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Original Article

Change of Essential Oil Composition of Parsley in Response to Static Magnetic Field

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ABSTRACT

Background: The composition of essential oil of plants is influenced by genetic and environmental conditions. Volatile oils extracted from traditional herbs are interesting natural products and represent an important part of the traditional pharmacopeia.
Methods: The effect of the continuous static magnetic field (30 mT, 8 hours) exposure on the composition of essential oil in harvested parsley plants (*Petroselinum crispum* L.) was investigated. Essential oil was extracted using Clevenger distillation and its composition was determined by GC-MS.
Results: Essential oil yield increased from 2.15% in control plants to 2.4% in samples exposed to static magnetic field. Thirteen compounds were identified representing over 98% of the oil components in control parsley plants with major components of myristicin (68.9%), phytol acetate (6.4%), sesqui phellandrene (beta) (5.9%), and germacrene D (4.1%). In magnetic field, the treated plants, myristicin quantity increased significantly up to 90.7%; whereas the other components were decreased or not detected.
Conclusion: Concerning the importance of myristicin as an effective cancer chemo preventive agent, post harvest exposure of parsley plants to the magnetic field can be suggested as an effective method to enhance the myristicin selectivity.

Keywords: *Petroselinum crispum*, essential oil, myristicin, static magnetic field.

1. Introduction

Respiration, transpiration, ripening, senescence, and changes in both external and internal quality characters are the main activities occurring in live products during their postharvest period (Kataria *et al.*, 2019)[7]. The biosynthesis of secondary metabolites, although controlled genetically, is also sensitive to the storage and environmental conditions (Zakeri *et al.*, 2020; Toncer *et al.*, 2009)[19, 20]. The fresh green herbs become a highly perishable postharvest product due to the senescence-accelerated metabolism accompanied by loss of freshness, chlorophyll (Aharoni *et al.*, 1993)[1]. The harvested plants are seriously susceptible to fungi and other pathogens. In the past few years, postharvest treatments have attracted increasing interest as a result of the growing demand to reduce the postharvest use of chemical fungicides. The postharvest treatments have been used to induce plant tolerance to the cold temperatures, pathogen diseases, and fruit decay (Hong *et al.*, 2007; Schirra *et al.*, 2004; Petriacq *et al.*, 2018)[6,11,15]. However, little is known about the character and postharvest behavior of medicinal plants.

Parsley is widely cultivated in the temperate regions of the world as a medicinal and spicy plant and its leaves are good sources of vitamins (i.e. A and C) and minerals (i.e. Ca, K, P, Fe, and Mg) (Pennington and Church, 1985)[12]. Traditionally, parsley has been used for treatment of diseases of the prostate, liver, diabetes, anemia, arthritis, and cancers. Parsley pharmaceutics have been also used as expectorant, antimicrobial, aphrodisiac, hypotensive, and laxative agents (Ozsoy-Sacan *et al.*, 2006; Zheng *et al.*, 1992)[10,21]. The essential oil of parsley is also used as flavoring agent or fragrance in perfumes, soaps, and creams (Atta-Aly, 1999)[3]. The main components of essential oil reported for parsley include a-pinene, b-pinene, myrcene, p-phellandrene, 1, 3, 8-p-menthatriene, apiol, and myristicin (Simon and Quinn, 1988)[17]. Myristicin is found in the other species of Umbelliferae (Shulgin, 1966)[16] and has been introduced as an effective cancer chemopreventive agent (Zheng *et al.*, 1992)[21]. Myristicin also potentiates the activity of the insecticide paraoxon in flies by inhibiting its degradation. It has been shown that myristicin induces glutathione S-transferase and also helps to prevent liver injury caused by lipopolysaccharide in mice (Morita *et al.*, 2003)[9]. The effects of magnetic fields on the metabolism of plants have recently attracted significant curiosity. For instance, the contents of phenolic compounds in red cabbage, essential oils of basil and taxanes in the hazel cells were altered by exposure to static magnetic field (Ghanati *et al.*, 2007; Khoshsokhan *et al.*, 2006; Rezaei *et al.*, 2010)[5, 9, 13]. However, the effects of magnetic field on the secondary metabolites and pharmaceutics of plants after postharvest exposure to the magnetic fields have been rarely studied.

The present study was undertaken to investigate the yield and composition of essential oil in parsley (*Petroselinum crispum*) after exposure to the static magnetic field (SMF).

2. Material and Methods

2.1. Plant material and storage condition

The plants were grown in commercial fields at 21± 5 °C (day time) and 9± 5 °C (night) and were harvested in December 2011. Plants were then washed thoroughly. Great care was taken to keep plant system moist and to avoid any mechanical damage due to handling and the subsequent treatments. Further desiccation of the plants (during exposure period) was avoided by keeping the plants in the aerated hydroponic systems.

2.2. Exposure to the static magnetic field, extraction of essential oils, and GC-MS analysis

The plants with the unique size and appearance were selected and divided to different groups. Exposure to 30 mT SMF was conducted via a locally designed apparatus that has been previously described (Ghanati *et al.*, 2007)[5]. Control groups were placed in the same conditions in terms of humidity, temperature, and light and shielded from SMF. After 8 hours (after 8 hr treatment) the plants were collected, and also the roots and aerial parts were separated and weighed for determination of fresh weight. Plant materials were then shadow dried at room temperature for 4 days. To extract the essential oils, the dried plant materials (25 g) were subjected to hydrodistillaion for 5 hours using Clevenger apparatus. The extracted essential oils were analyzed by gas chromatography-mass spectrometry (GC-MS, TRACE MS, and Thermoquest-Finnigan).

3. Results and Discussion

Crop yield can be changed in response to the environmental conditions (Sarraf *et al.*, 2020)[14]. A potential link between SMF and its effects on plant metabolism is the fact that SMF causes an oxidative stress, that is, an increase in the activity, concentration, and lifetime of free radicals. These radicals are highly reactive by-products which may function as signaling molecules to trigger the production of defensive molecules (eg., phenolics, anthocyanins, alkaloids, and essential oils) (Belyavskaya, 2004; Ghanati *et al.*, 2007; Rajabbeigi *et al.*, 2006)[4, 5, 15].

The postharvest exposures of parsley plants to SMF did not bring significant increase in the essential oil yield (2.4% in SMF-treated versus 2.15% of control plants) (Table 1). Among the identified oils in control plants, myristicin (68.9%) was the major components which was followed by phytol acetate (6.4%), sesquiphellandrene (beta) (5.9%), and germacrene D (4.1%).

Recent study has shown that plants alter their gene expression and phenotypes in response to MFs (Anand *et al.*, 2019)[2]. The SMF exposure to remarkably increase the myristicin content of parsley of up to 90.7% (Table 1). Some components, for example beta sesquihellandrene and beta elemene even were not detectable in SMF-treated plants. The plants alter/adopt their metabolic pathways in response to a particular condition. It has been shown that any disruption in the normal metabolic pathway affects the sequence of steps of the oil biosynthesis (Yeritsyan and Economakis, 2002)[19]. Concerning the phenylpropanoid structure of myristicin versus terpenoid structure of β-sesquiphellandrene, β-elemene, and germacrene D, it can be speculated that the treatment with SMF has shifted the essential oil metabolism from terpenoid to phenylpropanoids pathway. The results are coincident with those previously reported by Ghanati *et al.* [5] on the increase of methylchavicol in essential oils of SMF-treated basil. The alteration of metabolic pathways may be indirectly resulted from the availability of photosynthates or directly through some factors responsible for efficient utilization of precursors coming from the primary synthesis, for example, enzymatic proteins (Yeritsyan and Economakis, 2002)[19]. Although it is plausible that parsley plants continue to photosynthesize during the SMF exposure, however, concerning the short period of the treatment, it is more reasonable to suppose that the SMF treatment indirectly affected the metabolism of essential oil, i.e. the alteration in the precursors utilization in the oil biosynthesis. It should be noted that due to the cancer chemopreventive properties of myristicin (Lee *et al.*, 2005) [8], the exposure of parsley plants to SMF can be suggested as a promising alternative and a rapid method to increase valuable pharmaceutics contents in the harvested medicinal plants.

Table 1. The SMF effect on essential oil constituents of parsley

Identified Compound	RT[a]	Area %	
		Ctrl	SMF
Elemene (beta)	22.1	2.2	-
Cryophyllene (trans)	23.0	1.1	-
Eemene (gamma)	23.0	2.9	1.1
Germacrene D	24.5	4.1	1.8
Liguloxide	24.8	1.2	-
Myristicin	25.3	68.9	90.7
Squiphellandrene (beta)	25.4	5.9	-
Kessane	25.7	1.7	-
Germacrene B	26.5	2.3	1.5
Dihydro agarofurane (4-epi cis)	26.5	1.9	1.9
Carotol	27.4	0.5	-
Khusinol	28.1	0.8	-
Apiol	29.0	0.4	-
Phytol actate (trans)	32.3	6.4	2.9
Heptacosane	41.9	0.3	-
Total		99.8	99.8

[a] Relative retention time

Abbreviation

SMF: Static Magnetic Field.

Conflict of interest

The authors declared that they have no conflict of interest, financial, or otherwise.

Consent for Publications

Authors have read and approved the manuscript for publication.

Ethics Approval

The Ethics Committee of Department approved the protocol of the study.

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