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NONRADIATIVE STATE IN ESSENTIAL OILS FROM AROMATIC PLANTS

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ABSTRACT

Emission and absorption spectra of oils (Mint species and Cymbopogon species) have been recorded in the visible and ultraviolet region using JY3CS spectrofluorimeter and Beckman DU-70 spectrophotometer respectively. Our results show the presence of strong nonradiative state in the ultraviolet region. It is also found that the fluorescence intensity of these oils are comparable to that of Rh 6G dye in methanol solution. The main spectral features in the absorption spectra of mint species are found to be due to the absorption of menthol and menthone. Spearmint oil shows an extra absorption band which is not present in Japanese and Peppermint oils.

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Introduction: The quality and characteristics of essential oils are however, subject to appreciable changes due to their origin and method of production [1]. It is, therefore, imperative to define their quality by means of measurable physical and chemical characteristics [2]. Composition of oils provide a useful guidance [3, 4], but the composition of the essential oils, as most of their naturally occurring organic materials, is very difficult to determine and is time consuming. Lewis and Kasha [5] suggested that organic molecules might be identified by their emission and absorption spectra. Therefore, we have planned to study the various molecules utilized in different drugs preparation and isolated from medicinal and aromatic plants [6, 7]. The present article describes the results of fluorescence and absorption spectroscopy of mint species and cymbopogon species.

Experimental: The fresh leaves collected from the plants grown in the research and demonstration farm of CIMAP Regional centre, Pantnagar, were hydrodistilled by cleavengers apparatus and the oils thus obtained were made moisture free and utilized in the present investigation. Menthol was separated from the *Mentha arvensis* oil by cooling the oil up to 0°C and centrifuging it. The menthol crystal were dissolved in ether and recrystallized with other alcohol (9:1). The menthone was separated from dementholized oil by fractional distillation (90% purity). The fluorescence spectra were recorded on a JY3 spectrofluorimeter and are given in detail elsewhere [6]. The absorption spectra were recorded on Beckman DU-70 spectrophotometer and are described in detail elsewhere [7].

Results and Discussion: The oils of cymbopogon species (*c. winterianus*, *c. martini*, *c. flenuosus*, *c. microstachys* and *c. jwarnechusa*) have very strong absorption in ultraviolet region (≈ 200 nm to 400 nm) [7]. Strong and broad absorption peaks in all these oils at ≈ 250 nm and 360 nm indicate that the same group of organic compounds predominate in all five oils of the cymbopogon species. Additional peaks at ≈ 395 nm in *c. microstachys* and *c. flenuosus* and at ≈ 290 nm and 395 nm in *c. jwarnechusa*, indicate the presence of extra organic compounds in these oils. The oils of the mint species (*Mentha arvensis*, *M. Pipreta* and *M. Spicata*) have also a very strong absorption in the ultraviolet region (200 nm to 400 nm). The strong and broad absorption peaks at ≈ 240 nm and ≈ 340 nm in all three oils indicate the presence of the same organic compounds in all three oils. An extra peak at ≈ 415 nm in spearmint oil indicate the presence extra organic molecules in this oil. To assign the above absorption peaks in mint species we have recorded the absorption spectra of some of their major constituents (Menthol and Menthone) easily separated from the oils and are shown in Figs. 1 and 2 respectively. It is clear from the figure that menthol and menthone show an absorption peak at ≈ 240 nm and ≈ 340 nm respectively. On the basis of the above spectra one can easily assign the peak at ≈ 240 nm and 340 nm present in all three oils of the mint species are due to the absorption of menthol and menthone respectively.

Fluorescence spectra of these oils show some interesting features: We found very strong fluorescence signal [6] between wavelength ≈ 400 nm to 650 nm by exciting the sample with wavelength $\lambda > \approx 400$ nm where it has a negligible absorption. But when we excite the oils with

wavelength $\approx 200 \text{ nm} < \lambda < 400 \text{ nm}$ where it has very strong absorption, the magnitude of the fluorescence signal is very small. This shows that total absorbed (excited) energy in this range $200 \text{ nm} < \lambda < 400 \text{ nm}$ of the molecule (oils) is not converting in electromagnetic radiation (fluorescence signal) when the molecule return to the ground state. When the molecule is excited by absorbing the energy, it come back to the ground state by two processes: 1) By radiative transition in which a photons of energy equal to the energy difference of the initial and final states are emitted (fluorescence signal is large). 2) By nonradiative transition in which no photons are emitted (fluorescence signal is very small). In the second case the absorbed energy is converted into the heat energy, k.E. etc. Therefore, on the basis of the above observation we assume that a strong nonradiative state is present in the ultraviolet region (between $\approx 400 \text{ nm}$ to $\approx 200 \text{ nm}$) in the oils of these two species, where as radiative state is present in the visible region ($\approx 400 \text{ nm}$ to 700 nm) in these oils.

For comparison of the fluorescence intensity of these oils, we have also recorded the fluorescence spectra Rh 6G in methanol at a concentration of $5 \times 10^{-3} \text{ M}$. Comparison of the spectra shows that the quantum efficiency of the fluorescence of these oils is comparable to that of Rh 6G. Therefore these oils may be used as a lasing material in dye laser at $\approx 400 \text{ nm}$ to $\approx 700 \text{ nm}$ wavelength region. To confirm this result a detailed study, preferably photoacoustic spectroscopy, will be needed.

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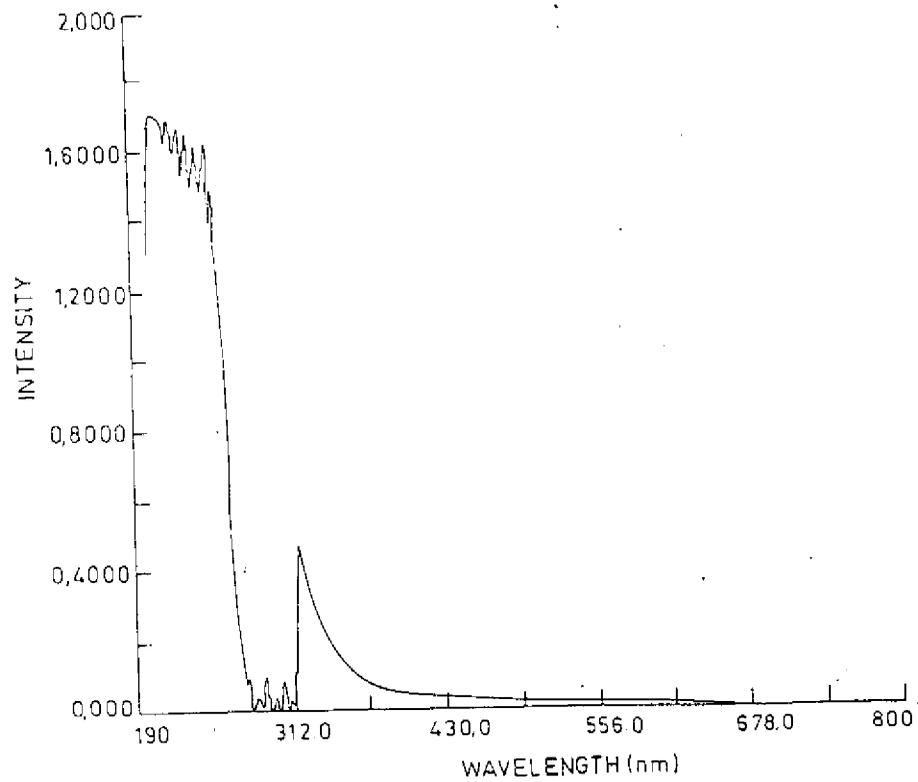


FIG. 1

Absorption spectra of menthol.

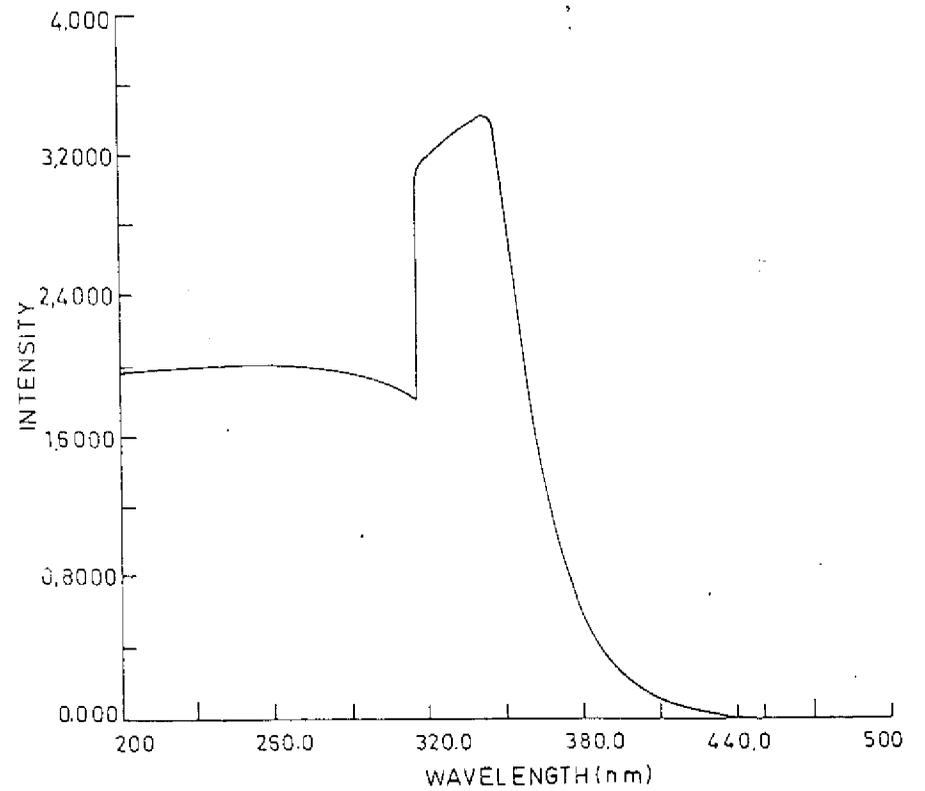


FIG. 2

Absorption spectra of menthone.

