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Changing in the Chemical Composition of the Essential Oils of Mentha piperita after MeJA treatment

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ABSTRACT: Peppermint (Mentha piperita L.) belongs to mint (Lamiaceae) family. Peppermint essential oil used for flavoring and pharmaceutical industries. 48 h-treated plants with methyl jasmonate (MeJA) concentrations (0, 0.1 and 0.5 mM) were analyzed for their component of essential oil. At the early bloom stage, the 48h- treated and untreated leaves were cut from the plants and total oil of the leaves was isolated and analyzed by GC/MS method. It can be concluded that exogenous application of MeJA increases the amount of some compounds (for example, methylacetate, β-pinene and 1, 8-Cineole) while reduce the amount of menthol, neomenthol and linalool. Our results also demonstrated that MeJA could change the percent of essential oil composition and increased medicinal value of Mentha piperita.
Key word: 1, 8-cineol; Essential oil; MeJA; Mentha piperita; Menthol, Methyl acetate; Pulegone

INTRODUCTION

Peppermint (Mentha piperita L.) belongs to mint (Lamiaceae) family (Mahmoud and Croteau, 2003; Tabatabaie. and Nazari, 2007). M. piperita is the most important sources of peppermint oil that used for flavoring and pharmaceutical industries and this plant is suitable for growing in loose texture loamy soils (Akhtar et al., 2009). It is herbaceous and perennial plant that used as a medical and aromatic plant (Mahmoud and Croteau, 2003; Tabatabaie. and Nazari, 2007). It grows in wet soils in temperate regions of Asia, Europe and America (Akhtar et al., 2009). Its essential oil was used extensively for the medical and food. Peppermint essential oil includes menthol, menthone, methylacetat, menthofuran and pulegone has medical effect (Mahmoud and Croteau, 2003; Tabatabaie. and Nazari, 2007). Peppermint is widely used in food, cosmetics and medicines. It is helpful in pain remission. It may also improve digestive problems like dyspepsia and nausea symptoms (Gardiner, 2000). There are highly specialized epidermal secretory structures in the leaves of Mentha species known as glandular trichomes that oils are synthesized and concentrated in this structures (Farooqi et al., 1999). Essential oil content and composition in these plants are affected by some environmental condition such as season, temperature, moisture, duration and intensity of solar irradiation, and other climatic and rhizospheric situations (Farooqi et al., 1999).

In general, different environmental factors impress plants during their life imply a diversity of interactions between hormones and signal factors, the accumulation and combined action of metabolites. Such diversity permits plants to tolerant stresses and to utilize their physiological potential (Ryabushkina, 2005).

Previous study showed that time of harvest of peppermint is more critical to yield and quality than the time of onset of irrigation (Marcum and Hanson, 2006). It was found that foliar application of 3ppm zinc chloride solution on Mentha peperita plant is very effective for vegetative growth and as well as quantitative yield of its essential oil (Akhtar et al., 2009). Many reports show that peppermint oil is affected by growing region, year, shading, fertilization, water balance of the plants, and harvest time. It was reported recently that the amount of individual monoterpenes in peppermint oil is strongly influenced by day length (Burbott and Loomis, 1967). MeJA is a key compound in the signal transduction pathway that elicits compounds with low-molecular weight involved in plant responses to stress (Creelman and Mullet, 1997). It was shown that the total phenolic content of the sweet basil significantly increased after 0.1 and 0.5 mM MeJA treatments compared with the untreated plants (Kim et al.,

2006). The present work aimed to study the changing in essential oil composition after exposure of Mentha piperita plant to different concentrations of MeJA at 48 hour after treatment, using GC/MS analysis.

MATERIAL AND METHOD

PLANT MATERIAL

This experiment was carried out under natural light conditions in the greenhouse. The peppermint plants were supplied kindly from Iranian Institute of Medicinal Plants, Karaj, Iran. In the flowering stage, the plants treated with different methyl jasmonate concentrations (0, 0.1 and 0.5 mM) and 48 h-treated plant analyzed for their component of essential oil.

Compositional analysis of essential oil

At the early bloom stage, the leaves were cut from the plants and total oil of the leaves was isolated by steam distilling of 30 g of the freshly chopped leaves in a Clevenger apparatus. Subsequently, the essential oil from plants was combined and analyzed using a gas chromatograph (model Hewlet Packard 6890N) fitted with a HP-5MS column phenyl methyl silo hexane capillary column (0.25 µm film thicknesses, 30 m × 0.25 mm i.d.) and an Agilent 5973 Network Mass Selective Detector. Oven temperature was programmed at 50 °C to 300 °C at 15 °C min^{-1}. Helium was used as a carrier gas. Flow rate of the carrier gas (Helium) was 8 ml min^{-1}. The constituents of essential oil were identified by comparing their mass spectra and retention indices with those in the computer library and other databases.

RESULT AND DISCUSSION

Essential oil of Mentha piperita is a combination of various components as shown in Table 1. The main components of this oil were menthol, neomenthol, menthone, menthofuran, 1,8-cineole and methylacetate. The components with small amount were α-pinene, β-pinene, caryophyllene, germacrene, veridiflorol, linalool and phenol. Different between amount of chemical compositions of the oils in treating plants with various concentrations of MeJA (0.1, 0.5 mM) and untreated plants can be seen in Figure (1, 2).

Table1. Percentage part of composition of the essential oil from the aerial Mentha piperita in different concentration of MeJA (0, 0.1, 0.5 mM)

Essential oil component	Control%	mM 0.1 **%**	mM **0.5%**
Menthol+neomenthol	39.54	37.2	37.55
Menthone+Menthofuran	25.9	25.64	24.96
Pulegone	4.64	4.59	5.01
Methyl acetate	4.15	4.59	5.24
1,8-Cineole	10.94	12.4	12.76
- Pineneα	0.88	90.9	0.97
-Pineneβ	1.96	2.15	2.19
Caryophyllene	2.03	1.98	2.06
Germacrene	0.9	0.93	0.96
Viridiflorol	0.46	0.23	0.49
Linalool	0.7	0.59	0.5
Phenol	0.32	. 0.75	0.32
total	92.42	92.31	93.01

Menthol+neomenthol amount in the essential oil was decreased 0.9-fold at 0.1 and 0.5 mM MeJA treatments relative to the control. There was not difference between MeJA treatment and control for Menthone+Menthofuran amount. Pulegone content was increased 1.1 fold in the 0.5 mM MeJA-treated plants compared to the control. Its amount didn't change compared with the untreated plants in 0.1 mM MeJA. This study showed that application of MeJA increment some components of essential oil as a secondary metabolite, this finding is confirmed with previous studies, which is shown that exogenous application of MeJA in various plants increase the amount of secondary metabolites (Hyun-Jin, 2007). In the essential oil, methyl acetate content was increased 1.2- and 1.3-fold at 0.1 and 0.5 mM MeJA treatments respectively relative to the control, also 1,8-cineol and β-pinene were increased in both concentration of MeJA compared with control plants. According to Pharmaceutical application of 1,8-cineol and β-pinene, this research shows that MeJA increased medicinal value of Mentha piperita.

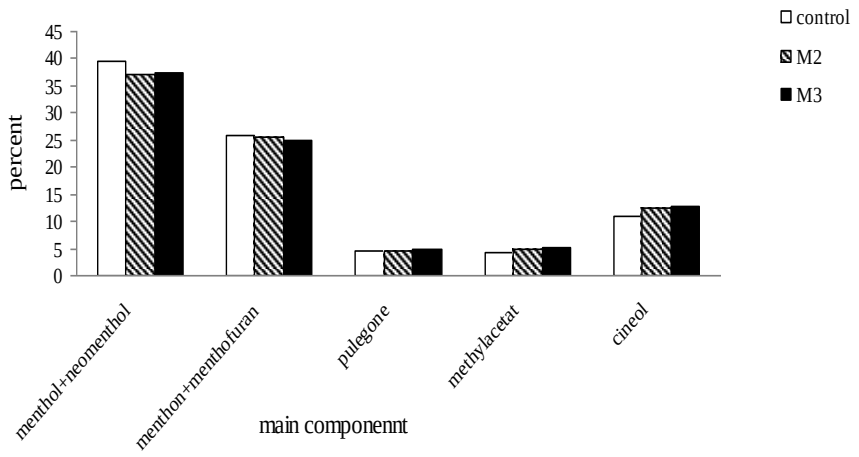

Figure1. changing in main component of essential oil 48 after MeJA in Mentha piperita

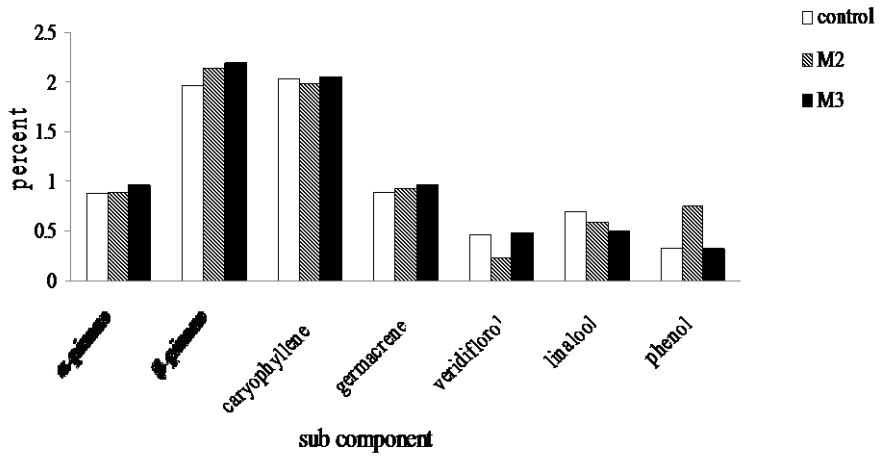

Figure2. changing in sub component of essential oil 48 after MeJA in *Mentha piperita*

Some competent in Mentha piperita essential oil decreased in treated plant compared untreated plants including linalool, menthol and neomenthol but Caryophyllen, menthofuran and menthone didn't change with different concentrations of MeJA treatment. Veridiflorol amont increased and decreased with 0.5 and 0.1 mM of MeJA respectively. According the results of the present study, it can be concluded that exogenous application of MeJA increases the amount of some compounds (for example, methylacetate, β-pinene and 1, 8-Cineole) while reduce the amount of Menthol, neomenthol and linalool. Our results also demonstrated that MeJA could change the amount of secondary metabolites in Mentha piperita. Changing in essential oil constituents was observed in medicinal plants under stress (Sangwan et al., 1993; Baher et al., 2002). It has been shown that different elicitors such as JA and MeJA can enhance secondary metabolites in various plants (Hyun-Jin, 2006). It was found that percent of some important constituents of essential oil changed with MeJA treatment.

CONCLUSION

Previous studies showed that application of MeJA increment some components of essential oil as a secondary metabolite. Our results also demonstrated that MeJA could change the percent of essential oil composition and increased medicinal value of Mentha piperita.

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