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The effect of electromagnetic field stimulation on the electromagnetic spectrum structure of essenstial oil

***Abstract**. Essential oils have found wide use due to their properties already observed in nature. Because of the new interest in natural products such as essential oils, despite their widespread use and familiarity as fragrances, it is important to better understand their mode of biological action for new applications in medicine, agriculture and the environment. an important goal of modern chemical physics is to gain external control over the dynamics of elementary chemical processes. Manipulating chemical transformations with external electromagnetic fields is at the heart of modular chemistry, chemical stereodynamics and quantum control of molecular dynamics. The aim of this study was to determine the degree of influence of an alternating elecromagnetic field on the structure of the electromagnetic spectrum in the visible light range of selected essential oils. The experiments conducted showed the effect of an alternating electromagnetic field on the electromagnetic spectrum of cedarwood oil. To generate significant changes in the light permeability of the suspension, for both oils, the oils must be subjected to a two-hour exposure to an electromagnetic field of 40 mT.*

***Streszczenie.** Olejki eteryczne znalazły szerokie zastosowanie ze względu na swoje właściwości zaobserwowane już w naturze. Ze względu na nowe zainteresowanie produktami naturalnymi, takimi jak olejki eteryczne, pomimo ich szerokiego zastosowania i znajomości jako substancji zapachowych, ważne jest, aby lepiej zrozumieć ich sposób działania biologicznego dla nowych zastosowań w medycynie, rolnictwie i środowisku. ważnym celem współczesnej fizyki chemicznej jest uzyskanie zewnętrznej kontroli nad dynamiką elementarnych procesów chemicznych. Manipulowanie przemianami chemicznymi za pomocą zewnętrznych pól elektromagnetycznych stanowi sedno chemii modularnej, stereodynamiki chemicznej oraz kwantowej kontroli dynamiki molekularnej. Celem badań było określenie stopnia oddziaływania zmiennego pola elekromagnetycznego na strukturę widma elektromagnetycznego w zakresie światła widzialnego wybranych olejków eterycznych. Przeprowadzone eksperymenty wykazały wpływ zmiennego pola elektromagnetycznego na widmo elektromagnetyczne olejków z drzew cedrowego. Aby wygenerować istotne zmiany przepuszczalności świetlnej zawiesiny, w przypadku obu olejków należy poddać olejki dwugodzinnej ekspozycji pola elektromagnetycznego o natężeniu 40 mT. (**Wpływ pola elektromagnetycznego na strukturę widma elektromagnetycznego olejków eterycznych**)*

Keywords: electromagnetic field, essential oils, electromagnetic spectrum
Słowa kluczowe: pole elektromagnetyczne, olejki eteryczne, widmo elektromagnetyczne

Introduction

Essential oils are volatile, natural, complex compounds characterized by a strong fragrance, formed by aromatic plants as secondary metabolites. They are obtained most often by steam distillation or hydrodistillation. Known for their antiseptic properties - bactericidal, virucidal and fungicidal, medicinal and aromatic, they are used in embalming, food preservation and as antibacterial, analgesic, sedative, anti-inflammatory, spasmolytic and local anesthetics. To date, these properties have not changed much, except that more is now known about some of their mechanisms of action, especially at the antibacterial level. In nature, essential oils play an important role in plant protection as antibacterial, antiviral, antifungal, insecticidal agents, as well as against herbivores by reducing their appetite for such plants. They can also attract some insects, promoting the spread of pollen and seeds, or repel unwanted others. Essential oils have found wide use because of their properties already observed in nature.

At present, about 3,000 essential oils are known, of which 300 are of commercial importance, especially for the pharmaceutical, agricultural, food, sanitary, cosmetic and perfume industries. Essential oils or some of their components are used in perfumes and makeup products, in sanitary products, in dentistry, in agriculture, as preservatives and food additives, and as natural remedies. For example, d-limonene, geranyl acetate or d-carvone are used in perfumes, creams, soaps, as food flavorings, as fragrances for cleaning products and as industrial solvents. In addition, essential oils are used in massage as blends with vegetable oil or in baths, but most commonly in aromatherapy. Some essential oils appear to exhibit special medicinal properties that treat one or another organ dysfunction or systemic disorder [1,2,3]. Given the new interest in natural products such as essential oils, despite their widespread use and familiarity as fragrances, it is important to better understand their mode of biological action for new applications in medicine, agriculture and the environment. Some of them are effective alternatives or supplements to the synthetic compounds of the chemical industry, without showing side effects [3,4].

The environment is abundant with electromagnetic fields of various frequencies and amplitudes, which is a consequence of the development of civilization. The density of these fields is very high and they are constantly present, which cannot but raise concerns about their biomedical impact and potential danger [5]. Many scientific studies have reported that there is a direct relationship between the biochemical effects of electromagnetic fields and the type, degree of and duration of field exposure. The effects of changes in biochemical systems have attracted the attention of many researchers working on biology, chemistry, medicine and agriculture. Especially in recent years, many scientists have begun to conduct research on the positive and negative effects of electromagnetic and magnetic fields, on living beings [6]. Therefore, an important goal of modern chemical physics is to gain external control over the dynamics of elementary chemical processes. Manipulation of chemical transformations by means of external fields or laser radiation is at the heart of modular chemistry, chemical stereodynamics and quantum coherent control of molecular dynamics. External electromagnetic fields can be used to orient and align molecules, which reduces the symmetry of electronic interactions between reactants in the input reaction channel and can result in suppression or enhancement of reaction rates [7].

The aim of the study was to determine the degree of influence of an alternating elecromagnetic field on the structure of the electromagnetic spectrum in the visible light range of selected essential oils.

Material and methods

Cedarwood essential oil was used in the study. Four samples each were prepared from the essential oil in ten repetitions: a control sample and three stimulated samples with durations of 1h, 2h and 3h. The samples were then subjected to an electromagnetic field (Figure 1) with a frequency of 50 Hz at two variants of magnetic flux density of 40 mT and 80 mT, and 3 variants of interaction, i.e. stimulation times of 1, 2 and 3 hours.

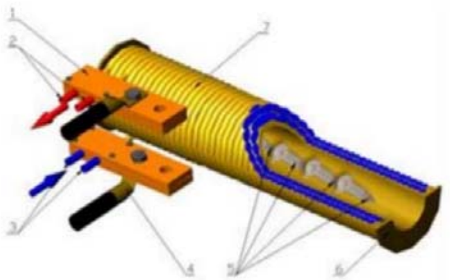

Fig. 1: Schematic of the solenoid for electromagnetic stimulation: 1 - feeding chamber; 2 - cooling water outlet; 3 - cooling water inlet; 4 - feeding cables; 5 - samples; 6 - carcass; 7 - coil.

Next, the registration of the spectrum of the tested essential oils was performed using a measuring station equipped with a Hammatsu C5964 multi-channel spectrophotometer (Figure 2). Registration of the spectrum involves the generation of a continuous spectrum by a light source (a), which passes through a light-proof chamber (b), then through a slit and is reflected by a diffraction grating, then the radiation is reflected by a mirror and recorded by a multi-channel spectrophotometer (c). The multi-channel spectrophotometer is connected to a controller that allows the spectrum to be read out in Application Software (d). The measurement is based on placing the test sample in a light-proof chamber located in the axis of light forcing interaction. The generated light passes through the analyzed material and is then recorded by the spectrophotometer.

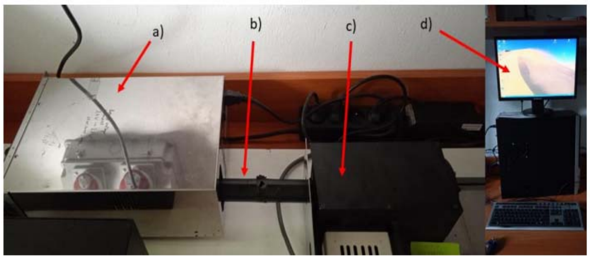

Fig. 2. C5964 multichannel spectrophotometer from Hammatsu: a) light source; b) light-proof chamber; c) C5964 multichannel spectrophotometer with controller; d) Applicaton Software

The results of the light spectral characteristics are visualized in the computer program interface (Figure 3), where the ordinate axis (Intensity) describes the value expressed in "mV," while the abscissa axis represents the light wavelength expressed in "nm" [8].

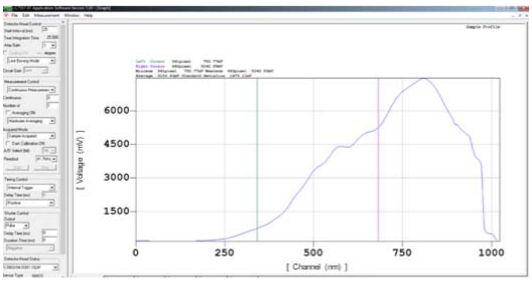

Fig. 3: Application Software

Results

The spectral properties of essential oil were investigated of cedarwood exposed to an alternating electromagnetic field with different exposure times. For the control sample of cedar oil, six peaks of increase in the value of light transmittance of cedar oil suspension were observed in the wavelength range from 447 nm to 823 nm (Figure 4). At a wavelength of 447 nm, the light transmittance was recorded with a value of 1002.15 mV. The highest values of light transmittance were recorded at 749 nm and 823 nm, which were 2669.24 mV and 2580.8 mV, respectively. The difference between the aforementioned values was 88.44 mV, which corresponded to a decrease in value of about 3.3%. In the aforementioned wavelength range, the mean value of the light transmittance of cedar oil was 1907.64 mV, while the standard deviation was 505.67 mV

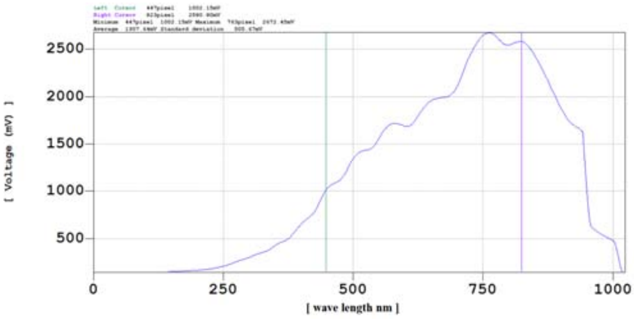

Fig. 4: Spectral characteristics of cedarwood oil not exposed to an alternating electromagnetic field

Figure 5 shows the spectral characteristics of cedarwood oil after exposure to a 40 mT electromagnetic field and an hour-long exposure. Similar to the control sample, six peaks of increase in light transmittance values were observed in the wavelength range from 447 nm to 823 nm. At a wavelength of 447 nm, a light transmittance of 1067.79 mV. The highest values of light transmittance were recorded at 749 nm and 823 nm, which were 2839.53 mV and 2740.08 mV, respectively. The difference between the aforementioned values was 99.45 mV, which corresponded to a decrease in value of about 3.5%. In the aforementioned wavelength range, the mean value of the light transmittance of cedar oil was 2033.07 mV, while the standard deviation was 537.29 mV. Compared to the control sample, an increase in the value of this parameter by 170.29 mV and 159.28 mV, respectively, was recorded for the peaks characterized by the highest permeability values

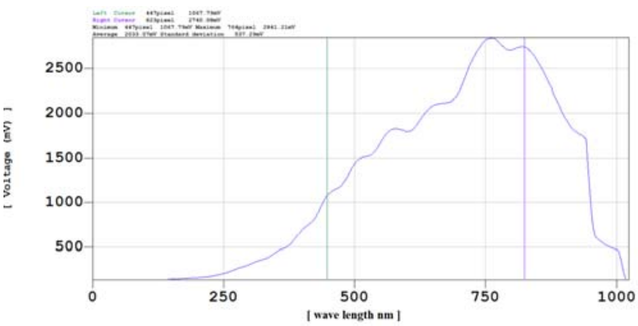

Fig. 5. Spectral characteristics of cedarwood oil after exposure to an electromagnetic field with an intensity of 40 mT and one-hour exposure

For a cedar oil sample subjected to an electromagnetic field of 40 mT and a two-hour exposure (Figure 6), six peaks of increase in light transmittance values were observed in the wavelength range from 447 nm to 823 nm. At a wavelength of 447 nm, a light transmittance of 1072.82

mV was recorded. The highest values of light transmittance were recorded at 749 nm and 823 nm, which were 2859.26 mV and 2766.39 mV, respectively. The difference between the aforementioned values was 92.87 mV, which corresponded to a decrease in value of about 3.24%. In the aforementioned wavelength range, the mean value of the light transmittance of cedar oil was 2049.38 mV, while the standard deviation was 542.17 mV. Compared to the control sample, an increase in the value of this parameter by 190.02 mV and 185.59 mV, respectively, was recorded for the peaks characterized by the highest values of light transmittance. On the other hand, an increase in the values of both peaks by 19.73 mV and 26.31 mV, respectively, was recorded compared to the sample subjected to an hour's exposure.

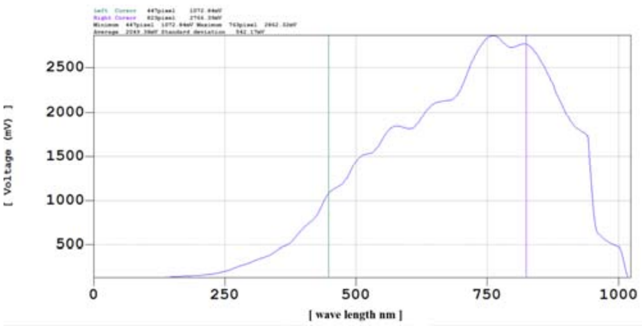

Fig. 6. Spectral characteristics of cedarwood oil after exposure to an electromagnetic field with an intensity of 40 mT and a two-hour exposure

For a cedar oil sample exposed to an electromagnetic field of 40 mT and a three-hour exposure (Figure 7), six peaks of increase in light transmittance values were also observed in the wavelength range from 447 nm to 823 nm. At a wavelength of 447 nm, a light transmittance of 995.88 mV was recorded. The highest values of light transmittance were recorded at 749 nm and 823 nm, which were 2652.1 mV and 2594.27 mV, respectively. The difference between the aforementioned values was 57.83 mV, which corresponded to a decrease in value of about 2.18%. In the aforementioned wavelength range, the mean value of cedar oil permeability was 1904.94 mV, while the standard deviation was 507.67 mV. Compared to the control sample, for the peaks characterized by the highest values of light transmittance, there was a decrease in the value of this parameter in the first peak by 17.14 mV, while an in the second peak an increase in the value of light transmittance by 13.47 mV. On the other hand, a decrease in the values of both peaks of light transmittance of the cedar oil suspension was recorded in comparison with the sample subjected to one-hour and two-hour exposures.

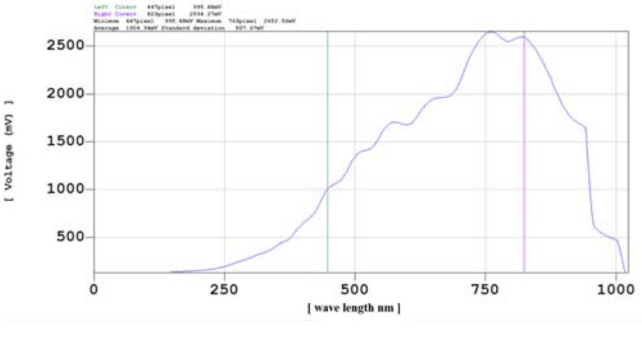

Fig. 7. Spectral characteristics of cedarwood oil after exposure to an electromagnetic field with an intensity of 40 mT and a three-hour exposure

Figure 8 shows the spectral characteristics of cedarwood oil after exposure to an electromagnetic field of 80 mT and an hour-long exposure. Six peaks of increase in light transmittance values were observed in the wavelength range from 447 nm to 823 nm. At a wavelength of 447 nm, the light transmittance of the suspension was recorded with a value of 1070.69 mV. The highest values of light transmittance were recorded at 749 nm and 823 nm, which were 2840.75 mV, respectively and 2759.05 mV, respectively. The difference between the aforementioned values was 81.7 mV, which corresponded to a decrease in value of about 2.87%. In the aforementioned wavelength range, the mean value of the light transmittance of the cedar oil suspension was 2037.7 mV, while the standard deviation was 538.63 mV. Compared to the control sample, for the peaks characterized by the highest values of light transmittance, there was an increase in the value of this parameter in both peaks by 171.51 mV, respectively and 178.25 mV, respectively.

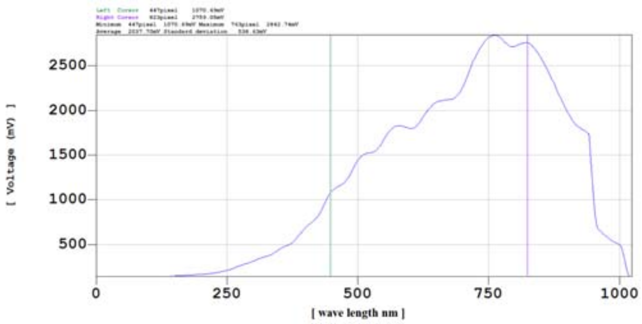

Fig. 8. Spectral characteristics of cedarwood oil after electromagnetic field exposure of 80 mT and an hour-long exposure.

Figure 9 shows the spectral characteristics of cedarwood oil after exposure to an electromagnetic field of 80 mT and a two-hour exposure. Six peaks of increase in the light transmittance value of the essential oil suspension were observed in the wavelength range from 447 nm to 823 nm. At a wavelength of 447 nm, the light transmittance of the suspension was recorded at 993.43 mV. The highest light transmittance values were recorded at 749 nm and 823 nm, which were 2639.86 mV and 2587.69 mV, respectively. The difference between the aforementioned values was 52.47 mV, which corresponded to a decrease in value of about 1.98%. In the aforementioned wavelength range, the mean value of the light transmittance of the cedar oil suspension was 1897.06 mV, while the standard deviation was 505.55 mV.

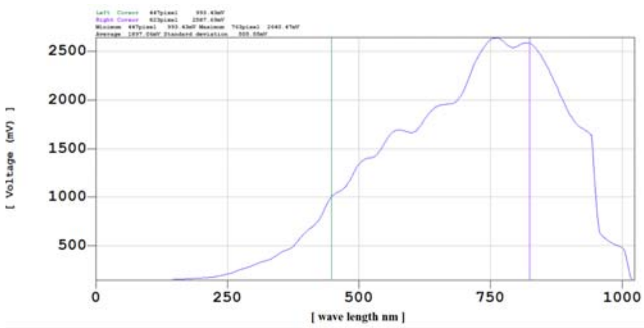

Fig. 9: Spectral characteristics of cedarwood oil after exposure to an electromagnetic field of 80 mT and two-hour exposure.

Compared to the control sample, for the peaks characterized by the highest values of light transmittance, there was a decrease in the value of this parameter in the first peak by 29.38 mV, while the an increase in the value of this parameter by 6.89 mV was recorded in the second peak. On the other hand, a decrease in the values of both light transmittance peaks by 200.89 mV and 171.36 mV, respectively, was recorded compared to the sample subjected to an hour's exposure.

Figure 10 shows the spectral characteristics of cedarwood oil after exposure to an electromagnetic field of 80 mT and a three-hour exposure. Six peaks of increase in the light transmittance value of the essential oil suspension were observed in the wavelength range from 447 nm to 823 nm. At a wavelength of 447 nm, a light transmittance of 1050.5 mV was recorded. The highest values of light transmittance of the suspension were recorded at 749 nm and 823 nm, which were 2787.97 mV and 2719.73 mV, respectively. The difference between the aforementioned values was 68.24 mV, which corresponded to a decrease in value of about 2.44%. In the aforementioned wavelength range, the mean value of the light transmittance of cedar oil was 2004.82 mV, while the standard deviation was 531.57 mV. Compared to the control sample, the peaks characterized by the highest values of light transmittance showed an increase in the value of this parameter in both peaks by 118.73 mV and 138.39 mV, respectively. On the other hand, compared to the sample subjected to a two-hour exposure, an increase in the values of both peaks of light transmittance was recorded respectively
by 148.11 mV and 132.04 mV.

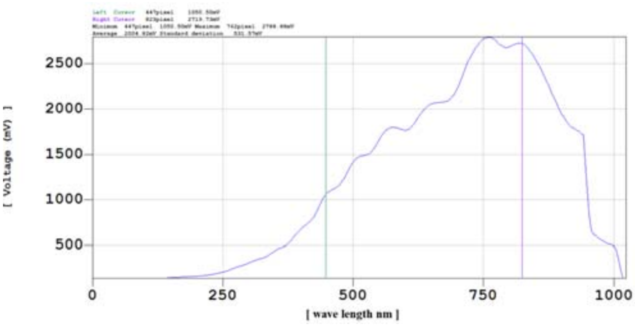

Fig. 10. spectral characteristics of cedarwood oil after electromagnetic field exposure with an intensity of 80 mT and a three-hour exposure.

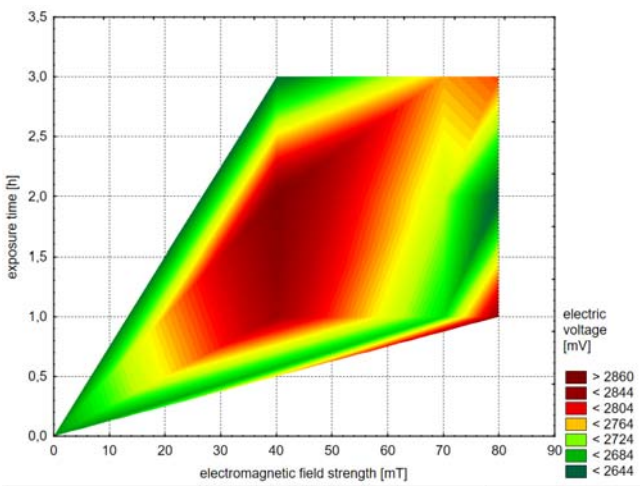

Fig. 10. Relationship between the intensity and chad of electromagnetic field exposure and the voltage of cedar oil

Stimulation with an electromagnetic field of a cedar oil suspension (Figure 11) with an induction of 20mT for 0.5h yields a light transmittance value of 2724 mV, while a further increase in the electromagnetic field induction to a value of 65mT regardless of the exposure time of the material does not increase the light signal passing through the suspension. The highest permeability of the suspension was observed between electromagnetic induction values of 30 and 60 mT and exposure time of 0.75 - 2.5h (red color).

Conclusion

The experiments conducted showed the effect of varying electromagnetic field on the electromagnetic spectrum of cedarwood oil. Both exposure time and electromagnetic field strength affect the spectral characteristics of cedar oil. To generate significant changes in light transmittance, cedar oil should be subjected to a two-hour exposure to an electromagnetic field with an intensity of 40 mT.

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