Fluorescence Spectra Measurement of Essential Oils

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Abstract. Identifying materials using fluorescence spectroscopy methods have several advantages including fast, accurate, and relatively low cost. This method is used not only to identify the material but also to detect whether the material is still pure or not. The purity of patchouli oil has been identified by observing and analyzing the fluorescence spectrum ($\lambda_{abs} = 509$ nm, $\lambda_{eks} = 542$nm). The observations were made for pure and mixed (impure) patchouli oil, respectively. By comparing the two data, the patchouli oil is distinguished and the contained mixture is determined. The measurement results show that the mixture oil spectrum is indicated by a shift in the maximum wavelength ($\lambda_{em, max}$) of fluorescence emissions. Nevertheless, the intensity of the fluorescence beam is change.

1. Introduction

In 1925 it was found that the ability of olive oil (Olive Oil) emits fluorescent radiation when illuminated with mercury lamps [1-2]. In that, the authenticity of oil from pollution can be shown from various emitted fluorescence. The used method is virgin olive oil, which is the fluorescence give the yellow spectrum to the orange but unable to give the white spectrum to light blue. However, this method is then replaced by using gas chromatography and analysis with the absorbance spectrum [3-4].

Along with the rapid advances in science and technology, the analysis of the fluorescence spectrum observations can be done quickly and practically, with the help of modern equipment. There are several advantages of analysis and identification based on observing the fluorescence spectrum compared to the absorbance spectrum [5-6], they are: i) sensitivity, the detection with fluorimeter is far more sensitive than spectrophotometers, ii) wide concentration range, the fluorimeters can be used for the range of 3 to 6 decades of the concentration without modification of sample cells. iii) simplicity and speed, the fluorimeter is a relatively simple analysis technique. Sensitivity in fluorometry almost causes preparation so simple but also keep with speeds up analysis. iv) low costs, the reaction materials and fluorimeter instrumentation require lower costs compared to other analysis techniques [7].

In addition, the problem of using Absorptiometry is the observation for multi-component. The possibility of two different components on absorbing the same wavelength is occurred, therefore the spectrum of the two materials cannot be separated, while the fluorimeter of the fluorescent signal can still be separated. Based on those phenomena, the idea of identify the molecular samples in general and the patchouli oil specifically from the fluorescence emitted spectrum by these molecules is proposed. The identification involves two things which are the identification of pure or mixed (with other components) sample, respectively and determination the molecule type (name) based on the fluorescence spectrum analysis (based on the database as a comparison). The development of essential oils in Indonesia is very fast and a lots of various packaging brands in the market is very high, so it's
hard to detect which one is the best. To determine the type and authenticity of the oil, a fast, simple/practical and low-cost identification is needed. One method that is felt to be supportive is identification based on observation and analysis of the fluorescence spectrum. By comparing fluorescence parameter data with the previous data, it can be determined both the type and the authenticity and the level of impurity accurately [8-9]. This study aims to identify patchouli oil based on the fluorescence spectrum. Based on the analysis of fluorescence spectrum data, it is expected to know the type and purity, even the level of impurities of essential oils by comparing the previous data.

2. Related Work
The related work used to analyze the material is to use absorption spectroscopy. The working principle of absorption spectroscopy is that the material is irradiated with light in the area of UV (ultraviolet). Components of the ingredients contained in these materials will absorb light. So, that light is passed on only the part of the light that is not absorbed. In the absorption of a spectrum can be known as the component components contained in the material. With this is absorptions spectroscopic method, it seems complicated, slow and relatively expensive costs.

3. Proposed Approach
3.1. Research Methods
This study is an observational fluorescence spectrum with a fluorescence spectrometer (Fluorimeter). As the material studied or characterized is essential oil (such as patchouli oil, citronella oil). The method for characterization is that the oil is irradiated in the UV-vis region so that the material (oil) fluoresces [10-11]. The basic block diagram of the fluorimeter is as shown in Figure1 [12-13].

![Figure 1. Block Diagram of the Fluoremeter.](image)

The research process is shown in Figure 2 which is started with preparation of materials (samples) to be characterized. The irradiated material (sample) with an excited light in the UV-vis region, is passed to a monochromator to adjust a single wavelength. The fluorescence spectrum of the material is scanned by setting the second monochromator to get a spectrum of the intensity a wavelength. Then the fluorescence spectrum is analyzed from the analysis obtained results (Achievement Indicators) The maximum wavelength absorbed (λ abs.maks), The maximum wavelength emitted (λ em.maks), Stoke Shift (Δλ) and Quantum Efficiency (ΦF)[14-15].
4. Result and Discussions
Spectrum measurements are carried out in two conditions, namely: the first condition is to measure the spectrum of the sample in a pure state with the curve shown in the Figure 3. Then the sample is given an additional mixture of other molecules, namely kerosene. The curves of the fluorescence spectrum of the 3 ml of the patchouli oil and mixed with 0,1 ml, 0,3, and 0,5 kerosene, respectively are given in Figures 4 - 6.

![Figure 3. Pure Patchouli Oil Fluorescence Spectrum.](image-url)
Figure 4. Fluorescence spectrum patchouli oil 3 ml + 0.1 ml kerosene.

Figure 5. Fluorescence spectrum patchouli oil 3 ml + 0.3 ml kerosene.

Figure 6. Fluorescence spectrum patchouli oil 3 ml + 0.5 ml kerosene.
The fluorescence data of the patchouli oil and its intensity that obtained from Figures 3 – 6 are represented in the Table 1 and Table 2, respectively.

**Table 1. Patchouli Oil Fluorescence Data.**

| Name of oil                                  | λabs (nm) | λ em. (nm) | Stokes shift (nm) | Intensity (a.u) |
|----------------------------------------------|-----------|------------|-------------------|-----------------|
| Pure patchouli oil                           | 509       | 542        | 33                | 71              |
| patchouli oil 3ml+0.1 ml kerosene            | 509       | 548.5      | 39.5              | 73              |
| patchouli oil 3ml+0.3 ml kerosene            | 509       | 540.5      | 31.5              | 74              |
| patchouli oil 3ml+0.5 ml kerosene            | 509       | 544.5      | 35.5              | 76              |

**Table 2. Intensity to kerosene for patchouli oil.**

| Kadar kerosene (%) | 0  | 3.3 | 10  | 16.6 |
|--------------------|----|-----|-----|------|
| Intensity (a.u)    | 71 | 73  | 74  | 76   |

To see the correlation between the maximum intensity and kerosene level, the data in the Table 1 and Table 2 is plotted as shown in Figure 7.

![Figure 7. Relationship between mixture levels and intensity.](image)

From the analysis of above linear equations shows that by obtaining, $R = 0.993$ shows that there is a fairly good linear relationship between the levels of a mixture (kerosene) and the maximum intensity in patchouli oil fluorescence observation.

\[ y = 0.288x + 71.222 \]

\[ R^2 = 0.987; R = 0.993 \]
5. Conclusions
The measurement results show that the mixture oil spectrum is indicated by a shift in the maximum wavelength ($\lambda_{\text{em, max}}$) of fluorescence emissions. Nevertheless, the intensity of the fluorescence beam is change. This shows that this method can be used to distinguish pure and impure oils. Using linear equations, the correlation coefficient is obtained, $R = 0.993$. From the above analysis, it is strong enough to state that the relationship between the levels of the mixture with the maximum intensity correlates quite linearly.

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