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Study the Effect of PH on Absorption and Fluorescence Spectra of Eosin Y Dye in Ethanol

Waleed Khalid Hamood Al-Behadili^{a,*} , Yaqoob M. Jawad^b , Hasan J. Hasan^c 

^a Department of Physiology, College of Medicine, Misan University, Iraq

^b Department of Physics, College of Science, University of Diyala, Iraq

^c Sumer University, Faculty of Basic Education, University of Kufa, Kufa, Iraq

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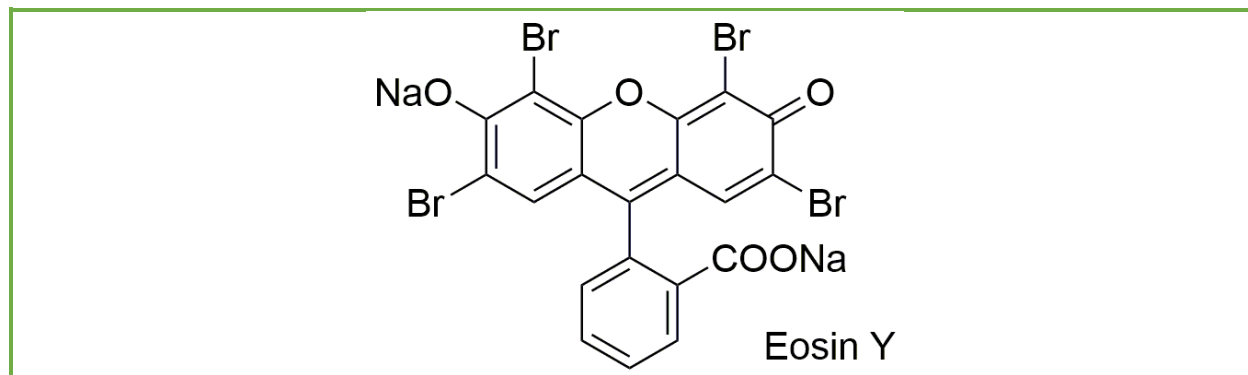
Dye

ABSTRACT

The excitation wavelength (λ_{ex} = 490 nm) at room temperature was determined to examine the impact of pH on the absorption and emission spectra of an eosin y compound dissolved in ethanol at a concentration of 1×10^{-5} M. The relative fluorescence intensity of eosin in ethanol at the concentration of 1×10^{-5} M was decreasing with the increasing of acidity (pH < 7) and the red shift of fluorescence was decreasing by adding a few drops of 1N solution of HCl, (pH normal = 7.26). However when a few droplets of NaOH were added, it was observed that the opposite, the relative fluorescence intensity was increasing with increasing basicity (pH > 7) and the red shift of fluorescence was decreasing with increasing basicity. Characteristics like fluorescence and absorption wavelength were further measured, along with graphical correlations like the one between pH and the relative fluorescence intensity. The relative fluorescence intensity of eosin in ethanol at the concentration of 1×10^{-5} M was decreasing with increasing acidity and the red shift of fluorescence was decreasing with increasing acidity (pH 7). However when a few droplets of NaOH were added, it was observed that the opposite was true: the relative fluorescence intensity was increasing with increasing basicity and the red shift of fluorescence was decreasing with increasing basicity.

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Graphical Abstract



Introduction

Among pH=3 until 13, eosin dyes which are fluorone derivatives of xanthene dyes exist as bivalent or univalent anions; at pH=3, however, some of the dye is available in basic solution [1]. Eosin yellow is a powerful dye but is extremely unstable. Since this is the case, desorption of the dye is a major problem when eosin is adsorbed using the standard immersing approach [2].

A cheap solar cell might be made with this chemical dye-sensitized $\text{SnO}_2/\text{TiO}_2$ linked screen [3]. Because a higher pH (basic pH) causes the molecules to be nucleophilic, decreasing their adsorption on the nucleophilic locations of a CAC [4]. Raising the acidity requires a direct to an alkaline range has indeed been discovered to be sufficient for dissolved eosin from the laden bead [5]. In all examined complexes, the quickest component may be attributed to relaxation due to the interaction between eosin and dendrimers [6]. Both Eosin Y and BSA have structures that change depending on their pH. Hence, the strength of the relationship between the two proteins was also pH-dependent [7]. Hydrogen production by photocatalytic reaction over Eosin Y-sensitized Pt-loaded TiO_2 and N- TiO_2 , and the consequences of nitrogen loading, are hypothesized as follows [8]. Crystal violet blue and Eosin yellow dye preparations diluted in

ethanol are also created [9]. It is only by combining TiO_2 with an aqueous Fe^{3+} solution and Eosin yellow powder that layered Y-sensitized TiO_2 can be made [10]. Picking the right dye with anchoring group to attach the dyes onto the graphene sheets can increase the photocatalytic properties of the dye functionalized system [11]. Emission spectra show that dimeric type of EY is most common in the ground state [12]. The systems' negative numbers for entropy of activation indicate that its adsorbed of eosin Y did not cause any appreciable changes to the De-Oiled Soya's atomic structure [13]. Concerning the energies above do not compensate for the solution environment, such as pH values, the discrepancy is within the accuracy of DFT calculations [14]. Despite serving as a cheap addition, applying eosin because after typical hematoxylin positive control cannot disrupt established processes in institutions or labs [15]. For a less complicated experiment, another dye with a longer half-life, such as likeros bengal, erythrosine, or eosin Y can be used instead [16]. Both liquid/dye mixes examined showed a drop in absorption signal and a shift to higher wavelength as temperature was increased [17]. An anionic xanthene dye called fluorescein serves as the basis for dyes and its related chemicals [18]. Eosin Y, a xanthene luminous dye, has indeed been examined for its

photocatalytic oxidative breakdown in the presence of artificial light [19]. The pH value is a critical factor in Eosin Y decolorization [20].

However, at neutral pH, the less advantageous solvation condition of charged systems largely cancels out this improvement [21]. If the buffer volume is too small, the pH will not be maintained, but if it is too large, the positive component of the buffer will compete with drug cations for coupling with the anionic dye, reducing the efficiency of the complex formation process [22]. The anionic eosin Y was absorbed onto the chitin nanoparticle because of the interaction between the protonated aromatic ring of the chitin and the anion exchange group of the dye. Temperature resulted in a greater eosin Y adsorption quantity [23].

Thermodynamic characteristics can be used to calculate the band gap in eosin dimers [24]. Lab experiments demonstrated a striking relation between both the hydrogen generation rate and the pH of the solution, with the highest rate being achieved at neutral circumstances (pH 7.0) [25]. Eosin Y was used as a prototype anionic dye to test the properties of produced PECs employing the optical techniques [26]. Researchers looked at how changing a few variables affected how easily Eosin yellow could be scrubbed away [27]. The gradual transition from color change tests to electrical procedures for determining acidity or basicity set the stage for the creation of pH [28]. The power transmission rate between the producer and recipient in a context of varying pH has been effectively measured using thermal lens technique [29]. The latter is depending on reliable pH control obviously [30]. The anionic Au ion is coordinated in a squared planar structure [31].

Methanol dispersion it into colorless Dimethyl sulfoxide (dms) yielded crystals appropriate for X-ray diffraction technique [32].

Atomic deformation variables expressed in terms of isotropic or similar isotropic coordinates [33]. Researchers as well-determined that optimum working temperature for procedure under investigation was 278.15 K [34].

Starting with peroxybenzoic acid the decarboxylation process involves three distinct phases hydride transition among o9 [35]. When you get close to both structures, you can find out how much energy is released and which kind of compounds are adsorbing onto them [36].

Nitrogen-oxygen linkages have weakened as seen by the lengthening of these bonds in tetryl-graphene derivatives [37]. In process synthesis, the enthalpy values (H) of inputs and outputs were determined [38]. The flask's supernatant was discarded after the unreacted melamine was added to it numerous times along with boiling water and swirled [39]. The major distinctive peak of graphene, at 24.5°, may be obscured by the primary peak of anatase, which occurs at a much higher temperature [40]. Strong adsorbate-adsorbate interaction leads to early surface adsorption, followed by a condensation effect [41].

Experimental

Materials and Methods

Eosin Y (Scheme 1) is a fluorescent organic compound with a chemical formula of $(C_{20}H_6Br_4Na_2O_5)$ dye was used eosin which is crystalline powder (yellow-red) and its disodium salt, tetrabromofluorescein. The main characteristics eosin is: (a) The molecular weight: (691.855 g mol⁻¹), (b) Melting point 295.5 °C, (c) Soluble in organic solvents such as, acetonitrile, methanol, ethanol, etc. and (d) the Eosin Y was dissolved in Ethanol prepared at concentration 1×10^{-5} M [42].

Used solvents to dissolve the eosin material are:

Ethanol

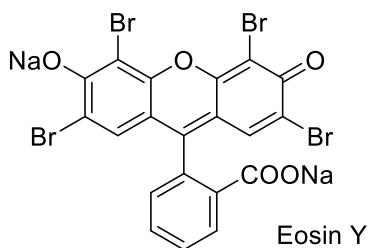
A polar solvent with the following physical characteristics is employed to dissolve the eosin y: melting point: -114.14 °C, dielectric constant: 25.3, refractive index: 1.69, boiling point: 78.24 °C, and molecular weight: 46.068 g/mol [42].

Hydrogen chloride

Molecular weight is 36.461 g/mol, melting point is -114.17 °C, boiling point is -85 °C, and solubility is extremely soluble in water, soluble in alcohol, ether, and (other names are anhydrous hydrochloric acid) [42].

Sodium hydroxide

Molecular weight is 40 gm/mol, melting point 323 °C, boiling point 1388 °C and solubility in water, ethyl alcohol, methyl alcohol, and glycerol and the (formula NaOH), and (Elements are sodium, oxygen, and hydrogen) [42].



Scheme 1. Chemical structure of eosin yellow

Preparation of dye solution

The following equation describes how much of the study material can be dissolved in how much of the solvents was used to make the solution, with a concentration of 1×10^{-5} M.

pH Meter

The pH values of solutions were checked using a digital pH meter (Schott, Mainz,

Germany,) calibrated with standard buffers of pH 7.00 and 4.00 at 20 ± 2 °C [28].

How a pH meter works

pH of a solutions can be further calculated by immersing a pH meter in the liquid and measuring the consequent change in electrical voltage. The pH scale, it measures the amount of neutral, positively charged hydrogen ions, is used to determine the solution acidity.

Absorption measurement

The absorbance spectrum was obtained using a (CARY 100 Conc. UV-Visible spectrophotometer) that functions in the visible and ultraviolet region and has two lamps of excitation are deuterium lamp that emit light with wavelengths spanning 190-322.5 nm and Tungsten-lamp that emits light with a spectrum spanning 322.5-800 nm in wavelength.

Fluorescence measurement

The excitation and emission wavelength were measured from the range of 300 to 750 nm because the eosin was visibly fluorescent. The samples prepared at the section using spectrofluorophotometer type of (RF-5301pc Shimadzu), the exciting wavelength ($\lambda_{ex}=490$ nm) is used in the measurements.

Results and Discussion

In this article, the absorption and fluorescence spectrum of eosin y solution is used as a standard compound dissolved in ethanol with concentration 1×10^{-5} M, are be measured when the exciting wavelength $\lambda_{ex} = 490$ nm and comparative effect pH values. A correspond to the molecular transition from zero point vibration level of electronic ground state to the vibration levels of electronic excited state, which corresponds to the (0-0) electronic

transition, it also shows that the absorbance increases with the molecular concentration of solution which increases, according to Beer-Lambert law that increases in the molecular concentration of solution and consequently lead to increases in the number of molecular in the solution and this lead to increases in the absorbance. This work includes the study of various forms on the absorbance and fluorescence spectra of eosin yellow.

The pH values depending on the type of solvent and the concentration, before the addition of the basic (Na OH) or acid (HCl), as listed in Table 1 (the original and adjusted pH of eosin y in ethanol at the concentration of 1×10^{-5} M). The solutions without HCl or NaOH added the Stokes shifts the change depending on the

type of solvent. Electrical charges carried by ionization dye molecules are modulated by the medium's pH [44].

According to Table 2 (absorbance's intensity parameter for eosin y in (ethanol)/pH values at concentration 1×10^{-5} M) shows that shifted towards the shorter wavelength (blue shift) of absorbance spectra with pH of acidity (pH < 7) by adding a few drops of 1 N solution of HCl also (pH > 7) adding a few drops of 1N solution of NaOH solutions or basicity the wavelength of absorbance spectra is decreasing, pH normal = 7.26. The absorption spectra of eosin solution in ethanol was examined and compared with pH values at concentration 1×10^{-5} M, as shown in Figure 1 (absorption spectrum for eosin y in different pH value at concentration 1×10^{-5} M).

Table 1. The original and adjusted pH of eosin y in ethanol at concentration 1×10^{-5} M

Solvent	pH normal	pH after NaOH addition	pH after HCl addition
Ethanol	7.26	8.57 9.69	5.88 3.63

Table 2. Absorbance's intensity parameter for eosin y in (ethanol)/pH values at concentration 1×10^{-5} M

pH values	Peak of wavelength of the absorption spectrum (nm) at concentration of 1×10^{-5} M	Peak of absorbance's intensity (a.u) at concentration of 1×10^{-5} M
3.63	526	0.971
5.88	530	0.942
7.26	532	0.908
8.57	528	0.995
9.69	524	1.016

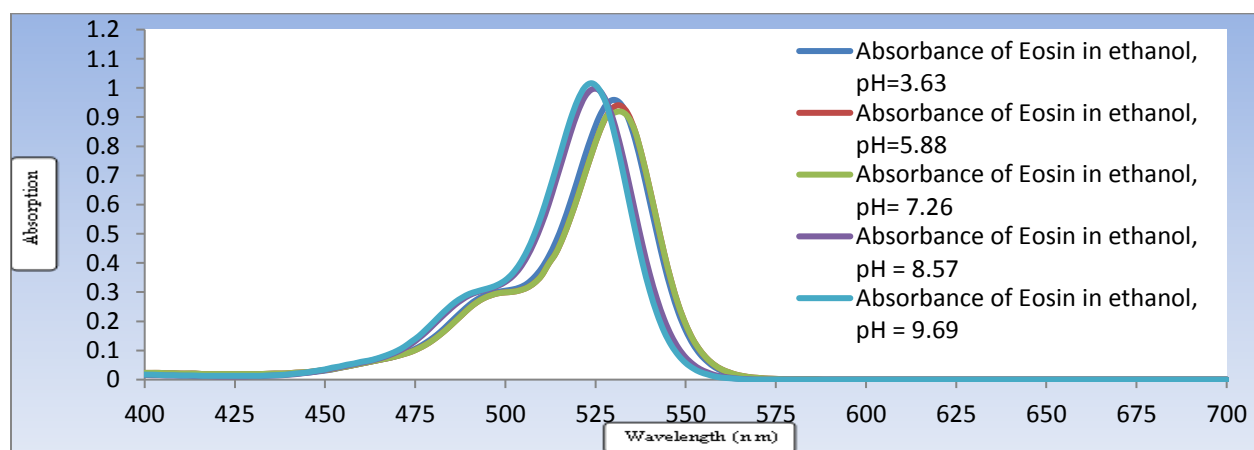


Figure 1. Absorption spectrum for eosin y in different pH value at concentration 1×10^{-5} M

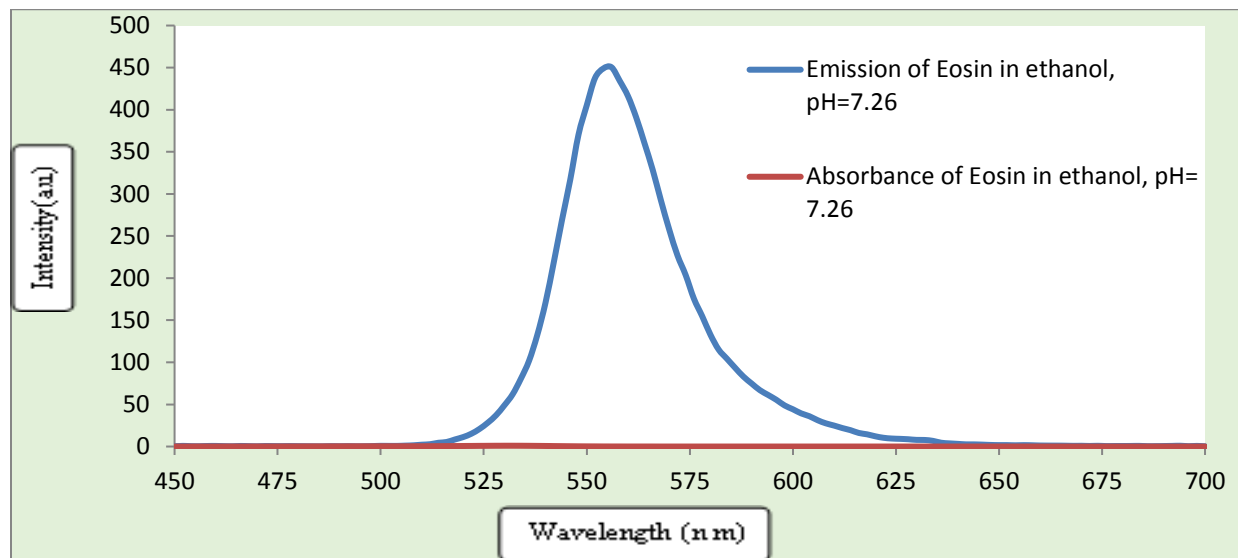


Figure 2. Absorption and emission spectra of eosin y in ethanol/pH =7.26 at concentration of 1×10^{-5} M

Table 3. Comparative between pH values with λ_{\max} and intensity, respectively, for eosin y at concentration 1×10^{-5} M

pH value	Peak of wavelength of the emission spectrum (nm) at concentration of 1×10^{-5} M	Peak of intensity of the emission spectrum (a.u) at concentration of 1×10^{-5} M
3.63	550	18.592
5.88	555	375.071
7.26	556	451.294
8.57	550	540.407
9.69	548	635.378

Eosin dyes are fluorone derivatives of xanthene dyes that exist as bivalent or univalent anions between pH=3 and 13; at pH lower than 3.0, some amount of dye exists in neutral form [6-8]. The first is the shape of spectrum and the location of the maximum wavelength, where enhancement in the intensity of absorbance of eosin yellow in ethanol at concentration 1×10^{-5} M with pH > 7 values in the basic medium.

The absorption and emission spectra of eosin y solution dissolved in ethanol with concentration 1×10^{-5} M, and at exciting wavelength ($\lambda_{\text{ex}}=490$ nm), as shown in Figure 2 (absorption and emission spectra of eosin y in ethanol /pH =7.26 at concentration 1×10^{-5} M). The emission spectrum consists of one peak that is located at wavelength ($\lambda_{\text{max}} = 556$ nm),

also Figure 2 (absorption and emission spectra of eosin y in ethanol/pH =7.26 at concentration of 1×10^{-5} M and Table 3 (comparative between pH values with λ_{max} and intensity, respectively, for eosin y at the concentration of 1×10^{-5} M) showing the relative maximum fluorescence intensity of eosin y solution in ethanol (451.294 a.u) at concentration of 1×10^{-5} M. Before the addition of basic (NaOH) or acid (HCl), the solutions of eosin have pH values depending on the type of solvent. The pH value for eosin solution in ethanol at concentration 1×10^{-5} M which is measured by pH meter was 7.26, as be denoted in Table 1 (the original and adjusted pH of Eosin y in ethanol at concentration of 1×10^{-5} M).

Figure 3 (emission spectra of eosin y in ethanol/pH =7.26, pH =5.88, and pH =3.63 at concentration of 1×10^{-5} M) which shows emission spectra of eosin in ethanol at different values of pH, which are ranging from (7.26, 5.88, and 3.63) at concentration of 1×10^{-5} M. It is important to observe changes in the emission spectra indicated that the of eosin are converted from a general form into another, when a few droplets of the addition of acid (HCl), the solution of eosin have pH values depending on the type of solvent that were (pH =7.26) before the addition this means a neutral, when adding (HCl), the solution becomes (low basic) or acidic medium and studying the properties of solution. This affected conversion in the eosin pH of solution was reflected on the emission spectra.

When adding HCl a few droplets and its clearly observed intensity of emission spectra of eosin in ethanol at concentration 1×10^{-5} M was decreased with pH values (7.26, 5.88, and 3.63), Where it is found at ethanol solution, the fluorescence peak was shifted toward longer wavelength (red shift) with pH values (3.63, 5.88, and 7.26), respectively. This shift can be interpreted to the interaction (solute-solvent) molecules with high electric dipole moment in the vibronic excited state which morly, strongly affected in polar surrounding (solvent ethanol), means increasing in the stability of energy excited state due to the relaxation process for solvent molecules, This shift leads to decrease the intensity of spectrum, when pH became (5.88 and 3.63) the intensity was decreased due to the monoanion form (low intensity, the changes in fluorescence intensity of eosin y when addition of acid (HCl) are shown in **Figure 3** (emission spectra of eosin y in ethanol/pH =7.26, pH =5.88, and pH =3.63 at concentration 1×10^{-5} M) and **Table 3** (comparative between

pH values with λ_{\max} and intensity, respectively, for eosin y at concentration 1×10^{-5} M).

In **Figure 1** (absorption spectrum for eosin y in different pH values at concentration of 1×10^{-5} M), the change in the absorption spectra indicates that eosin forms are converted from the general into another form, this conversion into the eosin form to change of pH value in the solution was affected by the emission spectrum.

Figure 4 (emission spectra of eosin y in ethanol/pH =7.26, pH =8.57, and pH =9.69 at concentration of 1×10^{-5} M) involves all the fluorescence spectra of eosin y solution in ethanol for different pH values (7.26, 8.57, and 9.69), respectively, when a few droplets of (NaOH) solvent were added. The fluorescence spectra of eosin y solution in ethanol are shifted the decrease of the wavelength with increasing pH values. **Figure 4** (emission spectra of eosin y in ethanol/pH =7.26, pH =8.57, and pH =9.69 at concentration of 1×10^{-5} M) above compares the fluorescence spectrum of eosin y solution in ethanol at 1×10^{-5} M with excitation wavelength ($\lambda_{\text{ex}}=490$ nm) at room temperature for various pH values, illustrated in the increase of pH values leading to the increase of relative fluorescence intensity after initial addition of (NaOH) drops gradually as explanation above this becomes the solution changing to more basic, this increase in the intensity is due to the dainion form (high intensity) was prevalent. According to **Table 3** (comparative between pH values with λ_{\max} and intensity respectively for eosin y at concentration 1×10^{-5} M) involved in evaluating fluorescence spectra for pH ranged (7.26, 8.57, and 9.69) shows the intensity for spectra increased (451.294, 540.407, and 635.378), respectively, with pH of solution, as demonstrated in **Figure 4**.

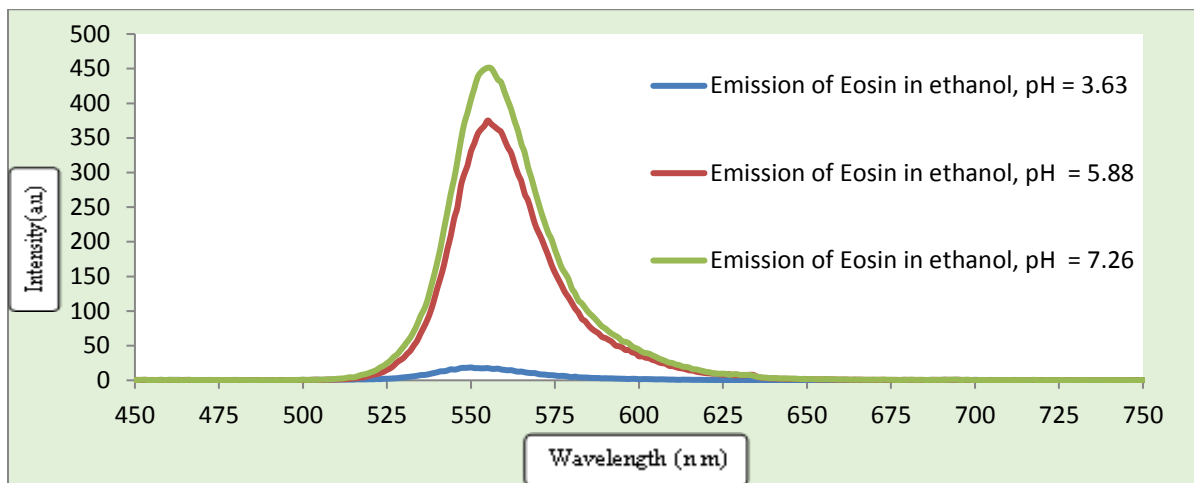


Figure 3. Emission spectra of eosin y in ethanol / pH =7.26, pH =5.88, and pH =3.63 at concentration 1×10^{-5} M

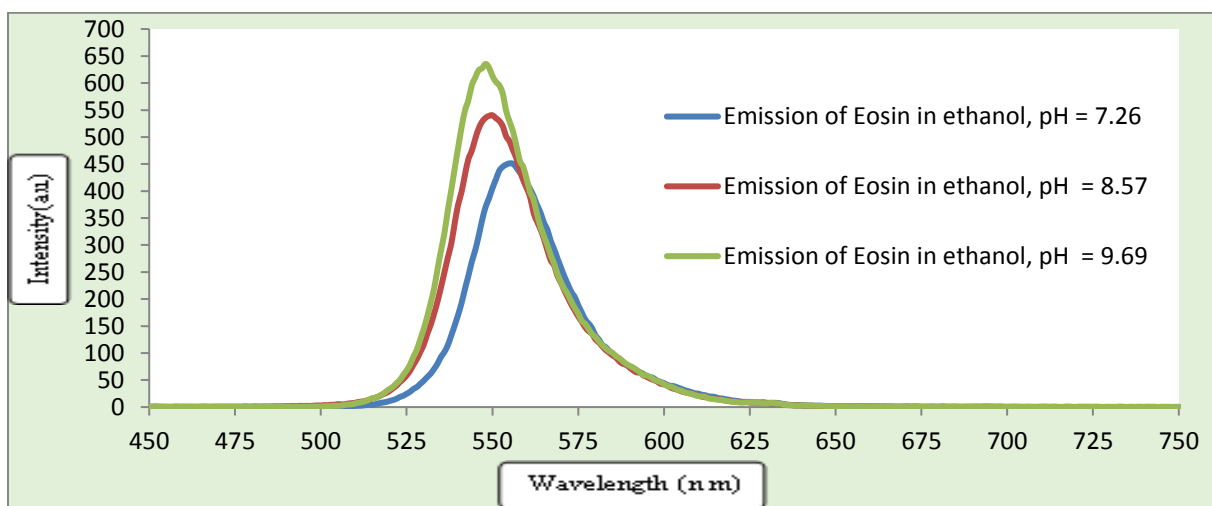


Figure 4. Emission spectra of eosin y in ethanol/pH =7.26, pH =8.57, and pH =9.69 at concentration 1×10^{-5} M

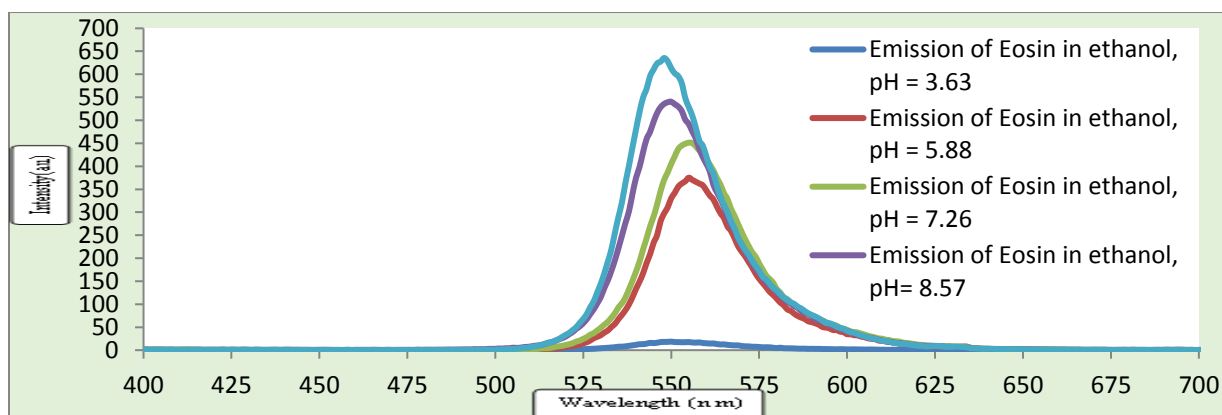


Figure 5. Comparative intensity of emission spectrum of each eosin y in ethanol in different pH values at 1×10^{-5} M

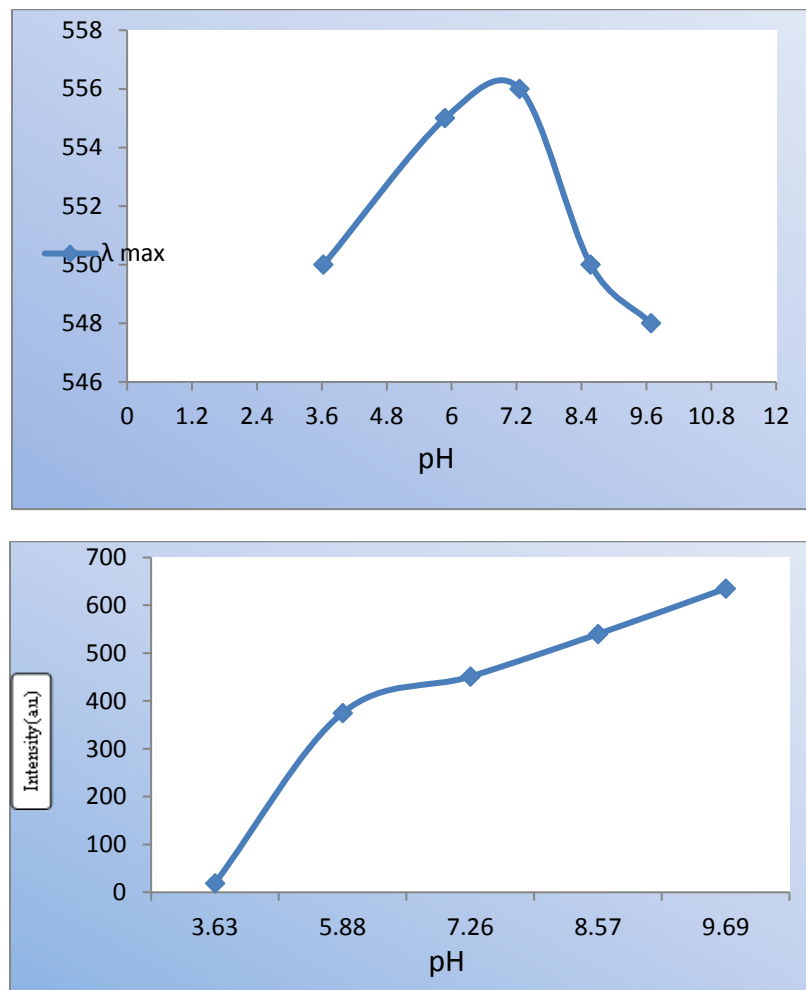


Figure 6. Discern the relation between pH values with (λ_{max} and intensity, respectively) for eosin y solution in ethanol at 1×10^{-5} M

Figure 5 (comparative intensity of emission spectrum of each eosin y in ethanol in different pH values at 1×10^{-5} M) shows the comparison between fluorescence spectra of eosin y solution dissolved in ethanol with concentration of 1×10^{-5} M at excited wavelength ($\lambda_{ex} = 490$ nm), illustrates the emission spectrum at the consists of one peak located at wavelengths (550 nm, 555 nm, and 556 nm) at pH values (3.63, 5.88, and 7.27), respectively. For the peaks of fluorescence, it is observed that there is a shift happening toward the longer wavelength with increases in the solvent polarity. Figure 5 (comparative intensity of emission spectrum of each eosin y in ethanol in

different pH values at 1×10^{-5} M) for eosin y solution in ethanol at 1×10^{-5} M) shows clearly observed comparison of the relative fluorescence intensity for various pH values (7.26, 5.88, and 3.63), respectively, of eosin y solution in ethanol at concentration 1×10^{-5} M, it is noticed that relative fluorescence intensity was decreased after the initial addition of (HCl) gradually with the decreasing of pH values, and also the shift was decrease. Although there is a (red shift) which is occurred, the relative fluorescence intensity was increased, expect when pH values (8.57, 9.69) respectively, illustrates the emission spectrum for (ethanol) at the consists of one peak located at

wavelengths (550 nm and 548 nm), it is observed that there is a shift happening decreased, the intensity increase with increasing the pH values with the concentration 1×10^{-5} M after addition (NaOH and HCl).

Figure 6 (discern the relation between pH values with (λ_{\max} and intensity, respectively) for eosin y solution in ethanol at 1×10^{-5} M, illustrated in the increase of pH values leading to the increase of intensity of fluorescence spectrum.

Conclusion

In the present article, the following conclusions are reached:

The red shift of fluorescence was decreased with the increasing of acidity (pH < 7), also the red shift was decreased with the increasing basicity (pH > 7). The fluorescence intensity of eosin solution y at in ethanol at the concentration of 1×10^{-5} M was dependent on pH value and its increasing pH values. Eosin react with NaOH to forms different the solute molecules converted into the dianoin species upon an increase in pH which is affected by fluorescence intensity. Eosin reacts with HCl to forms different the solute molecules converted into the monoanoin species upon an increase in pH which is effect of fluorescence intensity. After initial addition of (HCl), illustrated in the decrease of pH values leading to the decrease the relative fluorescence intensity and shifted was decreased. After initial addition of (NaOH), illustrated in the increase of pH values leading to the increase of relative fluorescence intensity while shifted was decreased. Increasing acidity (pH < 7) and rising basicity (pH > 7) both had effect on the fluorescence's red shift. The eosin y solution at in ethanol at concentration 1×10^{-5} M exhibited a pH-dependent, rising fluorescence intensity when the pH value was increased.

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Authors' Contributions

All authors contributed to data analysis, drafting, and revising of the paper and agreed to be responsible for all the aspects of this work.

Orcid

Waleed Khalid Hamood Al-Behadili

<https://orcid.org/0000-0002-2563-7978>

Yaqoob M. Jawad

<https://orcid.org/0000-0002-8637-282X>

Hasan J. Hasan

<https://orcid.org/0000-0001-5462-4239>

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