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# Preliminary investigation of the effect of peppermint oil on an objective measure of daytime sleepiness

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**Abstract**

The assertion, often quoted in the popular literature, that peppermint has invigorating properties has been investigated through objective assessment of daytime sleepiness. Pupillary fatigue oscillations have been used to give an index of pupillary unrest that can be used as a reliable measure of daytime sleepiness. When compared with a no-odour condition, the presence of peppermint oil limited the increase in sleepiness during 11 min spent in a darkened room. This significant difference in sleepiness between the peppermint oil and the no-odour conditions was shown not to be related to differences in subjective ratings of initial sleepiness, from the Stanford Sleepiness Scale (SSS). Neither was it related to differences in initial pupillary unrest or mean pupil size. It seems that in conditions that favour an increase in daytime sleepiness, peppermint oil can indeed reduce sleepiness. However, the mechanisms by which peppermint oil has its effect and the applicability of these findings to situations in everyday life will require further empirical investigation.


*Keywords:* Sleepiness; Peppermint; Essential oil; Pupillary; *Mentha x piperita*

## 1. Introduction

There seems to be, within popular literature at least, some consensus as to the benefits and effects of various essential oils. In particular, peppermint oil is thought to be both stimulating (Hopkins, 1991) and invigorating (Devereux, 1993). More recently, peppermint has been shown to be an aid to athletic performance (Raudenbush et al., 2001). Others make even more specific claims as to its effectiveness in reducing sleepiness. These include the inhalation of peppermint oil to revive and stimulate junior doctors while on a night shift (Buckle, 1997) or to counteract after lunch sleepiness in the workplace (unsourced quote appearing on multiple websites). These commonly held assertions about the invigorating effects of peppermint have been confirmed, at a subjective level, by a sensory profiling assessment of 16 essential oils in a variety of experimental settings (Sugawara et al., 1999).

In contrast to these widely held beliefs about the effects of peppermint oil, there are comparatively few

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empirical studies into these 'invigorating' effects. Several studies have looked at the effects of essential oils on aspects of attention and task performance. Using a visual attention task, Warm et al. (1991) showed that the presence of peppermint significantly increased detection of critical signals but had no effect on the subjective experience of workload or stress. This was further supported by EEG studies showing that presentation of peppermint oil could lead to and increased ability to sustain attention (Parasuraman et al., 1992). However, using a visual vigilance task, Gould and Martin (2001) found that there was a significant effect of bergamot (a relaxing odour) on task performance, with participants detecting fewer targets, but there was no effect of peppermint.

There is greater support for the effect of peppermint oil on sleep itself. By recording EEG sleep stages, Badia et al. (1989) found a circadian 'time of night' effect where participants were less responsive, when administered peppermint oil during stage 2 or towards the middle or end of the night. They suggest that peppermint oil may have an arousing effect but seems not to be pervasive enough to interrupt lower levels of sleep. In subsequent experiments, participants who were exposed to peppermint oil spent a significantly greater percentage of time in stage 1 sleep and experienced more spontaneous awakenings as compared to the air control group (Badia et al., 1990a,b).

There is little doubt that in addition to any direct physiological effect of an essential oil, there are also other factors that may influence both task performance and one's level of alertness. One example of this is the mismatch between the patterns of EEG activity and the perceptual similarities of various essential oils (Lorig and Schwartz, 1988). Furthermore, it has been demonstrated that the perceptual quality of an odour (hedonics) can have an affective reaction on a person's mood (Knasko, 1992). There are many other indirect factors that may influence odour perception in the individual, such as culture, expectations and belief in the qualities of the odour (Broughan, 1998). A useful categorisation of the mechanisms by which odours have their influence has been provided by Jellinek (1997). He identifies four mechanisms: (i) quasi-pharmacological influences on the central nervous system, (ii) semantic influences that are dependent on the individual's experience with that odour, (iii) the influence of the odour's hedonic valence (pleasantness) and (iv) an expectation effect (often referred to as placebo).

This latter expectancy effect was elegantly demonstrated by Ilmberger et al. (2001), where they found that in a control condition with water, if participants rated the water as being more stimulating (than the previous water condition) then their reaction times and motor movements were faster. This expectation effect is thought to play a particularly critical role in mediating attentional processes when low odour concentrations are used (Torii et al., 1998).

In many of the studies mentioned above, the measures are either of an attentional performance task or a direct measure of the effect on stages of sleep. In this study, we investigate the 'invigorating' effects of peppermint oil more directly by using an objective measure of daytime sleepiness. However, most of the commonly used objective measures of sleepiness involve sleep latency and are therefore not appropriate for a study involving an acute presentation of an odour. A pupillary measure of daytime sleepiness was therefore chosen. In sleepy participants, in darkness, there are spontaneous low-frequency pupillary oscillations with increasing amplitude, whereas in alert participants, the pupil is relatively stable with small amplitude oscillations (<0.3 mm) at approximately 1 Hz. Pupillary fatigue oscillations have been shown to be both effective and reliable measures of daytime sleepiness in a variety of experimental conditions (Lowenstein et al., 1963; Yoss et al., 1970), and they correlate well with the most commonly used objective measure of sleepiness: the Multiple Sleep Latency Test (Danker-Hopfe et al., 2001; McLaren et al., 2002). Pupillary fatigue oscillations have been used as a significant indicator of daytime sleepiness for both sleep-related disorders (Wilhelm et al., 1998a) and for sleep-deprived normals (Wilhelm et al., 1998b).

The size of the pupil is determined by the antagonistic pairing of the dilator and sphincter muscles. These muscles are double reciprocally innervated by the sympathetic and parasympathetic nervous systems. The steady-state size of the pupil in darkness is largely dependent on sympathetic activity and paired central parasympathetic inhibition. As alertness decreases, there are reduced levels of central sympathetic activity. It is this reduction in the sympathetic activation of the Edinger–Westphal