**International Journal of Bioinformatics and Biomedical Engineering**
Vol. 1, No. 2, 2015, pp. 143-146
http://www.aiscience.org/journal/ijbbe

# Effect of Gamma Radiation on Essential Oil Compositions of Dill Flowering Herb

**Hussein A. H. Said-Al Ahl[1, *], Atef M. Z. Sarhan[2], Abou Dahab M. Abou Dahab[2], El-Shahat N. Abou-Zeid[1], Mohamed S. Ali[1], Nabila Y. Naguib[1]**

[1]Department of Medicinal and Aromatic Plants, National Research Centre, Dokki, Giza, Egypt
[2]Department of Ornamental Horticulture, Faculty of Agriculture, Cairo University, Cairo, Egypt

## Abstract

A field experiment was carried out to investigate the effect of gamma radiation doses (0, 2, 4, 8, 16, 32 and 64 k-rad) on essential oil composition of *Anethum graveolens* L. plants. The treatment of dill seeds presowing to gamma radiation doses led to differences in percentages of essential oil composition. The obtained data revealed that, p-cymene, carvone and dillapiole were the most abundant in the flowers; the main compounds of essential oil in the leaves+stems were dillether and p-cymene. However, four main compounds were identified in the whole flowering herb such as p-cymene, carvone, dillether and dillapiole.

## Keywords

*Anethum graveolens* L., Essential Oil Composition, Gamma Radiation

Received: July 8, 2015 / Accepted: July 31, 2015 / Published online: August 12, 2015



## 1. Introduction

In recent years the scientific literature reports pharmacological effects of dill such as antibacterial Singh et al., 2001; Lopez et al., 2005), anti mycobacterial (Stavri and Gibbons, 2005), antioxidant (Satyanarayana et al., 2004; Taher et al., 2007; Singh et al., 2006), cancer chemopreventive (Zheng et al., 1992). The well-known properties of dill from the traditional medicine, such as carminative, stomachic, diuretic have been reported (Hosseinzadeh et al., 2002; Amin and Sleem, 2007). The dill essential oil has hypolipidemic activity and could be a cardioprotective agent (Hajhashemi and Abbasi, 2008). Many studies showed that dill essential oil quantity and chemical composition varies depending on the plant parts and the developing stage of the plant at harvest time (Amin and Sleem, 2007; Yili et al., 2006; Faber et al., 1998; Hodisan et al., 1980). The scientific literature data concerning chemical composition of volatile oil from different plant parts of *Anethum graveolens* L. are poor and differ from one author to the other (Amin and Sleem, 2007; Hajhashemi and Abbasi, 2008; Yili et al., 2006; Mahran et al., 1992). The aim of this paper is to elucidate the chemical composition of the essential oil from leaves+stems, flowers and full flowering herb of dill cultivated in Egypt.

## 2. Materials and Methods

### 2.1. Plant Material and Experimental Procedure

The experiments of this study were carried out at the Farm Station of National Research Centre, at Shalakan, Kalubia Governorate during the two successive seasons of 2001/2002. Seeds of dill (*Anethum graveolens* L.) were obtained from Medicinal and Aromatic Research Dep., Ministry of Agriculture, Egypt. Dry seeds of dill were irradiated with

* Corresponding author
E-mail address: hussein_saidalahl@yahoo.com (H. A. H. Said-Al Ahl)

gamma rays doses at 2, 4, 8, 16, 32 and 64 krad before sowing. The source of irradiation is installed at the Middle Eastern Radioisotope Centre for the Arab Countries, Dokki, Giza, Egypt. The dill seeds were sown in 15th October in 2001/2002.

### 2.2. Essential Oil Extraction, Determination and Analysis

The extraction of the essential oil was carried out at the laboratory of cultivation and production of Medicinal and Aromatic plants (NRC), Dokki, Cairo, while gas liquid chromatographic (GLC) analysis was carried out at the Central laboratory of NRC. To extract and quantify the voltile oil, a weight of 100gm of fresh herb, fresh umbels and fresh leaves + stems in both seasons was separately subjected to hydro-distillation for 3 hours using a modified Clevenger apparatus according to Gunther (1961). The resulted oil was dehydrated over anhydrous sodium sulphate and stored at freezer till used for gas liquid chromatographic (GLC) analysis.

GLC analysis of the oil samples was carried out in the second season using Hewlett Packard gas chromatograph apparatus with the following specifications:

| | |
|---|---|
| Instrument: | (HP) 6890 Series Hewlett Packard |
| Column: | HP (Carbwax 20 M)<br>(25m length X 0.32 mm I.D)<br>Film thickness: 0.3 Mm |
| Sample size: | 1 µl |
| Oven temperature: | 60 °C – 190 °C |
| Program: | 60 °C/2min, 80°C/min,<br>190 °C/25min. |
| Injection port temperature: | 240 °C |
| Carrier gas: | Nitrogen |
| Detector temperature(FID): | 280 °C |
| Flow rate: | N2 30 mL/min<br>H2 30 mL/min<br>Air 300ml/min |

Main compounds of the essential oil were identified by matching their retention times with those of the authentic samples injected under the same conditions. The relative percentage of each compound was calculated from the peak area of the peak corresponding to each compound.

## 3. Results and Discussion

### 3.1. In the Flowering Stage

#### 3.1.1. In the Flowers

**Table (1).** Effect of gamma radiation on the constituents of dill volatile oil "umbels" (180 days after sowing).

| Treatments / Identified compounds | Control | 2K-rad | 4K-rad | 8K-rad | 16K-rad | 32K-rad | 64K-rad |
|---|---|---|---|---|---|---|---|
| α-phellandrene | 1.18 | 0.66 | 0.28 | trace | 0.43 | - | 0.34 |
| Limonene | 0.56 | 0.50 | 0.31 | 1.71 | 0.49 | - | 0.37 |
| β-phellandrene | 4.08 | 6.03 | 2.00 | 2.87 | 2.94 | 0.35 | 4.00 |
| P-cymene | 51.32 | 53.91 | 19.66 | 15.95 | 37.34 | 3.90 | 28.69 |
| Linalool | - | 0.12 | 0.93 | - | 0.16 | 0.29 | 0.16 |
| Dillether | 9.53 | 4.98 | 5.54 | 5.44 | 7.99 | 9.62 | 9.89 |
| Dihydrocarvone | 1.47 | 0.29 | 2.27 | 2.46 | 2.51 | 3.45 | 2.74 |
| Sabinol | 0.62 | 1.41 | 0.70 | - | 0.53 | 0.82 | 0.29 |
| Carvone | 20.01 | 15.06 | 28.73 | 48.82 | 29.23 | 33.55 | 26.03 |
| Piperitone | 1.81 | 0.12 | 0.47 | - | 5.04 | 4.94 | 3.13 |
| Carveol | 0.36 | 0.12 | 0.32 | - | 0.23 | 1.79 | 0.16 |
| Nerolidol | 0.34 | 0.14 | 0.55 | - | 0.18 | 0.58 | 0.22 |
| Eugenol | 0.27 | 0.17 | 0.35 | - | 0.30 | 0.33 | 0.21 |
| Thymol | - | 0.31 | 0.42 | - | - | 0.38 | 0.18 |
| Carvacrol | - | - | - | - | - | 0.30 | 0.15 |
| Myristicin | - | - | - | - | - | 0.41 | 0.33 |
| Dillapiole | 6.89 | 15.15 | 33.9573 | 22.72 | 10.18 | 37.17 | 20.67 |

The main constituents of the essential oil distilled from fresh umbels during flowering stage were indicated in Table (1). The obtained data revealed that, in all treatments p-cymene, carvone and dillapiole were the most abundant, but their quantitative contents varied to different extents. In this regard p-cymene ranged from 3.90% (under 2 k-rad treatemnt) to 53.91% (under 2 k-rad treatment), carvone ranged from 14.7493% (2 k-rad + Zn) to 48.82% (under 8 k-rad treatment) and dillapiole ranged from 6.89% (control plants) to 37.17% (under 32 k-rad treatment). All treatments caused increase dillapiole content. On the other hand, all treatments except 2 k-rad caused decrease p-cymene content. Gamma ray doses at 8, 32 and 64 k-rad increased carvone content compared to other treatments. Radulescu et al. (2010) reported that the

main components in flowers were α- phellandrene (30.26%), limonene (33.22%) and anethofuran (22%). Therefore various factors such as plant genotype and cultivar and also environmental parameters have great effects on the compounds variety of plant essential oils (Yazdani et al., 2004). In addition, Reichert and Masandl (1998) found that essential oils compounds differed from one part and growth stage of the same plant to others. According to the Sefidkon (2001) findings the main compounds of dill flower essential oil consisted of α-phellandren, limonene and ρ-cymene.

### 3.1.2. In the Leaves + Stems

The main constituents of the essential oil as affected gamma radiation doses are shown in Table (2). The main compounds of essential oil were dillether and p-cymene. Dillether ranged from 4.09% (16 k-rad treatment) to 41.35% (8 k-rad treatment) and p-cymene ranged from 5.14% (4 k-rad treatment) to 17.96% (32 k-rad treatment). All treatments except of 32 k-rad caused decrease p-cymene content. Whereas the doses of gamma rays at 2, 8 and 16 k-rad resulted in the highest contents of piperitone, (8.49%), carvone (7.83%) and dillapiole (24.42%). The treatments of 8 and 32 k-rad enhanced the contents of carvone and piperitone. The treatments of 2 and 64 k-rad caused an increase in the contents of dillapiole and β-phellandrene. Radulescu et al. (2010) found that the main components in leaves were α- phellandrene (62.71%), limonene (13.28%) and anethofuran (16.42%).

**Table (2).** Effect of gamma radiation on the constituents of dill volatile oil "leaves+stems" (180 days after sowing).

| Treatments / Identified compounds | Control | 2K-rad | 4K-rad | 8K-rad | 16K-rad | 32K-rad | 64K-rad |
|---|---|---|---|---|---|---|---|
| α-phellandrene | - | 0.22 | 0.26 | 0.27 | - | 0.35 | 0.35 |
| Limonene | 0.41 | 27.40 | 25.87 | 1.41 | - | 0.37 | 0.92 |
| β-phellandrene | 1.31 | 1.66 | 1.81 | 0.39 | - | 1.64 | 1.43 |
| P-cymene | 15.52 | 6.35 | 5.14 | 15.37 | 4.45 | 17.96 | 9.15 |
| Linalool | 0.70 | 4.19 | 5.44 | 1.01 | - | 0.24 | 0.35 |
| Dillether | 29.74 | 9.98 | 8.45 | 41.35 | 4.09 | 41.01 | 19.42 |
| Dihydrocarvone | - | 1.17 | 1.19 | - | 5.59 | - | - |
| Sabinol | - | 0.77 | 0.98 | - | 3.32 | - | - |
| Carvone | 6.20 | 1.14 | 1.23 | 7.83 | 3.34 | 6.33 | 4.81 |
| Piperitone | 7.38 | 5.40 | 5.34 | 8.49 | 2.99 | 8.46 | 5.95 |
| Carveol | 6.12 | 8.45 | 7.98 | 3.24 | 1.58 | 4.21 | 3.34 |
| Nerolidol | 2.63 | 4.84 | 7.09 | 1.97 | 1.09 | 2.47 | 2.13 |
| Eugenol | 2.84 | 2.71 | 2.39 | 3.15 | 2.18 | 1.92 | 2.68 |
| Thymol | 1.71 | 2.34 | 2.37 | 0.88 | 6.15 | 1.22 | 2.87 |
| Carvacrol | 3.25 | 1.97 | 2.26 | 3.02 | 3.58 | 1.91 | 2.57 |
| Myristicin | 1.28 | 3.44 | 2.88 | 2.24 | 4.12 | 1.02 | 1.67 |
| Dillapiole | 1.42 | 1.64 | 1.04 | 0.84 | 24.42 | 1.20 | 4.42 |

**Table (3).** Effect of gamma radiation on the constituents of dill volatile oil "herb" (180 days after sowing).

| Treatments / Identified compounds | Control | 2K-rad | 4K-rad | 8K-rad | 16K-rad | 32K-rad | 64K-rad |
|---|---|---|---|---|---|---|---|
| α-phellandrene | 0.59 | 0.44 | 0.27 | 0.13 | 0.21 | 0.17 | 0.52 |
| Limonene | 0.48 | 13.95 | 13.09 | 1.56 | 0.24 | 0.18 | 0.65 |
| β-phellandrene | 2.70 | 3.84 | 1.91 | 1.63 | 1.47 | 0.99 | 2.71 |
| P-cymene | 33.42 | 3.013 | 12.40 | 15.66 | 20.90 | 10.93 | 18.92 |
| Linalool | 0.35 | 2.15 | 3.19 | 0.50 | 0.08 | 0.27 | 0.25 |
| Dillether | 19.63 | 7.48 | 6.99 | 23.40 | 6.04 | 25.32 | 14.66 |
| Dihydrocarvone | 0.73 | 0.73 | 1.73 | 1.23 | 4.05 | 1.72 | 1.37 |
| Sabinol | 0.31 | 1.09 | 0.84 | - | 1.92 | 0.41 | 0.14 |
| Carvone | 13.10 | 8.10 | 14.98 | 28.33 | 16.29 | 19.94 | 15.42 |
| Piperitone | 4.60 | 2.76 | 2.90 | 4.24 | 4.01 | 6.70 | 4.54 |
| Carveol | 3.24 | 4.28 | 4.15 | 1.62 | 0.91 | 3.00 | 1.75 |
| Nerolidol | 1.48 | 2.49 | 3.82 | 0.98 | 0.63 | 1.53 | 1.18 |
| Eugenol | 1.55 | 1.44 | 1.37 | 1.57 | 1.24 | 1.13 | 1.45 |
| Thymol | 0.85 | 1.33 | 1.40 | 0.44 | 3.07 | 0.80 | 1.53 |
| Carvacrol | 1.62 | 0.98 | 1.13 | 1.51 | 1.79 | 1.11 | 1.36 |
| Myristicin | 0.64 | 1.72 | 1.44 | 1.12 | 2.06 | 0.72 | 1.00 |
| Dillapiole | 4.16 | 8.40 | 17.50 | 11.78 | 17.30 | 19.18 | 12.54 |

### 3.1.3. In the Herb

The influence of gamma radiation on the compounds of volatile oil distilled from fresh herb during flowering stage is recorded in Table (3). It is evident that four main compounds were identified such as p-cymene ranged from 10.93% (under 32 k-rad treatment) to 33.42% (control plants), carvone ranged from 8.10% (under 2 k-rad treatment) to

28.33% (under 8 k-rad treatment), dillether ranged from 6.99% (under 4 k-rad treatment) to 25.32% (under 32 k-rad treatment) and dillapiole ranged from 4.16% (control plants) to 19.18% (under 32 k-rad treatment). All treatments caused an increase in dillapiole content. On the other hand, all treatments caused a decrease in p-cymene content. Gamma ray doses from 4 to 64 k-rad increased carvone content. Gamma ray at 32 k-rad resulted in the highest piperitone content (6.70485%). Whereas, 2 k-rad gave the highest compound of β-phellandrene (3.84%) and carveol (4.28%), respectively when compared with the other treatments.

## 4. Conclusion

Using gamma rays led to differences in the percentages in the volatile oil compounds of dill. Also we found differences in the volatile oil compounds in the flowers for the leaves+stems and total herb. p-cymene, carvone and dillapiole were the most abundant in the flowers; the main compounds of essential oil in the leaves+stems were dillether and p-cymene. However, four main compounds were identified in the whole flowering herb such as p-cymene, carvone, dillether and dillapiole.

## References

[1] Amin, W.M.; Sleem, A.A. (2007). Chemical and biological study of aerial parts of dill (*Anethum graveolens* L.), Egyptian Journal of Biomedical Sciences, 2007, 23(1):73-90.

[2] Faber, B.; Bangert, K.; Mosandl, A. (1998). GC-IRMS and enantioselective analysis in biochemical studies in dill (*Anethum graveolens* L.), Flavour and Fragrance Journal, 12(5): 305-314.

[3] Gunther, G. (1961). The Essential Oils. Nastrand Press, New York, USA.

[4] Hajhashemi, V.; Abbasi, N. (2008). Hypolipidemic activity of Anethum graveolens in rats, Phytother. Res., 22(3): 372-375.

[5] Hodisan, V.; Popescu, H.; Fagarasan, E. (1980). Studies on *Anethum graveolens*.I. II. Chemical composition of essential oil from fruits, Botanical Contributions, Babes-Bolyai University, Cluj-Napoca, 263-266.

[6] Hosseinzadeh, H.; Karemi, G.R.; Ameri, M., (2002). Effects of *Anethum graveolens* L. seed extracts on experimental gastric irritation models in mice, J. BMC Pharmacol., 2(1): 21-30.

[7] Mahran, G.H.; Kadry, H.A.; Thabet, C.K.; El-Olemy, M.M.; Schiff, P.L.; Wong, L.K.; Liv, N. (1992). GC/MS analysis of volatile oil of fruits of *Anethum graveolens*, Pharmaceutical Biology, 30(2): 139-144.

[8] Lopez, P.; Sanchez, C.; Batlle, R.; Nerin, C. (2005). Solid- and vapor-phase antimicrobial activities of six essential oils: susceptibility of selected foodborne bacterial and fungal strains, J. Agric. Food Chem., 53(17): 6939-6946.

[9] Radulescu, V.; Popescu, M. L.; Ilies, D.C. (2010). Chemical composition of the volatile oil from different plant parts of *Anethum graveolens* L. (Uumelliferae) cultivated in Romania. Farmacia, 58 (5):594-600.

[10] [10] Reichert, S.; Masandl, A. (1998). Stereoisomericflavor conpounds LXXXI: dill ether and its cisStereoisomers: synthesis and enantioselectiveanalysis. J. High Resol. Chromatogr., 21(3): 185 - 188.

[11] Stavri, M.; Gibbons, S. (2005). The antimycobacterial constituents of dill (*Anethum graveolens*). Phytother. Res., 19(11): 938-941.

[12] Sefidkon, F. (2001). Essential oil composition of *Anethum graveolens* L. Iranian Med. Arom. Plants Res., 8: 45 - 62.

[13] Singh, G.; Kapoor, I.P.S.; Pandey, S.K.; Singh, U.K.; Singh, R.K. (2001). Studies on essential oils: part 10, Antibacterial activity of volatile oils of some spices. Phytother. Res., (16): 680-682.

[14] Singh, G.; Maurya, S.; De Lampasona, M.P.; Catalan, C. (2006). Chemical constituents, antimicrobial investigations, and antioxidative potentials of *Anethum graveolens* L. essential oil and acetone extract: part 52, Journal of Food Science, 70(4): 208- 215.

[15] Satyanarayana, S.; Sushruta, K.; Sarma, G.S.; Srinivas, N.; Subba Raju, G.V. (2004). Antioxidant activity of the aqueous extracts of spicy food additives-evaluation and comparison with ascorbic acid in in-vitro systems J. Herb. Pharmacother., 2004, 4(2): 1-10.

[16] Taher, M.; Ghannadi, A.; Karmiyan, R. (2007). Effects of volatile oil extracts of *Anethum graveolens* L. and *Apium graveolens* L. seeds on activity of liver enzymes in rat, The Journal of Qazvin Univ. of Med. Sci., 11(2): 8-12.

[17] Yazdani, D.; Jamshidi, A.H.; Rezazadeh, S.H.A.; Mojab, F.; Shahnazi, S. (2004). Variaion of essential oil percentage and constituent at different growth stages of dill (*Anethum graveolens* L.). Iranian Journal of Medicinal Plants, 3(11):38-41.

[18] Yili, A.; Yimamu, H.; Maksimov, V.V.; Aisa, H.A.; Veshkurova, O.N.; Salikhov, Sh.I. (2006). Chemical composition of essential oil from seeds of *Anethum graveolens* cultivated in China, Chemistry of Natural Compounds, 42(4): 491-492.

[19] Zheng, G.; Kenney, P.M.; Lam, L.K.T. (1992). Anethofuran, Carvone and Limonene: Potential cancer chemopreventive agents from dill weed oil and caraway oil, Planta Medica, 58: 339-341.