Effect of Polarity of Solvents on Linear Optical Properties for Organic Dye.

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Abstract. In this paper, preparation and study the effect of polarity of two solvents (Dimethyl sulfoxide and acetone) on linear optical properties for solutions of organic dye (Aurintricarboxylic acid) with different concentrations were investigated. This dye has characterized using nuclear magnetic renounce (H-NMR) and Fourier translation infrared (FTIR) devices. Absorption and transmission spectra of samples recorded using UV-VIS spectrophotometer. The results referred to that the samples dissolved in dimethyl sulfoxide solvent had very large linear optical properties as compared with samples dissolved in acetone solvent due to high polarity of dimethyl sulfoxide solvent. As a result, this organic dye can be used as active laser medium and photonic devices

1. Introduction

Aurintricarboxylic acid (ATA) is a chemical compound that readily polymerizes in aqueous solution, forming a stable free radical that inhibits protein-nucleic acid interactions. It is a potent inhibitor of ribonuclease and topoisomerase II by preventing the binding of the nucleic acid to the enzyme [1]. It has been discovered that using aurintricarboxylic acid against influenza-A post-infection has a strong protective effect by inhibiting the virus' ability to reproduce, it was found to reduce viral reproduction and infection when applied post-infection, but not when used as a 'vaccine' [2]. It is used to inhibit protein biosynthesis in its initial stages. Nominally, it is used in biological experiments as a protein inhibitor, and as an ammonium salt (known as aluminon) it is used as a reagent to estimate the aluminum in water, biological tissue, and foods[3]. Here, we report that ATA can substantially inhibit the replication of several strains of influenza [4]. We further investigated the combinational effects of ATA and amantadine hydrochloride, an M2 blocker, on the replication of influenza viruses. Finally, we found that ATA inhibits influenza neuraminidase, possibly elucidating its anti-influenza mechanism of action[5]. Ali, Q.R., studied the spectra of absorption and fluorescence and the calculation of the, fluorescence lifetime to (Coumarin 307 Acriflavine, and RhodamineB after dissolved in a suitable solvent (ethanol, chloroform, Dimethyl Sulfoxide DMSO propanol) and a wide range of concentrations (10⁻⁴,10⁻⁵ and 10⁻⁶) M [6].

Al-Zahra and W. J. studied the rod Jaber Abdul-Zahra studied linear spectral characteristics (absorption and permeability and Flora and the refractive index and absorption coefficient) of the Acridine dye with different concentrations [7].

The present study reports the effect of solvents on linear optical properties of organic dye such as (absorbance , transmittance, refractive index and absorption coefficient) at room temperature of (ATA) have been discussed.
2. Material and Methods

Chemicals were purchased from Aldrich and Lancaster chemicals and mostly used without further purification. $^1$H NMR spectra were recorded on a Bruker AV500 spectrometer operating at 500 MHz for $^1$H. Chemical shifts $\delta$ are reported in parts per million (ppm) relative to TMS and coupling constants $J$ are in Hz and have been rounded to the nearest whole number. Assignments of signals are based on integration values, coupling patterns and expected chemical shift values and have not been rigorously confirmed.

A. Typical experimental procedure for the preparation of Aurintricarboxylic acid (A):

70 millilitres of concentrated sulphuric acid were mixed with 10 grams (0.014mol) of solid potassium nitrate. When solution is complete, add 20 grams (0.014mol) of salicylic acid with stirring. The mixture should then be light red to brown in colour. It is surrounded by an ice-salt bath. Add 1.95 gm (0.065 mol ) of formaldehyde is slowly with extremely vigorous stirring. About 100 grams of crushed ice is then added, the stirring should be vigorous during the addition. The contents of the flask are stirred until the aurintricarboxylic acid has disintegrated into small pieces.

5,5'-((3-carboxy-4-oxocyclohexa-2,5-dien-1-ylidene)methylene)bis(2-hydroxybenzoic acid) A, Yield 75% Mp ( 300 302  ) C ; IR (v, cm$^{-1}$): 3400-2990 (OH), 1707 (C=O), 1602 (ph=O), 2987,2848 (C- H aliph), 3118 and 2891 (Aromatic CH);$^1$H-NMR (d-DMSO) (ppm): 5.35 (s, 2 H, OH), 6.40 (d, 2H, ph-H), 7.10-7.50 (d, 6H, Ar-H), 8.10 (d, 1H, ph-H), 11.0 (s, 3H, carboxyl OH).

Table 1. Show physical properties of compound(A).

| Comp.No. | M.F         | M.Wt | Color   | Yield % | M.P (°C) |
|----------|-------------|------|---------|---------|----------|
| A        | C$_{22}$O$_9$H$_{23}$ | 473  | Brown   | 73      | 300-302  |

Figure 1. Preparation design of(Aurintricarboxy chlorid)
3. Infrared spectra
The preparation dye was measured using FTIR-Affinity-1 SHLMADZU devise around (400-4000) cm\(^{-1}\) using a KBR for solid material. Compound (A) was detected by FT-IR. The IR spectrum of the (A) showed a wide absorption band between (3340-2924) cm\(^{-1}\), around the vibrations that include stretching bond (OH), and absorption -band around the vibrations the carbonyl acid group at 1676 cm\(^{-1}\), as shown in Figure (2).

![Figure 2. FT-IR for compound (A).](image)

4. Solution Preparation
Concentrations from solution of (10\(^{-3}\), 10\(^{-4}\), 10\(^{-5}\), and 10\(^{-6}\)) M of compound (A) in different solvents were prepared. The powder was weighed using an electronic balance type (BL 210 S), Germany, having a sensitivity of four digits. Different concentrations were prepared according to the following equation [9]:

\[
W = \frac{M_w \times V \times C}{1000}
\]  

(1)

Where, \(W\): Weight of the dissolved material (g), \(M_w\): Molecular weight of the material (g/mol), \(V\): Volume of the solvent (mL), \(C\): concentration (M). The prepared solutions were diluted according to the following equation [10]:

\[
C_1 V_1 = C_2 V_2
\]  

(2)

Where: \(C_1\): Primary concentration\(\rightarrow\), \(C_2\): New concentration\(\rightarrow\), \(V_1\): The volume before dilution\(\rightarrow\), \(V_2\): volume after dilution.

5. Theory
The linear absorption coefficient (\(\alpha\)) was determined using formula [11]:

\[
\alpha = \frac{\ln \left(\frac{1}{T}\right)}{t}
\]  

(3)

Where \((t)\) is the thickness of test and \((T)\) is the transmittance.

Where \((t)\) is the thickness of sample and \((T)\) is the transmittance. The refractive index (\(n\)) can be found from transmittance spectrum of the film according to the following equation[12]:

\[
n = \frac{1}{T} + \left(\frac{1}{T} - 1\right)^{1/2}
\]  

(4)

Transmittance is the general percent of light that goes through the dissolvable. In this way, if a large portion of the light is transmitted, the arrangement has half transmittance [13].

\[
T\% = \left(\frac{I}{I_0}\right) \times 100\%
\]  

(5)
Where \(I_0\) is the intensity of the incident light shaft and \(I\) is the incident of the light leaving the dissolvable. The connection between transmittance (T) and absorbance (A) can be expressed by the following [14]:

\[
A = \log_{10} \left( \frac{1}{T} \right) \tag{6}
\]

6. Linear Optical Properties

The optical measurements for (Aurintricarboxylic acid) that include spectral transmittance (T) and absorbance (A) obtained using spectrophotometer (Shimadzu UV-VIS) with wavelength range from (190-1100) nm. It is a computer programmer to conduct the survey of all wavelengths and give the wavelength at which maximum absorption occurs and less transmittance. Linear optical properties (absorbance, transmittance, absorption coefficient and refractive index) of compound (A) at concentration \((10^{-4})\) M in acetone and DMSO solvents shown in Figures (3,4,5 and 6), respectively. Acetone solvent gives less absorption, less absorption coefficient and the refractive index when compared to DMSO solvents, the absorption spectra was smaller than the absorbance spectrum at Aston solvent due to highly polarity of the solvent. Intensity of absorption expanded and transmittance diminished, while concentrations increases, which in concurrence with Beer - Lambert law.

The linear refractive index \((n_o)\) and linear absorption coefficient \((\alpha_o)\) of all samples are increases when the concentrations is increases. The linear parameters are calculated ,as showed in Table (2) from this Table we show that Aston solvent have less absorption, less linear absorption coefficient and less refractive index, so its transmittance are higher due to relatively higher polarity when compared with DMSO solvent .The results showed that the material was quickly dissolved in DMSO solvent due to its high polarity .

![Figure 3. Absorption spectra of compound (A) in DMSO and acetone solvents at \((10^{-4})\) M concentration.](image-url)
Figure 4. Transmittance spectra of compound (A) in DMSO and acetone solvents at (10⁻⁴) M concentration.

Figure 5. Absorption coefficient (α) of compound (A) in DMSO and acetone solvents at (10⁻⁴) M concentration.

Figure 6. Refractive index (n) of compound (A) in DMSO and acetone solvents at (10⁻⁴) M concentration.
Table 2. The linear optical parameters at different concentrations of complex (A) and different solvents

| Solvents | Concentration (M) | \( \lambda_{\text{Max}} \) (nm) | Absorbance | Transmittance | \( \alpha_{c} \) cm\(^{-1} \) | n. |
|----------|-------------------|-------------------------------|-------------|---------------|------------------|---|
| Acetone  | \( 10^{-4} \)     | 281                           | 0.70875     | 0.195546479   | 1.63225125       | 2.061018074 |
|          | \( 10^{-5} \)     | 281                           | 0.1183      | 0.761552766   | 0.2724449        | 1.295864106 |
|          | \( 10^{-6} \)     | 281                           | 0.035       | 0.922571427   | 0.080605         | 1.018834497 |
|          | \( 10^{-4} \)     | 305                           | 0.8565      | 0.139155379   | 1.9725195        | 2.461093772 |
| DMSO     | \( 10^{-5} \)     | 305                           | 0.853       | 0.14028137    | 1.964459         | 1.358247272 |
|          | \( 10^{-6} \)     | 305                           | 0.8195      | 0.15153048    | 1.8873085        | 1.410231955 |

Conclusions
The present paper demonstrates the linear optical properties of solutions of Aurintricarboxylic Acid at different concentrations, using UV-VIS spectrophotometer in different solvents (DMSO and Aston). Intensity of absorption expanded and transmittance diminished, while concentrations increases, which in concurrence with Beer-Lambert law.

Concentration increases and transmittance decreased, while concentrations increases, which in agreement with Beer–Lambert law. The linear refractive index (n.\(_{o}\)) and linear absorption coefficient (\( \alpha_{c} \)) of all samples were increased when the concentrations were increased. The experimental results showed that the linear optical properties of compound (A) in DMSO solvent was greater than Aston in diverse concentrations (\( 10^{-4} \), \( 10^{-5} \), and \( 10^{-6} \)) M. Acetone was less absorption, less linear absorption coefficient and less refractive index, so its transmittance are higher due to relatively higher polarity compared with another solvent. As a result, it can be used as active laser medium and photonic devices.

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