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RESEARCH ARTICLE

THE CONSTITUENTS OF VOLATILE OIL OF PEPPERMINT (*Mentha piperita* L.) GROWN IN SUDAN

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ABSTRACT

The objective of this study was to assess the oil composition of peppermint grown in the National Botanic Garden, Khartoum, Sudan. The essential oil obtained by hydro-distillation (0.4%) of the fresh leaves of *Mentha piperita*, were analyzed by GC and GC/MS. Eleven compounds representing 89.28% of the oil were identified. Menthone (47.38%), menthofuran (9.79%), menthol (8.58%), pulegone (7.92%), cineol 1.8 (5.29%), isomenthone (4.64%)and limonene (2.73%) were the major components. The study showed that *M. piperita* could be raised for production of its essential oil under the prevailing environment of central Sudan. To obtain good quality oil attention should be paid to the selection of the growing site and for developmental stage of the harvested leaves.

INTRODUCTION

Peppermint (*Mentha piperita* L.) oil is one of the most popular and widely used essential oils, mostly because of its main components menthol and menthone. The oil is used for flavouring pharmaceuticals and other oral preparations. Menthol is the most abundant component of the essential oil of mature peppermint plants, but the overall quality of the oil and thus the compositional balance of several oil constituents (Guenther, 1961; Court *et al*., 1993) determines its commercial value. Developmental and environmental factors are known to greatly influence the yield and composition of peppermint oil. For example, oil yield and menthol content increase with leaf maturity, and a range of stress conditions tend to promote the accumulation of pulegone and menthofuran (Burbott and Loomis, 1967; Clark and Menary, 1980; Voirin *et al.,* 1990; Brun *et al*., 1991). According to Turner *et al*. (2000), monoterpene production is restricted to developing glands of young leaves. The oil composition of young leaves, grown under long day condition changes from menthofuran to menthone and menthol (Clark and Menary, 1980). Menthol and menthofuran content are greatly affected by changes in the growing season (Court *et al*., 1993). The objective of this study was to assess the oil composition of peppermint grown in the National

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Botanic Garden, Khartoum, Sudan. This is the first report on the chemical composition of this mint species from Sudan.

MATERIALS AND METHODS

Stolons of the plant were brought from Egypt and raised at the National Botanical Garden in November 2004. The top part (approximately 4-8 cm) was cut during April 2005 and hydro-dis tilled for 2 hours using a Clevenger-type apparatus. The oil content was measured based on ml oil per 100 gram of the fresh leaves (mL/100g). The obtained oil was stored at 4 °C until analysis.Gas chromatography (GC) study was performed on Perkin Elemer Autosystem YL GC equipped with fused silica capillary column (PE-5 50 m x 0.32 mm x 0.25 µm). The initial temperature of the column was 100 °C for one minute and then heated at a rate of 3 °C to 280 °C. The injector and detector temperatures were maintained at 250 ºC and 300 °C, respectively. Hydrogen gas was used as a carrier (Column pressure was 10 psi H_2)

The Gas chromatography and Mass Spectroscopy (GC/MS) were recorded on a Perkin Elemer Autosystem XL GC and Turbo mass spectrometer with a capillary column (PE-5 50 m x 0.32 mm. film thickness 0.25 µm); helium was used as carrier gas at the rate of 2 ml/min. The column temperature was programmed from 100 ºC to 200 ºC at a rate of 3 °C/min. The identity of the components was assigned by comparing their GC retention times with those of authentic samples as well as with known components of standard essential oils and composition of the fragmentation pattern with that reported in Nist and Willey computer libraries.

RESULTS AND DISSCUSSION

Extraction of the fresh leaves of peppermint gave 0.4ml/100 g essential oil, which was lower than the reported values (Guenther, 1961).This might be because the distilled leaves were at early stages of development at which time the oil content is low (Guenther, 1961). The essential oils obtained by hydro-distillation of the leaves of *Mentha piperita* were analyzed by GC and GC/MS. Eleven compounds (Table 1 and Fig. 1) representing 89.28% of the oil were identified (Fig.1). Menthone (47.38%), menthofuran (9.79%), menthol (8.58%), pulegone (7.92%), cineol 1,8 (5.29%), isomenthone (4.64%)and limonene (2.73%) were the major components. The high menthone content obtained in this result may likely be due to that the sampled leaf was predominantly immature and this result is in line with the earlier findings of Clark and Menary, (1980) and Brun *et al*. (1990) who state that the young leaves are rich in menthone. In this context, Mahmoud and Croteau, (2003), find that the most predominant monoterpene constituent of peppermint oil is menthone in wild type (71.4%) and transgenic (55-67%) plants grown under optimal conditions.

Table 1. The major chemical constituents of the peppermint oil

Compound	Content (%)
α-pinene	0.83
β-pinene	1.15
Sabinene	0.58
β-myrecene	0.37
Limonene	2.73
1,8 cineole	5.29
Menthone	47.38
Menthofuran	9.79
Isomenthone	4.64
Pulegone	7.92
Menthole	8.57
Total	89.28%

The increased menthofuran and pulegone content may be due to ecological factors that prevailed during the growth of this plant. The area where the mint plant was growing is shaded by the surrounding trees of the garden, which created a microclimate of reduced photon flux during the day. This result is in line with that of Burbott and Loomis (1967) and Clark and Menary, (1980) who found that plants grown under stress conditions (decreased photon flux during daylight coupled by elevated night temperature) tend to accumulate menthofuran and pulegone.

During essential oil syntheis in *M. piperita*, the isoprenoid pathway leads to the formation of geranil pyrophosphate, from which limonene originates, next forming piperitone, which in turn forms pulegone that can form menthone and/or

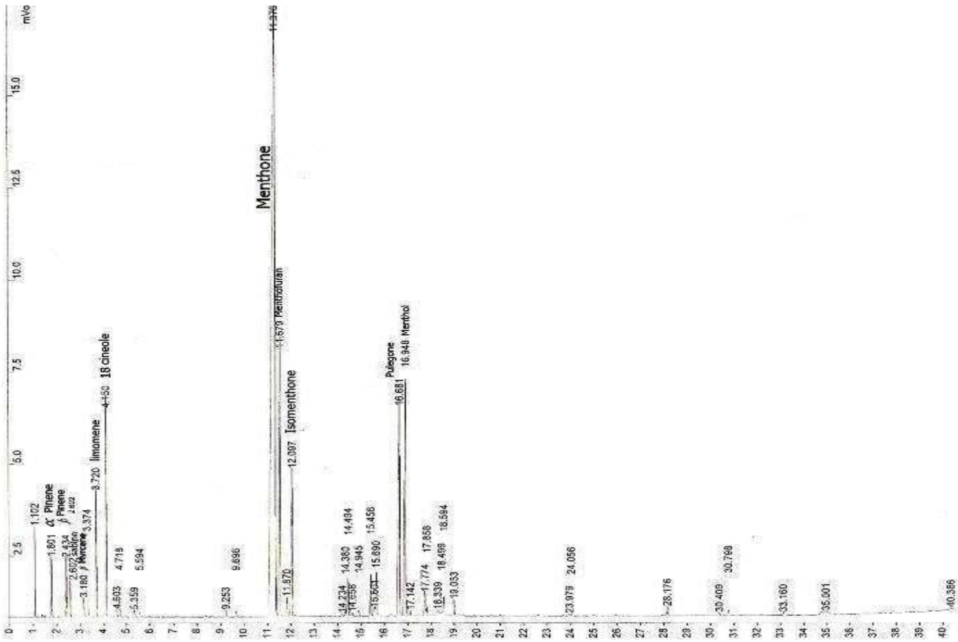

Fig.1. Chromatogram showing the peaks of the peppermint oil constituents

menthofuran (Dey and Harbone, 1997; Croteau *et al*., 2000). Based on this, it is understood that in the present study the growing conditions to which the mint plant was subjected favoured the formation of menthone. The increase in monoterpene ketones and oxides (i.e., menthone and menthafuran) and decrease in monoterpene alcohol such as menthol (Table 1) may suggest that the reduced activity of the reducing enzyme may at least partially be responsible for the reduced level of transformation of monoterpene ketone to alcohol. According to McConkey *et al*. (2000), the monoterpene formation in peppermint oil gland cell is tightly controlled by the biosynthesis, and menthone is the major end product in the young leaves. But this ketone (menthone) declines greatly during leaf development as conversion to alcohol (menthol) by reductase enzyme, a condition that doesn't occur in the present study because the plant was harvested before maturity. This preliminary study showed that *M. piperita* could be raised for production of its essential oil under the prevailing environment of central Sudan. The result obtained has important implications in the production of commercial mint oil of high quality. Attention should be paid to the selection of the growing site and for the developmental stage of the harvested leaves. Further studies are needed to evaluate the growth and oil quality of the plant under appropriate growing conditions.

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