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PREPERATION AND SPECTROANALYTICAL STUDIES OF TWO NEW AZODYES DERIVED FROM PROCAINE HYDROCHLORIDE AND METACLOPRAMIDE

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ABSTRACT

This study involves the preparation of two new azodyes derived from [procaine hydrochloride and 4-aminoantipyrine] (L_1), and [Metoclopramide hydrochloride and 4-amino, 5-hydroxynaphthalene-2, 7-disulphonic acid disodium salt dihydrate] (L_2). They have been described by FT- IR, NMR, Visible spectroscopic and TG techniques. The acid-base properties were studied at different pH values (2-12), then the ionization and protonation constants were determined. The solvents effect of different polarities was studied

KEYWORDS: Metoclopramide, Azodyes, Ionization & Protonation constants and Spectral studies.

INTRODUCTION

Aromatic azo dyes are the largest group of organic dyes for their widespread applications in many areas of textile and medicine.[1] Most of azodyes are weak acids or weak bases[2] of very important class of chemical compounds receiving attention in scientific research.[3] They have high soluble in common solvents and highly colored (from yellow to blue , due to conjugated π system).[4] They have been used as dyes and pigments for a long time and have been widely used in many practical applications such as coloring fibers[5], photoelectronic applications[6],printing system[7] ,textile dyes[8], as well as in many biological reactions and in analytical chemistry.[9] Because of their specific physico-chemical properties and biological activities, they have found a broad application viz in pharmaceutical, cosmetic, food, dyeing or textile industry and analytical chemistry. Recently azo metal chelate have also attracted increasing attention due to their interesting electronic and geometric features.[10, 11] Most of azodyes having acid – base properties with presence of a fixed isobestic points (which represent the number of equilibriums in such azodye), for this reason they are used as acid – base indicators.[12-14] some of them can be used as metallochromic indicator or used as antipyretic reagents or as inhibitors from spectra corrosion. The solvents of different polarities may be affected on the absorption of π – conjugated compound exhibit n → π^* transition as well as $\pi\rightarrow\pi^*$transition causing blue or red shifts. They were used as good reagents for the extraction and spectrophotometric determination of metal ions[15-19], such as procaine azo dyes with imidazole , phenylephrine , oxindol and 4,5-diphenyl imidazole.[20] Metoclopramide azo dyes was also with imidazole , phenylephrine , oxindol and 4,5-diphenyl imidazole.[21] Procaine was used as azo compound with 4-amino, 5-hydroxynaphthalene-2,7-disulphonic acid.[22] Many research of using 4- aminoantipyrine azo reangent with 8-hydroxyquinoline, 2- thiobarbituric acid and 2-methylthiobarbituric acid.[23] The present work involves preparation of two new azo dyes derived from procaine hydrochloride and 4-aminoantipyrine and Metoclopramide hydrochloride and 4-amino, 5-hydroxynaphthalene-2,7-disulphonic acid disodium salt dihydrate . They were characterized by, IR, NMR, V. and thermal analysis . The acid – base properties , solvents effect and biological activities were studied .

EXPERIMENTAL

Double distilled water and all the reagents and solvents were of reagent-grad quality and for spectral use.

Apparatus

Visible absorption spectra were recorded by using PD-303 UV.V. spectrophotometer , FT-IR-4200S spectrophotometer (JASCO) Polymer research center Basrah university , pH-meter (H.Jurgons Co. Beremen,L. Puls Munchen 15), Bunchi B190K for melting point measurement, accurate balance E-Mette Weender (Land Strasse) 94-108.and NMR analysis, TG analysis at Amirkabir university (Iran).

Preparation of azo dyes L_1 & L_2

With respect to L_1, was prepared by coupling reaction of dizonium salt of 0.004 mole (1.0912 g) procaine hydrochloride with alkaline solution of 0.004 mole (0.8130 g) of 4-amino antipyrine. With respect to L_2 was prepared by coupling reaction of dizonium salt of 0.002 mole (0.8133g) of metoclopramide hydrochloride with alkaline solution of 0.002 mole (0.8880 g) of 4-amino, 5-hydroxynaphthalene-2,7-disulphonic acid disodium salt dehydrate.

Then the formed azo dyes were neutralized and converted to the hydrogen forms by adding diluted hydrochloric acid. The precipitates were filtered off and twice recrystallized from aqueous ethanol. The purity of the prepared dye was checked via thin layer chromatography and melting point methods.

Solutions: A stock solution of (1 x 10-3 M) of each L_1 and L_2 dyes were prepared by dissolving an accurately weighed amount of the compounds in the required volume of ethanol (L_1) and with water (L_2). More dilute solutions were obtained by accurate dilution. Universal pH (2-12) and) buffer solutions[24] were prepared.

Procedure

- For Acid–Base studies

To study the effect of pH values on the absorption spectra on the dyes (L_1&L_2) and to determine of their protonation and ionization constants[21], a series of dyes with buffer solutions were prepared at different pH values (2–12) using concentrations of each dye (0.6×10^{-4})M. The absorbances of these solutions were recorded at range of (350–640 nm.) w.r.t. (L_1) and (350-700 nm.) w.r.t. (L_2) using a cell of 1cm length and buffer solution as a blank solution. By the aid of half height method the constants were calculated.

- For solvent effect studies

A series of solutions of azo dyes (L_i & L_2) were prepared of concentration of each (0.6×10^{-4}) M in Ethanol, H_2O, Acetone, Dioxane, Tetrahydrofuran (THF), Dimethylformamid (DMF) and Dimethyl sulfoxide (DMSO).The absorbance of these solutions were recorded at range of (310 – 520 nm.) w.r.t. (L_1) and (350-650 nm.) w. r.t. (L_2) using cell of 1cm length and using a solvent as a blank solution.

RESULTS AND DISCUSSION

IR Analysis: Table (1) shows the famous IR frequencies of important bands of functional groups frequencies as seen in Fig. (1).

Table 1: The famous IR frequencies of important bands of azo dyes L_1 & L_2

Dye	υ C-N	υ C-H	υ N=N	υ C=C	υ C=O	υ OH, υ NH	υ C- Cl	υO=S=O vas o=s=o
L_1	1163.83	2984.3	1500	1603.52	1694.16	3416.76	----	----
L_2	1041.85	2926.93	1526.86	1596.29	1634.38	3423.99	673.51	1394.44 1194.69

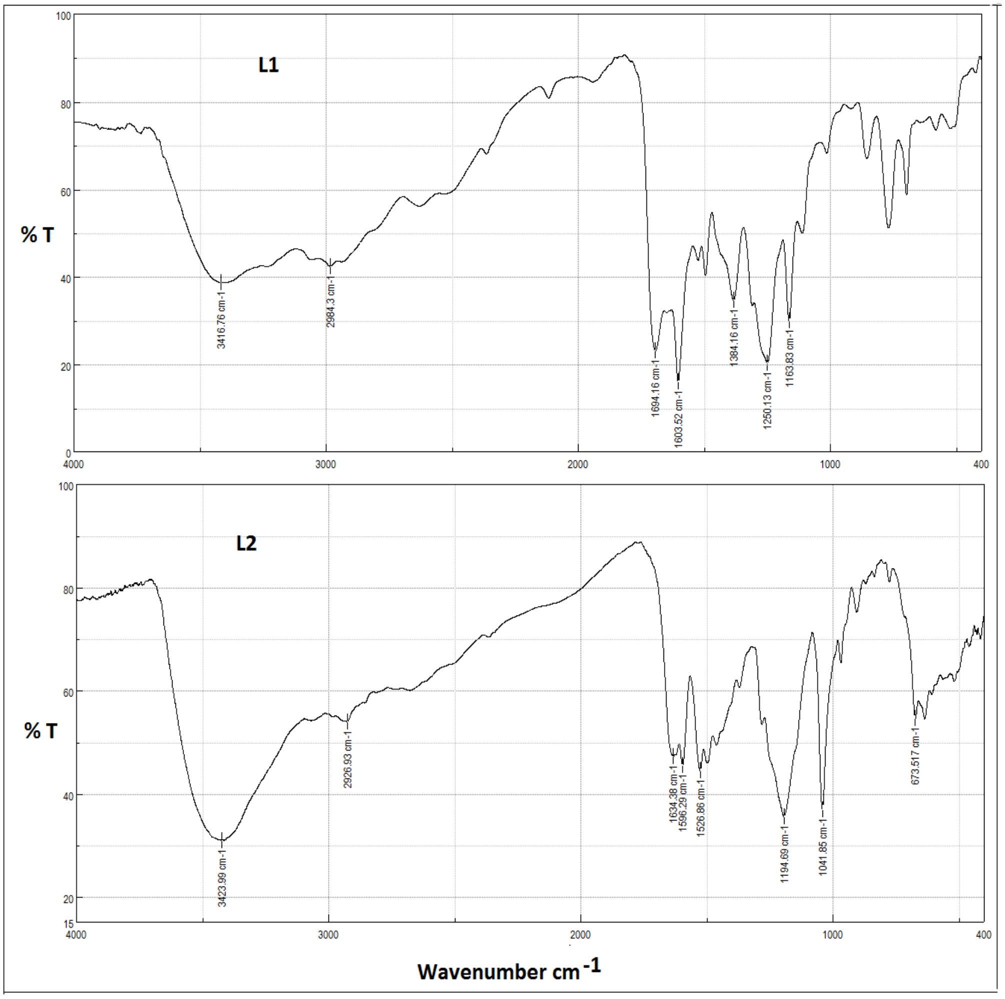


Fig.-1: IR spectra for dyes L_1 & L_2

NMR Analysis

Table (2) shows the chemical shifts of important bands as seen in Fig. (2).

Table 2: The Chemical shifts of important bands of azo dyes L_1& L_2

L_1		L_2	
Chemical shifts ppm	**Group**	**Chemical shifts ppm**	**Group**
5.77	(amine) NH_2	8.58	OH(sulfonic acid)
6.610-6.629	CH (1-benzene)	9.62	OH (alcohol)
7.663-7.668	CH (1-benzene)	6.480	NH_2 (amine)
7.788-7.805	CH (1-benzene)	8.65	NH(Amide)
6.533-6.554	CH (1-benzene)	8.037	CH (1-benzene)
4.40	CH_2(methylene)	7.113-7.116	CH(1-Naphthalene)
2.728	CH_3 (methyl)	7.526	CH(1-Naphthalene)
2.167-2.339	CH_2(methylene)	7.318	CH (1-benzene)
2.091	CH_3 (methyl)	4.042	CH_3 (methyl)
1.14	CH_3 (methyl)	3.186-3.939	CH_2(methylene)
-	-	1.161-1220	CH_3 (methyl)

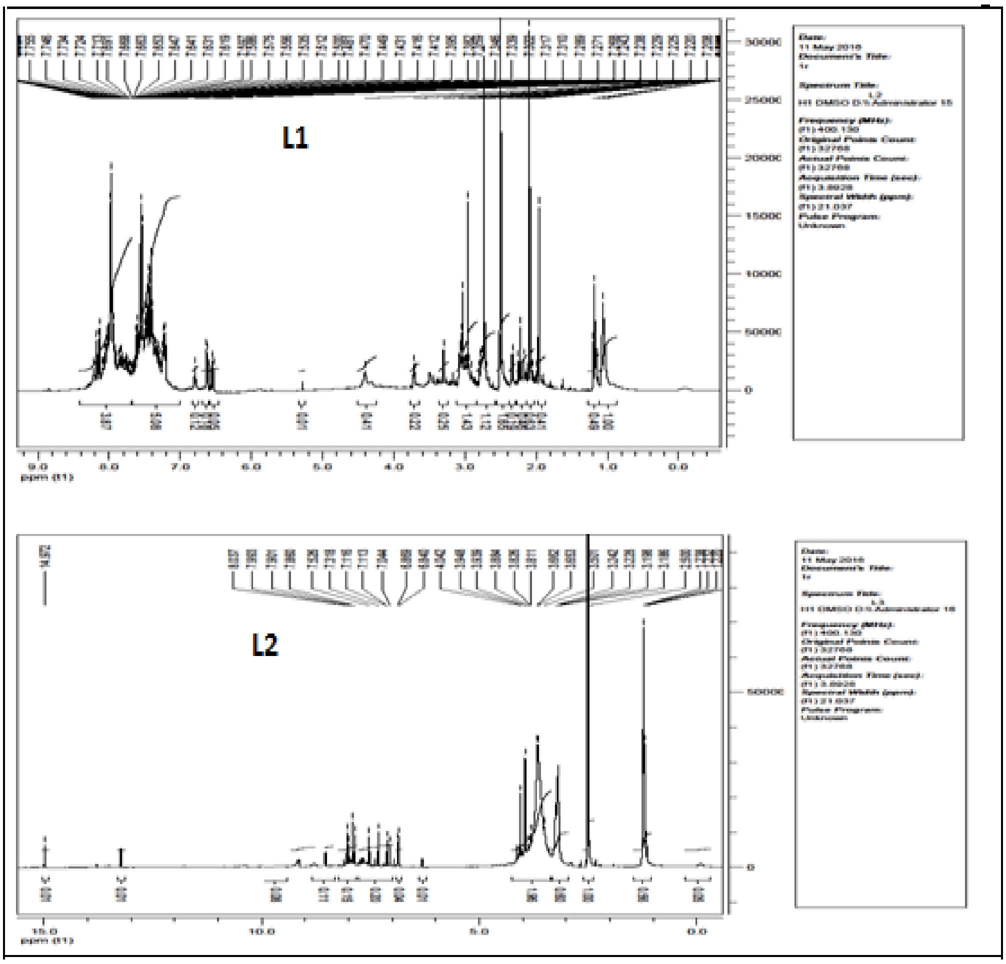


Fig.- 2: NMR spectra of the azodyes L_1& L_2

TG-Analysis

Table (3) shows T_i ,T_{max} , T_f and %wt.loss , as seen in Fig. (3).L_1 shows four endothermic steps while L_2 shows three endothermic steps

Table 3: shows T_i, T_{max} , T_f of azodyes L_1&L_2

Dye	Coking Ratio	T_i °C	T_{max} °C	T_f °C	%wt.loss
L_1	12.6	143.3	151.2	167.2	5
		167.2	264	328.8	20
		328.8	509.6	525.6	50
		525.2	552.9	625.6	90
L_2	16. 5	200	290	357.6	10
		357.6	409.6	460.8	41
		460.8	589.6	638.4	87

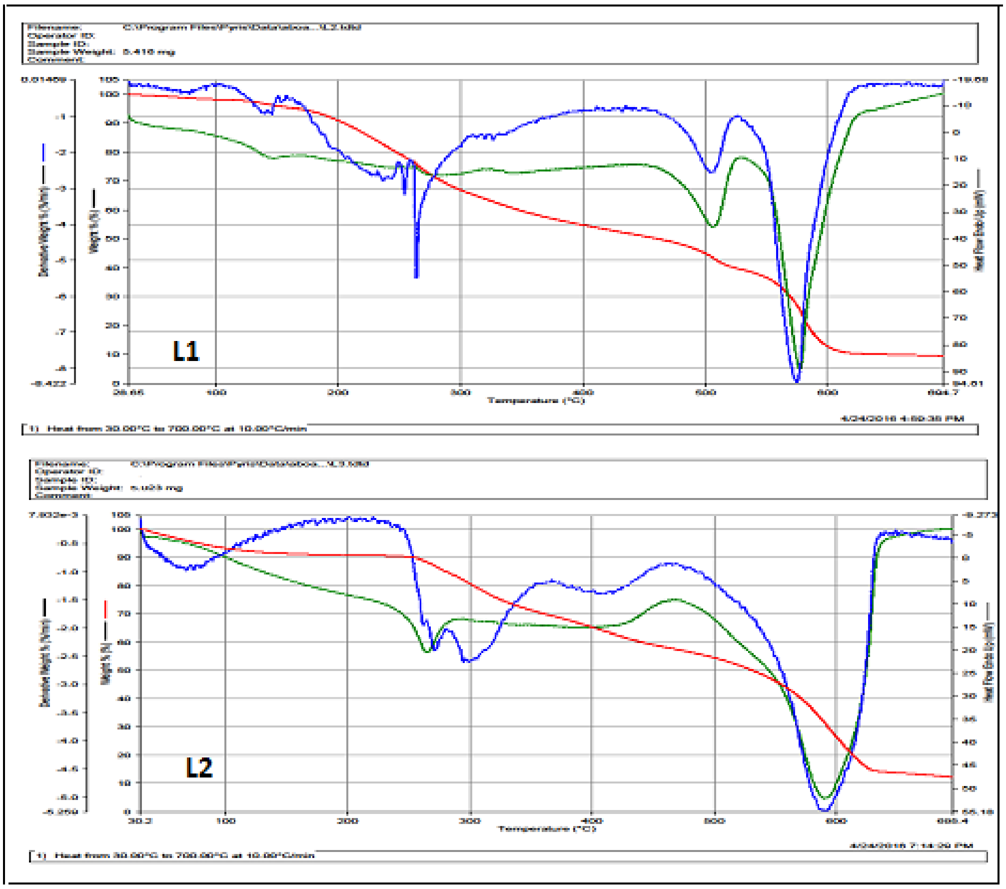
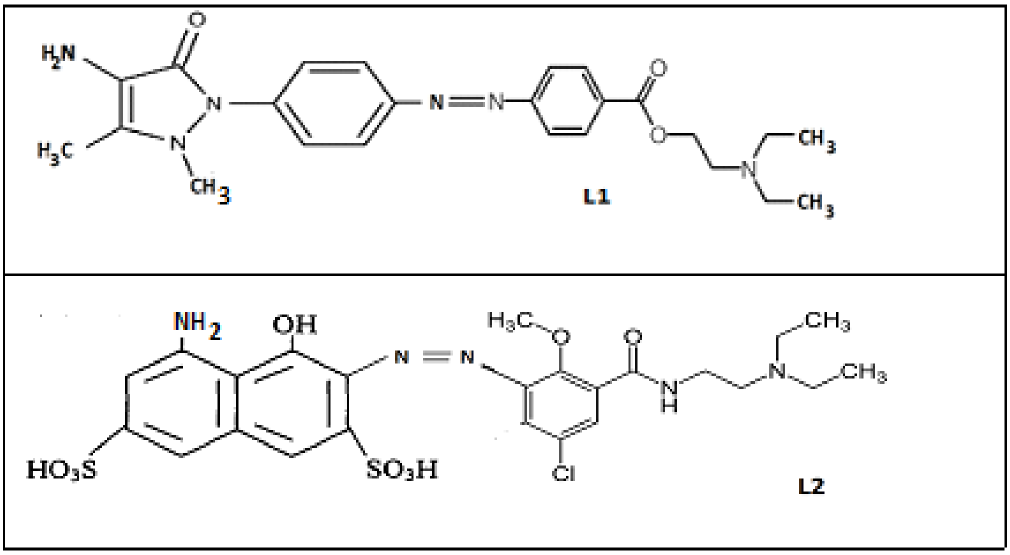


Fig.- 3: TG , DTA spectra of the azodyes L_1&L_2

From IR analysis, NMR analysis, TG analysis, literatures and scientific previous researches, the chemical structures of azo dyes L_1 & L_2 were suggested (schemes 1)



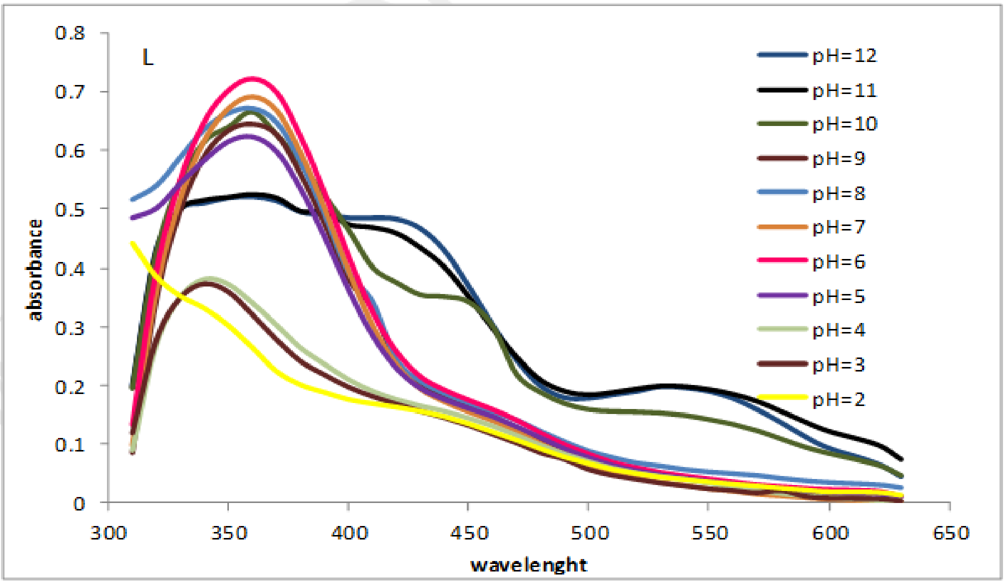
Schemes – 1

Acid-Base properties

For study the effects of acidity and basicity of buffer solutions on the dyes and to calculate the ionization and protonation constants, a series of universal buffer solutions were prepared at different pH values (2-12) for each dye.

The absorption spectra of 0.6 x 10^{-4} M solution of L_1 dye of varying pH values (2– 12) were represented graphically (Fig. 4) . The spectra characterized by two maximal bands at 360 nm. in pH range (3 - 10) and 540 nm. in range of (10 – 12). The first due to the absorption of the protonated form of hydroxyl group (acidic form or cationic form) liable to exist in acid medium and the second is more intense bands due to ionized form of hydroxyl group (basic form or anionic form) except for at pH 10 value there are two bands at 360 and 540 nm. The spectra were characterized by the presence of two isobestic points at 400 nm. and 450 nm. due to the equilibrium of dye in acidic and basic medium .It was found that no any band on the spectrum at pH 2 or below , that means the decomposition is happened at highly acidic solution.

For L_2 , the spectra characterized by two maximal bands at 370 nm. And in 530-560 nm. Range (Fig. 5) . The first due to the absorption of the protonated form of hydroxyl group (acidic form or cationic form) liable to exist in acid medium and the second is more intense bands due to ionized form of hydroxyl group (basic form or anionic form). It was also found that no any band on the spectrum at pH 2 or below, that means the decomposition is happened at highly acidic solution. Fig.5 shows two isobestic Points at 410 and 500 nm.



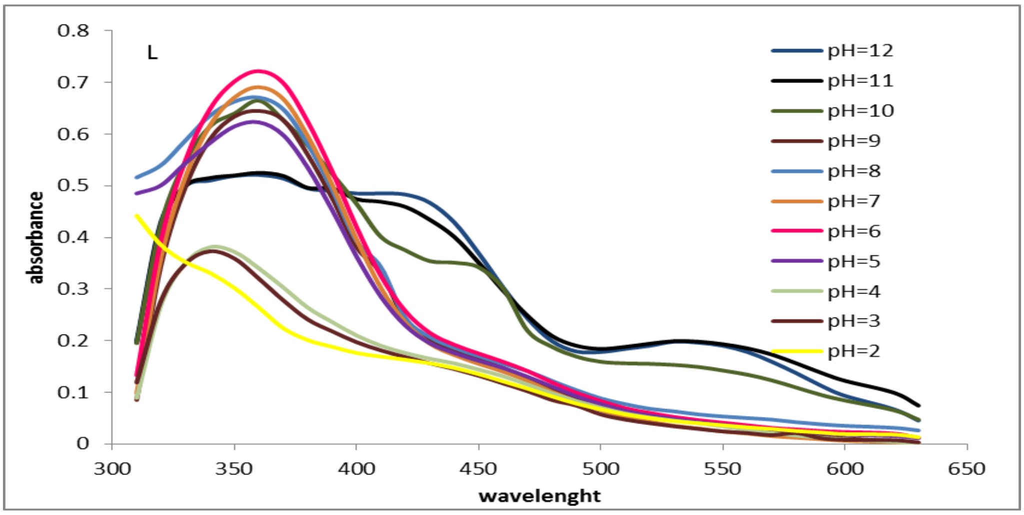


Fig.- 4 : The electronic spectra of L_1 at different pH values

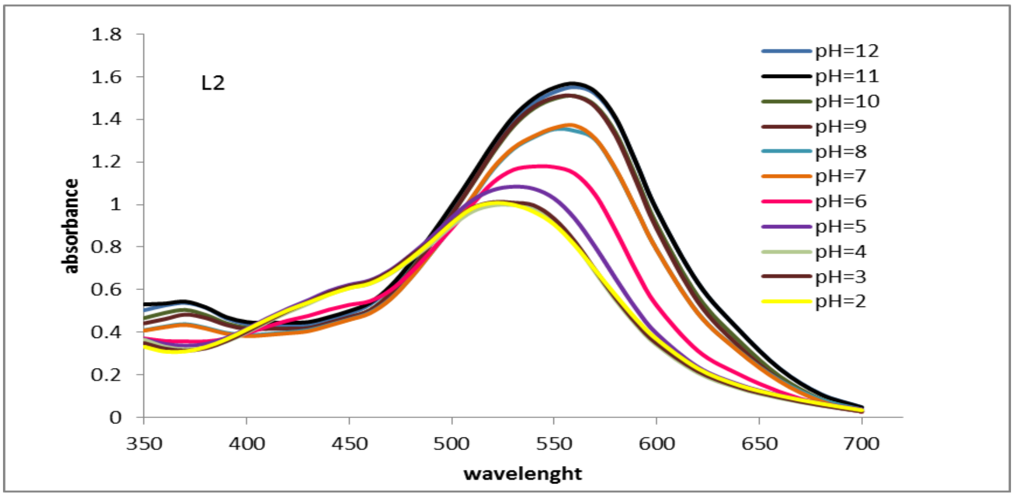


Fig.- 5 : The electronic spectra of L_2 at different pH values

Kind of buffer solution used

From Fig. 4 & 5 , it was found that the max. absorbance at pH values 6 (buffer solution kind **A** for L_1) and 11 (buffer solution kind **D** for L_2) . Table (4) and Figs. 6 & 7 show several kinds of buffer solutions of pH value of 6 and 11 for azo dyes L_1 and L_2 respectively.

Table 4: kinds of buffer solutions used[24, 25]

Kind of buffer	pH 6 for L_1	pH 11 for L_2
A	(Universal buffer) 50 ml of acidic mixture + 21 ml 0.2 M NaOH	(universal buffer) 50 ml of acidic mixture + 42 ml 0.2 M NaOH
B	(Hexamine buffer) 0.0 ml of 200 ml 10% hexamine solution	(Hexamine buffer) 0.8 ml of 200 ml 10% hexamine solution
C	50 ml of 0.1 M KH_2PO4 + 5.6 ml 0.1 M NaOH --- >100 dis. water	25 ml 0.1 M NaOH ---- > 50 ml sol.No.1
D	3.56 ml (0.2 M $Na_2HPO_4.2H2O$) + 3.7 ml of	24.5 ml of 0.1 M NaOH ---- > 50 ml sol. No. 1

	0.1 M citric acid ---- > 100 ml dis.water	
E	40.4 ml of 0.1 M NaOH ----- > 100 ml sol. No.3	25 ml of 0.05 M of $NaHCO_3$ + 11.4 ml of 0.1 M NaOH ---- > 50 ml dis.water
F	12.1 ml of sol. No. 4 --- > 100 ml sol. No. 5	--------------

Where :

Sol.No.1 = 1.2367 g. boric acid+ 10 ml 1 M NaOH --- > dis.water

Sol.No.2 = (0.7507 g. glycocoll + 0.585 g. NaOH) ----- > 100 ml. dis.water

Sol.No.3 = [2.1014 g. sodium citrate ($H_3C_6O_7$.H2O) + 20 ml. 1 M NaOH]----- > 100 ml. dis.water

Sol.No.4 = 1.1866 g. sodium hydrophosphate (Na_2HPO4.2H2O) ---- > 100 ml. dis.water

Sol.No.5 = 0.9073 g. potassium dehydrophosphate (KH_2PO_4.2H2O) ------ > 100 ml. dis.water

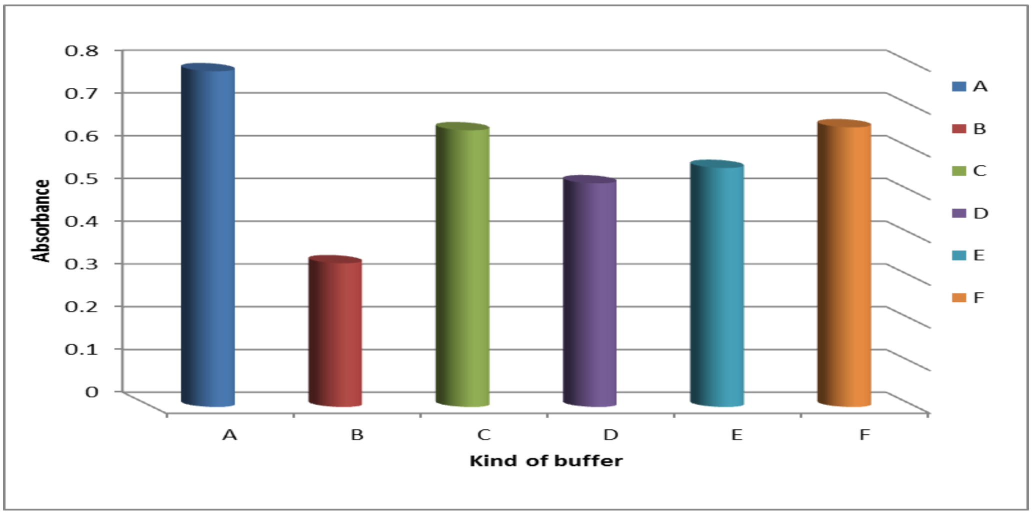


Fig.-6: Kinds of buffer solution for azo dye L_1 of pH 6

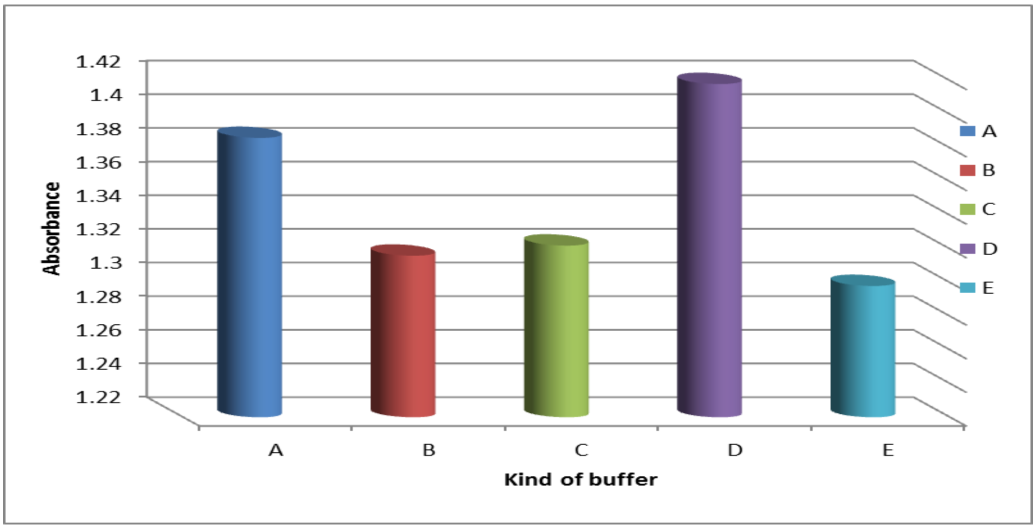
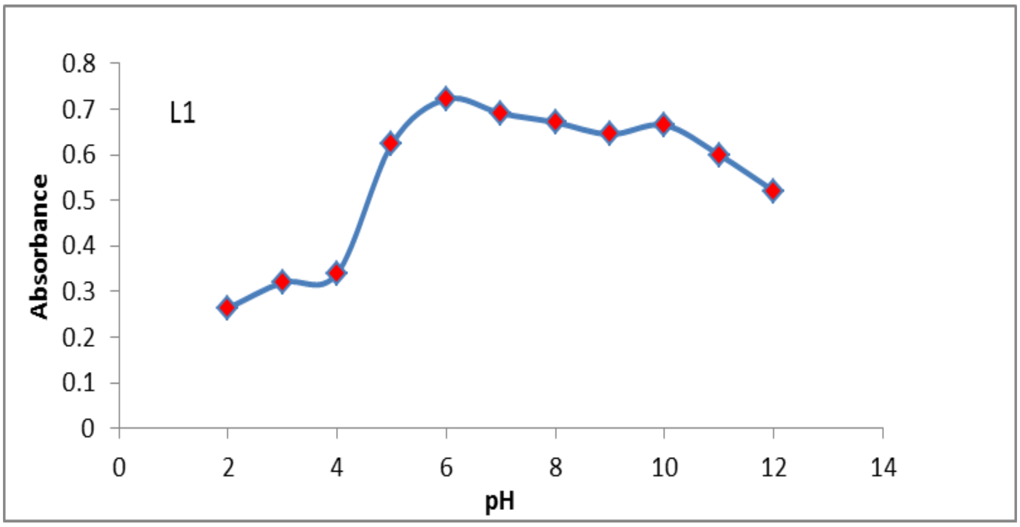


Fig.-7: Kinds of buffer solution for azo dye L_2 of pH 11

At certain wavelength (560 nm.) of each azo dye (from Figs. 4 & 5) , the absorbance – pH curves were plotted for azo dyes L_1 and L_2 (Fig. 8). The ionization and protonation constants were calculated (Table 5) from Absorbance–pH curve by the aid of half-height method, and the pK values were obtained by this relation

pK = pH (at $A_{1/2}$) where ; $A_{1/2} = (A_L + A_{min.}) / 2$

and A_L and A_{min} are limiting and minimum absorbance's respectively.



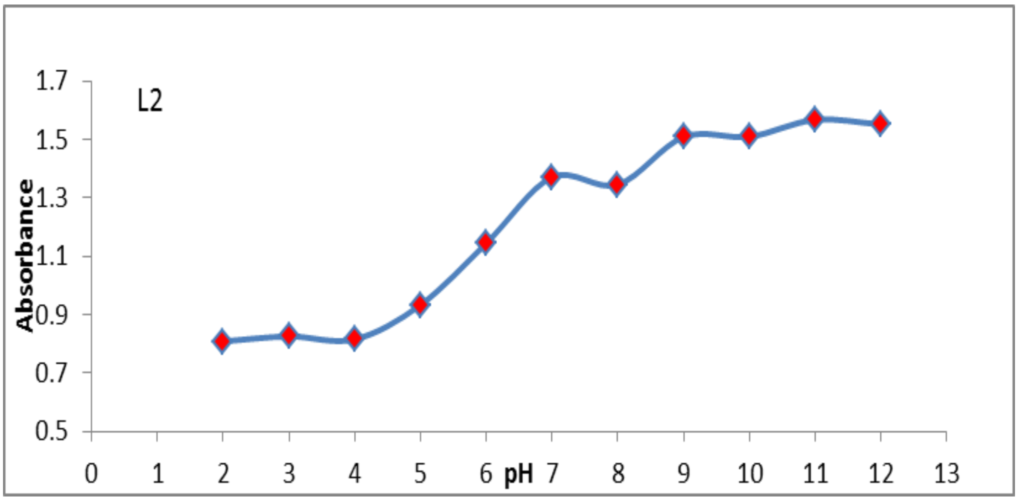


Fig.- 8: pH – Absorbance curve for dyes L_1 & L_2

Table 5: The protonation (pKp) and ionization (pKa) constants of azodyes

Dyes	**λ nm.**	**$A_{1/2}$**	**pK_a**	**$A_{1/2}$**	**pK_p**
L_1	360	0.65	9.5	0.62	5.0
L_2	560	1.45	8.5	1.04	5.5

From Fig. 8 , it was found that each azo dye containing two equilibrium (protonation and ionization processes) . In case of L_1 , the protonation of N atom in $-NH(CH_3)_2$ group and ionization of -OH group as enol form of keto group of 4-aminoantipyrine ring . In case of L_2 , the protonation of of N atom in $-NH(CH_3)_2$ group also and ionization of $-SO_3H$ group .

Solvent effect: Fig. (9 & 10) show the spectra of each dye with strong bands λ_{max} in the range of (300 – 520 nm.) for all solvents (water, ethanol ,1,4-dioxane , THF , DMSO , DMF, and acetone). For dye L_1 ; all solvents show λ_{max} at range of (350- 360 nm.) except for DMSO and acetone at 330 nm., with little blue-shift. These bands move to shorter wavelength due to $n \rightarrow \pi^*$ transition , because of the energies of the ground state (G.S) and excited state (E.S). The n energy level will decrease more than π^* decreasing and the $n \rightarrow \pi^*$ transition energy be more in the presence of polar solvent.

For dye L_2 all solvents show λ_{max} at range of (520 - 540 nm.) except for DMSO and acetone at 550 nm., with little red- shift (to the longer wavelength $\pi \rightarrow \pi^*$ transition) because of the polarities of the ground state (G.S) and excited state (E.S). Thus for solvent of increasing polarity, the energy of the E.S (π^*) will decrease relative to the that of the G.S (π).

The absorption spectra in various solvents are influenced by salvation and / or dielectric effects of solvents. To verify whether the band shift (Δv) is due to change in solvation energy or pure dielectric effects.

The plot of (D-1)/(D+1) against the λ_{max} (Table 6) gives more or less linear relation with solvents of moderate polarities (Fig. 11) where (Di) is the dielectric constant of the solvent. This denotes that the dielectric constant of the medium is the main factor governing the band shift in such solvents.

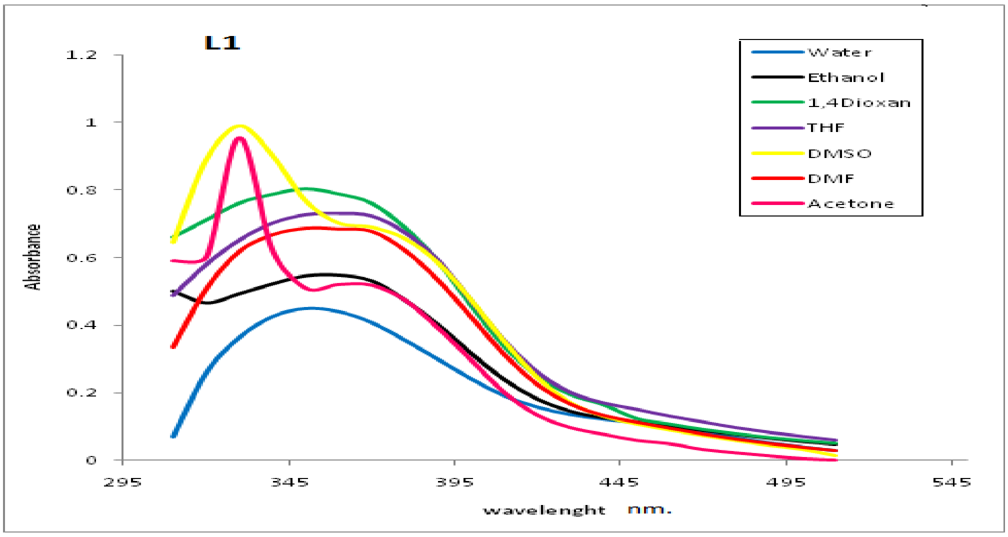


Fig.-9: The spectra of dye L_1 at different solvents of different polarities

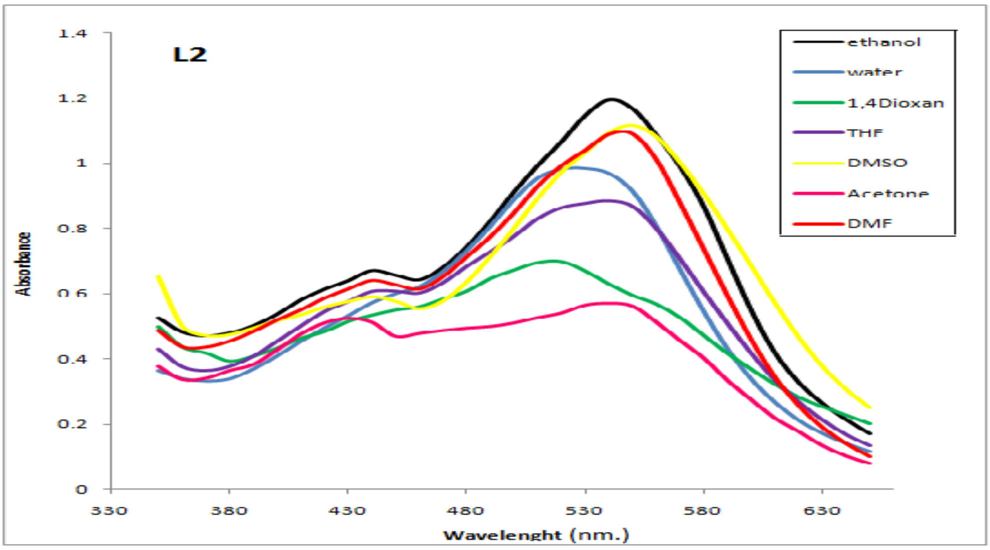


Fig.-10: The spectra of dye L_2 at different solvents of different polarities

Table 6: The (D-1)/(D+1) and λ_{max} values of using solvents if different polarities

Sovent	Symbol	Di	(Di -1)/(Di +1)
1,4-Dioxan	D	2.3	0.394
THF	T	7.58	0.766
Acetone	A	21.00	0.909
Ethanol	E	32.70	0.940
DMF	D`	36.71	0.947
DMSO	M	46.68	0.958
H_2O	W	78.30	0.975

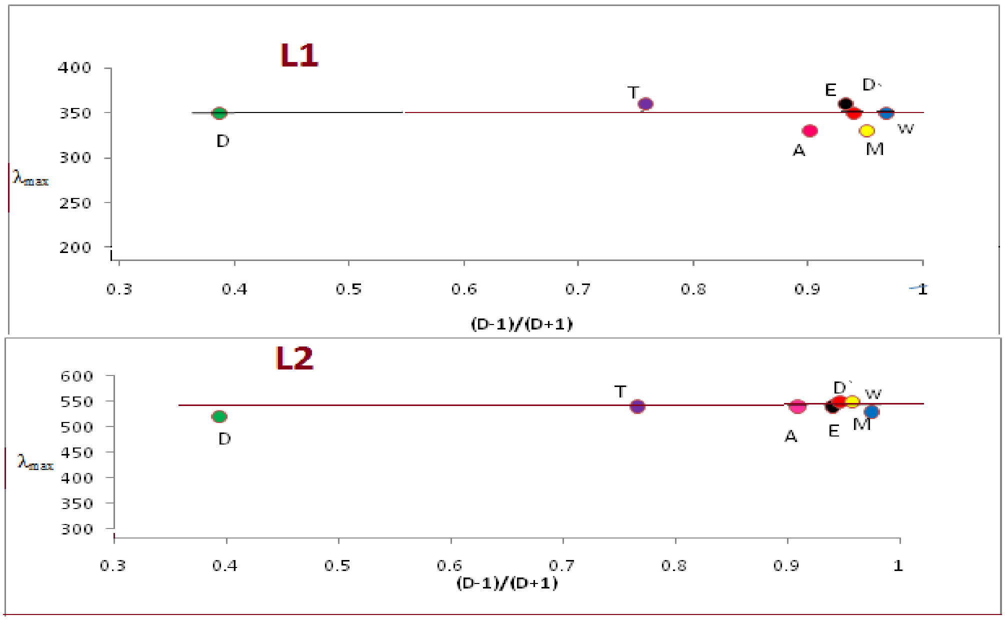


Fig.-11: (D-1)/(D+1) against the λ_{max} of azo dyes L_1 and L_2

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