.89	17.71	MS,KI
7	992	Myrecene	0.83	0.79	0.83	ST,MS,KI
8	1016	α- Terpinene	0.43	0.17	0.22	MS,KI
9	1026	P-Cymene	7.69	7.38	6.76	MS,KI
10	1033	Limonene	1.34	1.22	1.44	ST,MS,KI
11	1064	γ- Terpinene	20.95	15.13	16.58	ST,MS,KI
12	1207	Z-Verbenol	1.37	1.20	1.09	MS,KI
13	1214	Myrtenal	1.16	1.57	1.44	MS,KI
14	1247	Cuminaldehyde	26.45	22.59	22.00	MS,KI
15	1276	P-Mentha-1,3-dien-7-al	3.99	1.33	1.56	MS,KI
16	1279	P-Mentha-1,4-dien-7-al	12.31	9.68	10.68	MS,KI

-: not detected compounds listed according to their elution on DB5 column
a: Kovats index
b: Compounds identified by GC-MS(MS) and/or by comparison of MS and KI of standard compound run under similar conditions

REFERENCES

Abduganiew, B.E.; Abdullaev, U.A.; Aripov, K.N.; Baser, K.H.C. and Oexek, T., (1997). Composition of the essential oil of *Bunium persicum* (Boiss). B. Fedtsch. from Tajikistan. J. of Essent. Oil Res. 9: 597-598.

Adams. R.P. (2001). Identification of essential oil components by gas chromaogaphy/quadrupole mas spectroscopy. Carol Stream IL, USA: Allured.

Agarwal, S.G.; Ghosh, S.; Jamwal, P.S.; Raina, A.K. and Thappa, R.K., (1991). Comparative studies on the major volatiles of kalazira (*Bunium persicum* seed) of wild and cultivated sources. Food Chemistry 41: 129-134.

Anon., (1993).Coriandolo.Erboristeria domain,Studio Ed.,Milano,Italy,May, 29

Arganosa, G.C; Sosulski, F.W. and Slikard, A.E. (1998). Seed yields and essential oil of northern-grown Coriander (*Coriandrum sativum* L). J. Herbs, Spices Med, Plants 6:23-32.

Bandoni, A.L; Mizrahi, I. and Juarex, M.A. (1998) Composition and quality of the essential oil of Coriander (*Coriandrum sativum* L.) from Argentina. J. Essent. Oil Res. 10:581-584.

Behera, S.; Nagarajan, S. and Rao, L.J.M(2004) Microwave heating and conventional roasting of cumin seeds (*Cuminum cyminum* L.) and effect on chemical composition of volatiles. Food chemistry 87: 25-29.

Bertelli, D.; Pless, M. and Miglietta, F. (2003). Effect of microwaves on volatile compounds in origanum. Lebensm.Wiss.u. technol.36:555-560.

Boelens, M.H. (1991). Spices and condiments II. In H. Maarse (Ed.), volatile compounds in foods and beverages (pp-449-482). New York: Marced Dekker Inc.

Burt, S. (2004). Essential oils: their antibacterial properties and potential applications in foods- a review. International Journal of Food Microbiology, 94:223-253.

Carrubba, A. and la Torre, R. (2002). Statistical analyses on the essential oil of Italian coriander (*Coriandrum sativum* L.) fruits of different ages and origins. J. of Essent. Oil Res., 14: 389-396.

Chithra, V. and Leelamma, S. (2000). *Coriandrum sativum* effect on lipid metabolism in 1,2dimethyl hydrazine induced colon cancer. Journal of Ethnopharmacology, 71:457-463.

Diederichsen, A.(1996). Coriander *(Coriandrum sativum* L.*)*. Promoting the conservation and use of underutilized and neglected crops. 3. Institute of Plant Genetics and Crop Plant Research, Gatersleben/Internationl Plant Genetic Resources Institute, Rome. Italy.

Dorman, H.J.D.; Surai, P. and Deans, S.G. (2000). In vitro antioxidnt activity of a number of plant essential oils and phytoconstituents. J. of Essent. Oil Res., 12: 241-248.

Eikani, M.H.; Golmohammad, F. and Rowshanzamir, S. (2007). Subcrtical water extraction of essential oils from coriander seeds (*Coriandrum staivum* L.) J. of food Engineering 80: 735-740

Emam, O.A.; Farage, S.A. and Aziz, N.H. (1995). Comparative effects of gamma and microwave irradiation on the quality of black pepper. Zeischrift fuer Lebensmittel-Untersuchung und-Forschung, 21: 557-561

Foroumadi, A.; Asadipour, A.; Arabpour, F. and Amanzadeh, Y., (2002). Composition of the essential oil of *Bunium persicum* (Bioss.) B. Fedtsch. from Iran. J. of Essential Oil Research 14: 161-162.

Frank, C.; Dietrich, A.; Kremer, U. and Mosandi, A. (1995) GC-IRMS in the authenticity control of the essential oil of *Coriandrum sativum* L.J. Agric. Food Chem., 43: 1634-1637

Gallagher, A. M.; Flatt, P. R.; Duff, G. and Abdel-Wahab, Y.H.A. (2003). The effects of traditional antidiabetic plants on in vitro glucose diffusion. Nutrition research, 23: 413-424.

Heravi, M. J.; Zekavat, B. and Sereshti, H. (2007). Use of gas chromatography- mass spectrometry combined with resolution methods to characterize the essential oil components of Iranian *cumin and Caraway.* J. of chromatography A. Available online at www.sciencedirect.com

Kokkini, S.; Karousou, R. and Hanlidou, E. (2004). Essential oil composition of greek (*Origanum vulgare ssp. hirtum*) and Turkish (O. onites) Oregano: A tool for their distinction. J. Essent. Oil Res., 16: 334-338.

Lambert, R.J.W.; Skandamis, P.N.; Coote, P.J. and Nychas, G.J.E. (2001). A study of the minimum inhibitory concentration and mode of action of oregano essential oil, thymol and carvacrol. J. of Applied Microbiology, 91: 453-462

Lawrence, B. M. (1992). Progress in essential oils. Perfumer and flavourist, 17: 42-44.

Legnani, P.P.; Leoni, E.; Righi, F. and Zarabini, L.A. (2001). Effect of microwave heating and gamma irradiation on microbiological quality of spices and herbs. Italian J. of Food Science, 13: 337-345.

Msaada, K; Hosni, K; Taarit, M.B.; chahed, T.; Kchouk, M.E. and Marzouk, B. (2007). Changes on essential oil composition of coriander (*Coriandrum staivum* L.) fruits during three stages of maturity. Food chemistry, 102: 1131-1134.

Pino, J.A.; Rosado, A. and Fuentes, V. (1996). Chemical Composition of the seed oil of *Coriandrum sativum* L. from Cuba. J. Essent. Oil Res., 8: 97-98

Pourmortazavi, S.M.; Ghadiri, M. and Hajimirsadeghi, S.S. (2005) Supercritical fluid extraction of volatile components from *Bunium Persicum* Bioss (black cumin) and Mespilus germanica L. (medler) seeds. J. of food Composition and Analysis 18: 439-446.

Russo, M.; Galletli, G.C.; Bochini, P. and Carnacini, A. (1998). Essential oil chemical composition of wild population of Italian oregano spice (*Origanum vulgare ssp. Hirtum* (link) Ietswaart): A preliminary evaluation of their use in chemotaxonomy by cluster analysis.1. inflorescences. J. of Agric food chem.. 46: 3741-3746.

Siatis, N.G.; Kimbaris, A.C.; Pappas, C.S.; Tarantilis, P.A.; Daferera, D.J. and Polissiou, M.G. (2005). Rapid method for simultaneous quantitative determination of four major essential oil components from oregano (oreganum sp.) and thyme (thyms sp.) using F T-Raman spectroscopy. J. Agric food chem. 53: 202-206.

Srinivas, S.R. (1986). Atlas of essential oils (p.36). New York: Bronx. Stenhagen, E., Abrahamsson, S., and Mc Lafferty, F, W. (1974). Registry of mass spectral data (Vols. 1-4). New York: Wiley.

Susheela, R. U. (2000). Handbook of Spices, seasonings and flavourings (pp. 47-48). Lancaster, USA: Technomic Publishing.

The Wealth of India (2001). A dictionary of Indian raw materials and industrial products, (Vol. 2,p. 257), CSIR: New Delhi.

Tunc, I.; Berger, B. M.; Erler, F. and Dagli, F. (2000). Ovicidal activity of essential oils from five plants against two stored product insects. J. of stored Product Research 36: 161-168.

Ullrich, F. and Grosch, W. (1987). Identification of the most intense volatile flavour compounds formed during autoxidation of linoleic acid, Z. Lebensm. Unters. Forch. 184: 277-282.

Varo, P.T. and Heinz, D.E. (1970). Volatile components of cumin. J. Agric. Food Chem., 18: 234-238.

Wangensteen, H.; Samuelsen, A.B. and Malterud, K.E. (2004). Antioxidant activity in extracts from coriander. Food Chemistry, 88: 293-297.

Yang Y.; kayan, B.; Bozer, N.; Pate, B.; Baker, C. and Gizir, A.M. (2006). Terpene degadatrion and extraction from basil and oregano leaves using subcritical water. J. of chromatogrphy A. Available online at www.sciencedirect.com

Zheljazkov, V.and Zhalnov, I. (1995). Effect of herbicides on yield and quality of *coriandrum sativum* L., J, Agric, Food Chem., 43: 633-639

تـأثير التسـخين بـالميكروويف والتحمـيص العـادي علـي المركبـات الطيـارة لأوراق الاوريجانو وبذور الكسبرة والكمون

ماجدة عبد المنعم عبد المجيد

قسم كيمياء مكسبات الطعم والرائحـة- المركـز القـومي للبحـوث - القـاهرة – الـدقي – جمهورية مصر العربية

تهدف هذه الدراسة إلي دراسة تأثير التحميص بالميكروويف والفرن العـادي علـي الزيـوت الطيارة لكل من أوراق الاوريجانو وبذور الكسبره والكمون ومقارنتها بالزيوت الطيارة فـي العينـات الخام. تم استخلاص الزيت الطيار لكل نبات بطريقة التقطير وتحليله بجهاز الغاز الكرومـاتوجرافي- طيف الكتلة. تم تعريـف 23 مركبـا فـي الزيـت الطيـار للآوريجـانو و 17 مركـب فـي الزيـت الطيـار للكسبرة و16 مركب في الزيت الطيار للكمون.

و لقـد وجـد أن تـأثير التحمـيص فـي العينـات الثلاثـة يـؤدي إلـي نقـص تركيـز المركبـات التربينية بالمقارنـة بالعينات الخام ويرجع ذلك إلـي تكسير الـدهون وتكوين الهكسينال و 2 هكسينال، وإن كان تركيزهما في العينات المحمصة بالميكروويف أقل من العينات المحمصة بالفرن العادي مما يظهر أن التحميص بـالميكروويف أفضـل مـن الفـرن العـادي بالإضـافة إلـي أن ارتفـاع نسـبة الثيمـول والكارفاكرول فـي الزيـت الطيـار لأوراق الاوريجـانو المحمصـة بـالميكروويف (25.82%) مقارنـة بـالعينات المحمصة بالفرن العادي (20.44%) يجعل التحميص بالميكروويف أفضل حيـث أن هـذين المركبين همـا المسئولان عن إعطـاء النكهـة المستحبة للاوريجـانو كمـا يعتبـرا مقيـاس لجـودة أوراق الاوريجـانو. كمـا أظهـرت النتـائج إرتفـاع نسـبة الليـنـالول فـي عينـة الكسبرة المحمصـة بـالميكروويف (57.26%) عـن العينـة المحمصـة بـالفرن العـادي (55.35%) ممـا جعـل اسـتخدام الميكروويـف أفضل لزيادة هذا المركب الذي يعد مسئولا عن نكهة الفاكهة والنعناع لهذا النبات.

كما أظهرت النتائج أرتفاع نسبة مونوتربين الدهيد (الكيومين الدهيد وبارامنثـادايين الدهيـد/ والميرتينال) في الكمون المحمص بالميكروويف (35.68%) عن الكمـون المحمـص بـالفرن العـادي (34.17%) والتي تساهم في إعطاء الرائحة المميزة للكمون. كما ظهـر انخفـاض فـي تركيـز الجامـا تربينين وبـاراثيمين- وبيتابينين في بـذور العينـة المحمصـة بـالفرن العـادي وهـذه المركبـات يعتقـد أنهـا تقلل من جودة الزيت الطيار للكمون.يتضح من النتائج السابقة أن التحميص في كل العينات باسـتخدام الميكروويف يؤدي إلـي الحفـاظ علـي المركبـات المسئولة عن النكهـة والجـودة بشكل عـام بالمقارنـة بالتحميص بالفرن العادي.