

Studies of preparation and application properties of a new 4,4-diamino biphenyl stilbene - 2,2-disulphonic acid based reactive dye having two vinylsulfone paraester groups

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ABSTRACT

Reactive colors were at first acquainted industrially for application with cellulosic filaments and this was as yet their most vital utilize. The development rate of responsive colors for cellulosic strands was relied upon to keep expanding. The present research was identified with combine of new 4,4-diamino biphenyl stilbene - 2,2-disulphonic acid based reactive color. The reactive color was orchestrated through condensation and coupling forms. The basic portrayal of integrated 4,4-diamino biphenyl stilbene - 2,2-disulphonic corrosive based receptive color was finished with fourier transform infrared spectroscopy (FT-IR). The integrated color had been connected on cotton texture by exhaust process. The various after-effects of salt concentration, dyeing time, and dyeing temperature were also determined by exhaust technique.

Keywords: condensation, coupling, fourier transform infrared spectroscopy (FT-IR), exhaust technique, after-effects of salt concentration, dyeing time, and dyeing temperature.

1 INTRODUCTION

IN the present day age, responsive colors have a considerable measure of significance in various research ranges in light of their persuading properties and in addition immense applications. Receptive colors have been comprehensively utilized as dyestuffs for engineered filaments, fleece and cowhide because of their astonishing coloring and shading applications [1]. Because of high brightness, quickness (wet) and scope of shades, receptive colors are abused for cellulosic materials. They are very engaging for their effortlessness in the coloring procedure as in the fluid arrangement. The cellulosic material delivers a negative charge on its surface [2].

Particular about every single natural compound, colors have shading as they take up light in the noticeable range (400–700 nm). They contain as a base one chromophore. They contain a conjugated structure to such an extent that framework with substituting twofold and single bonds. They show reverberation conduct of electrons. The reverberation of electron is turned out to be consistent constrain in natural mixes [3]. When somebody of above viewpoints is by and large short from the atomic framework, the shading is vanquished. Notwithstanding chromophores, the dominant part colors likewise have bunches called auxochromes. Carboxylic corrosive, sulfonic corrosive, amino, and hydroxyl gatherings are a few cases of auxochrome. Auxochrome are not expected for shading. They move the shade of a colorant and they are almost all every now and again used to control color solvency [4].

These are the coloring of cellulosic material which contains a receptive gathering. It blends specifically with the hydroxyl or the amino gathering of the fiber. By virtue of the substance response the shading is quick and has a long life. Fleece, silk and cotton can be colored with this kind of coloring of textures. Speed is decide

of how firmly a color is hold fast to a texture and is a huge sign in the matter of whether the color will go into water when the material is washed [5]. For a long time, scientific experts longed for develop quick colors that would covalently cling to textures as opposed to just combination to the texture by powerless intermolecular powers. Amid the 1950, a gathering of scientific experts working for ICI set out on their scan for an enhanced color for fleece. William Stephen resolved to adjust the structure of azo colors by including responsive gatherings with the expectation that they would join with the amino gatherings of proteins in fleece. One of his thoughts was to change an azo color containing an amino gathering by responding it with trichlorotriazane. It was felt that the new color would respond with fleece. Be that as it may, the outcomes were extremely poor thus more work should have been done on the colors. Stephen understood that the response would probably happen in basic conditions. Be that as it may, this brought on an issue as basic conditions would harm the fleece. In its place, they utilized the colors with cotton, which would not be ruined by the soluble conditions. The color particles responded with both the amine and hydroxyl bunches on the cotton filaments. The principal fiber receptive colors had been framed [6].

Material responsive colors have one or extra R-N=N-R (azo) units in which nitrogen molecules are associated with carbon particles. One of the carbon iotas must be crimped with sweet-smelling ring i.e. with benzene or with naphthalene subordinates. Azo colors have application in practically every range of life. Azo colors indicate high force astonishing hues more than some other concoction class of colors [7]. The quantity of (-N=N-) azo gatherings show in the atom impact the force of shade. They have great speed properties embraced by the capacity to shape covalent securities and

improve the color substrate fascination [8]. The primary favorable position of engineered colors over common colors is that when these colors settle on textures through compound linkages. These colors can't be separated from texture. The wet-speed of a material texture hued with a manufactured color is vastly improved than textures shaded with other color. At the point when a color is fused into polymeric chain, its light quickness can be upgraded [9].

Azo colors are financially accessible colors. They are known as corrosive azo colors on the off chance that they have sodium salts of a sulfonic corrosive gathering with a phenolic gathering. Every single such color having phenolic and sulfonic corrosive moieties, contain sulfonic (-SO₃H) corrosive hydroxyl (-OH) bunch as auxochromic gathering [10]. These two responsive gatherings have been observed to be triumphant in coloring cellulosic strands i.e. bunches with dynamic hydrogen molecules which frame an amide or ester linkage and second is enacted vinyl bunches which can shape other linkage.

2 Material and method

The union, invention depiction and debasement of organized 4,4-diamino biphenyl stilbene - 2,2-disulphonic corrosive receptive color was discussed here. The mix of hues was done in Harris colors and shades in Faisalabad. The different engineered depiction and examination were done in a joint exertion with Pakistan Council Scientific and Industrial Research (PCSIR) labs complex Lahore. Each and every business reagent and solvents required in the mix were of logical survey and were utilized as gotten. Solid rough materials used for the union of hues were taken from Harris colors and shades private constrained Faisalabad.

2.1 Instrumentation

Propelled pH meter (Hanna 9818).

U-2001 Shimadzu (Japan) fourier change infrared spectrometer (FT-IR) was used at Pakistan Council Scientific and Industrial Research (PCSIR) labs complex Lahore.

Lab scale exhaust shading machine was used for the shading method.

2.2 Used Chemicals

Na₂CO₃, HCl, sodium nitrite, cynuric chloride, 4,4-diamino biphenyl stilbene - 2,2-disulphonic destructive, 1-amino-8-hydroxynaphthalene-3,6-disulphonic destructive and vinylsulfone paraester.

2.3 Technique to Prepare Color

A color was set up by 4,4-diamino biphenyl stilbene - 2,2-disulphonic destructive. The color N-1 was set up in 1000 ml measuring utencil containing 50 ml water. The shading N-1 had been joined by taking after the differing course with unique excellence of coupling and development parts. Failing miserably and vapor methodology are used [11]. Mechanical depiction is concentrated like briskness per current models society of dyers and colourist.

2.4 Preparation Route for Color NM-1

2.4.1 Diazotization Strategy

Diazotization was finished by including 5 mL course of action of sodium nitrite (0.02 moles containing 4.25g) and 45 mL of HCl (33% unadulterated) to 4,4-diamino biphenyl stilbene - 2,2-disulphonic destructive. The mix was preceded with stirrer for a

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hour. Little measure of sulfamic destructive (H₃NSO₃) was incorporated under interminable mixing till no shading on starch iodide paper was made.

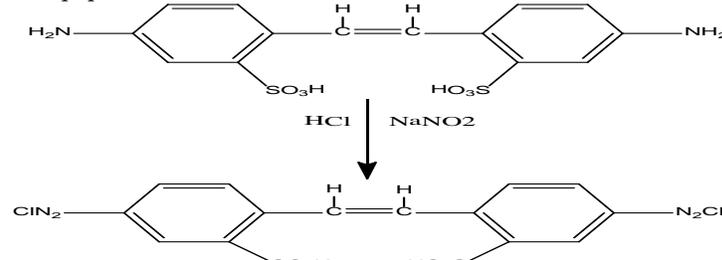


Figure 2.1 Diazotization of 4,4-diamino biphenyl stilbene -2,2-disulphonic acid with hydrochloric acid and sodium nitrite.

2.4.2 Coupling with H-Acid

Coupling was accomplished by adding 1-amino-8-hydroxy naphthalene-3,6-disulphonic acid (0.04 moles, 23.12g and 80% pure) to the diazotized 4,4-diamino biphenyl stilbene -2,2-disulphonic acid at pH 2 by putting reaction mixture on stirrer for four hours. The diazotized coupled product mixture was then allowed to stir overnight.

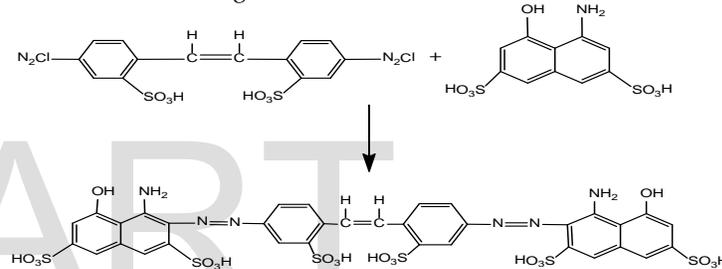


Figure 2.2 Coupling of diazotized 4,4-diamino biphenyl stilbene - 2,2-disulphonic acid with 1-amino-8-hydroxynaphthalene-3,6-disulphonic acid (H-acid)

2.4.3 Diazotization of Vinylsulfone Paraester

Suspension of 200 mL of vinylsulfone paraester (95%, 0.04 mole and 11.24 g) was blended and mixed with 150 mL HCl (33% unadulterated) for a hour at 0 °C by including ice. 250 mL of NaNO₂ (2.76 g) was added drop shrewd to vinylsulphone paraester for diazotization by ceaseless blending. The diazotized item framed was checked with congo red and iodine starch pointer paper which demonstrated blue and dark colored hues.

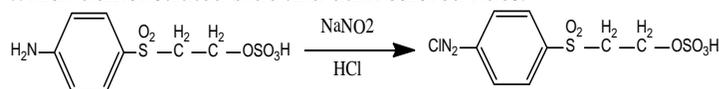


Figure 2.3 Diazotization of vinylsulfone paraester with hydrochloric acid and sodium nitrite.

2.4.4 Coupling

The above prepared diazotized coupled product was transferred to vinylsulfone paraester suspension product at pH 7. The reaction vessel was further stirred till the pH was stabilized. The synthesized dye was then dried in oven at 80°C-90°C.

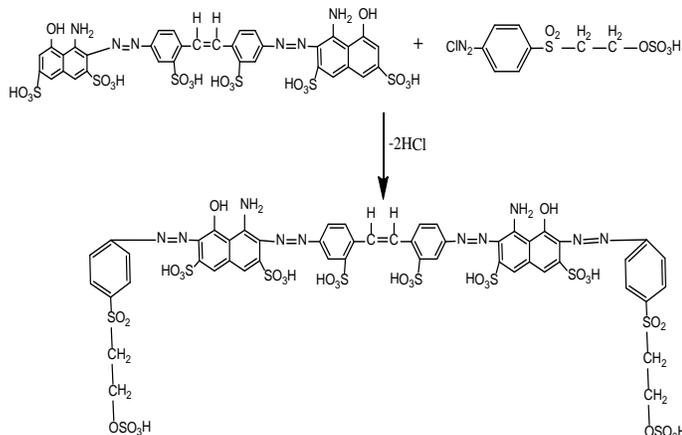


Figure 2.4 Chemical structure of synthesized dye NM-1 obtained through tetrazotization and double coupling processes.

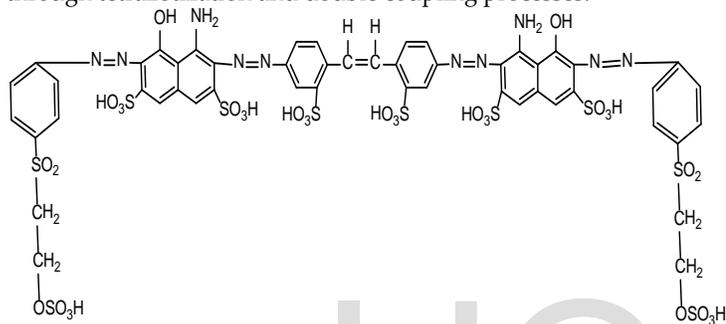


Figure 2.5 Chemical structure of synthesized dye NM-1 obtained through tetrazotization and double coupling processes.

3 RESULTS AND DISCUSSION

3.1 FT-IR Study

The purpose of this examination work was to prepare responsive hues in perspective of 4,4'-diamino biphenyl stilbene-2,2'-disulphonic destructive. I investigated their essential and invention properties. Corruption examination of these hues was in like manner performed. FT-IR spectroscopy is most basic logical procedure used for the affirmation of structure and unmistakable confirmation of utilitarian social affair of blends. Profiles of Fourier change infra red spectroscopy (FT-IR) in solid states for shading NM-1 lie in the area of 4000-400 cm^{-1} which displayed specific zeniths showed up in the figure 3.1. Appearance of trademark frequencies of 4,4'-diamino biphenyl stilbene-2,2'-disulphonic destructive based responsive hues with respect to different utilitarian social affair exhibit in them are revealed particularly region. Trademark bunches for shading NM-1 at expanding repeat are discussed here.

FT-IR spectra for 4,4'-diamino biphenyl stilbene-2,2'-disulphonic corrosive based receptive color NM-1 indicated particular useful gathering tops and translated in figure 3.1. Individual trademark groups for color NM-1 showed up at 3394.74 cm^{-1} is because of N-H extending, 1591.6 cm^{-1} is for N=N extending, 1498.48 cm^{-1} is because of C=C extending, 1395.65 cm^{-1} for -C-N extending, 1042.77 cm^{-1} for -S=O extending (-OSO₃H), 1132.99 cm^{-1} for -SO₂ and 840.08 cm^{-1} is for the presence of substituted benzene ring. The extending and bowing frequencies of trademark practical gatherings are bridged in the table 3.1.

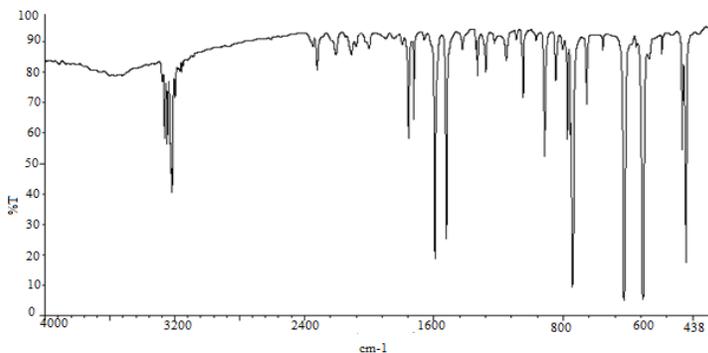


Figure 3.1 FT-IR spectrum of synthesized reactive dye NM-1

Table: 3.1 Stretching and bending frequencies of characteristic functional groups present in dye NM-1.

Characteristic peak (cm^{-1})	Assignment	Functional group
3394.74	NH stretching	-NH-
1591.6	N=N stretching	-N=N-
1498.48	C=C stretching	Aromatic ring
1395.65	-C-N stretching	Triazine ring
1042.77	-S=O stretching	-OSO ₃ H
1132.99	-SO ₂ stretching	-SO ₂
840.08	Substituted benzene rings	Benzene ring

3.2 Utilization of Synthesized Colors by Exhaust Technique

In exhaustion strategy, a picked measure of material is incorporated into the vapor shading machine and with particular shading time, it passes on to agreement with shading course of action. This procedure incorporates osmosis and desorption of hues from shading shower as a result of substantively of the chemicals to the material substrate. Generally, exhaust method is monotonous and require a significant measure of water and imperativeness.

3.3 Aftereffect of Salt Concentration on Exhaust Coloring

Salt is indispensable to assemble the rate and connect of exhaust shading. By using various joinings of salt, the results of shading quality were investigated for two 4,4'-diamino biphenyl stilbene - 2,2'-disulphonic destructive based responsive hues. Salt molecule, for instance, sodium chloride breaks to Na⁺ and Cl⁻ particles in water. Na⁺ particles executes edge between shading iota and fiber particles. It furthermore energizes the rate of exhaustion of shading to cellulosic fiber. Na⁺ particles are connected with water molecules and limit the level of hydrolysis of shading particles. The effect of salt is noted in different obsessions i.e. 2, 4, 6 and 8 g with respect to (%) shading quality qualities to update reaction conditions for two as of late orchestrated cellulosic open hues. The qualities procured for cellulosic materials illuminated most outrageous shading quality (%) in the extent of 70-80 %. The shading quality reductions with increase in salt concentration over the perfect regard. In case we use surplus electrolyte, it may achieve the social event of shading which realizes cutting down the development rate. It prompts unlevel of shading on cellulosic material [12]. 8 g of salt concentration was settled in the exhaustion examination of shading NM-1. The shading quality was enhanced for both the hues. 81.93 % shading quality was noted for shading NM-1. If salt obsession is higher than perfect concentration, it

might realize shading sworn statement on cellulosic material, which provoke uneven shading. In the occasion that salt concentration isn't as much as perfect obsession, it might achieve poor fixation on cellulosic material. Its results for shading showed up in the figure 3.2.

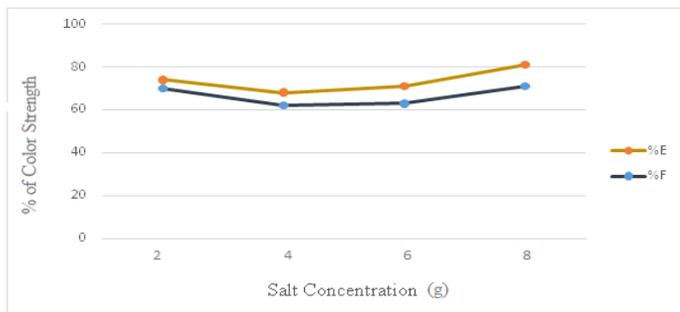


Figure 3.2 Effect of exhaustion (%E) and fixation (%F) values at different salt concentration for dye NM-1.

3.4 Aftereffect of Coloring Time on Shading Quality of Cellulosic Material

In shading process, cellulosic material are toned always with a shading homogeneously to get incredible shade. This technique is passed on in liquid course of action. Time is to a great degree capable parameter for checking consumption and fixation get ready on cellulosic fiber. The exhaust shading method was considered for different time between time i.e. 40, 50, 60 and 70 minutes. Its point was to check most extraordinary shading quality on cellulosic material. The rate of scattering of shading occurs through the shading shower on cellulosic surface and within fiber. The example of exhaustion (% E) and fixation (% F) was enhanced with shading time. The best shading nature of exhaustion for arranged shading NM-1 is 84 %. Occurs got elucidated that 70 minutes of shading method was adequate for most prominent exhaustion rate. It is reality that extra time is imperative for shading to move into within cellulosic material. The shading particles moreover require enough time to join with hydroxyl social affair of cellulosic material [13]. For brief time i.e. 40 minutes, hues address less % exhaustion esteems as balanced with shaded cellulosic material obtained at higher shading time of 70 minutes. Its results for the shading showed up in the figure 3.3.

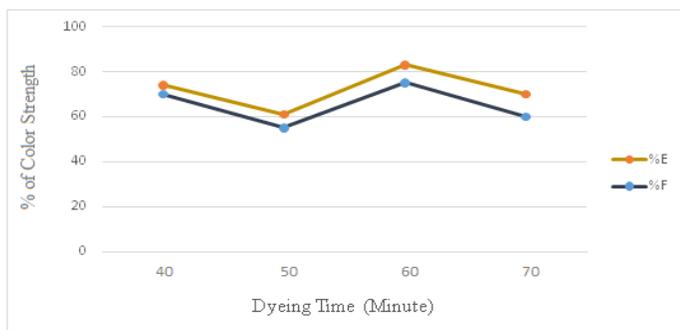


Figure 3.3 Effect of exhaustion (%E) and fixation (%F) values at different dyeing times for dye NM-1.

3.5 Consequence of Temperature on Coloring Procedure

The rate of shading system is affected by temperature of shading

shower course of action. To get perfect exhaustion and shading take-up, it is extraordinarily imperative to check and keep up the shading shower temperature. The temperature of shading method changes from shading to shading for perfect interest and it should be kept up. In the shading methodology, the particles of shading move into the cellulosic fiber. The rate of scattering of shading particles all through substrate increases with increase in temperature of shading shower. It has been watched that when temperature extends, porosity of cellulosic material similarly augments. Thusly, surface scope of cellulosic material redesigns and makes more space for shading molecule to ingest into the substrate i.e. cellulosic material. The going with figure 3.4 exhibits the eventual outcome of shading temperature for two organized responsive hues on cotton material. These examinations were performed on temperatures 50 °C, 60 °C, 70 °C and 80 °C. The vapor shading method was used on cotton material with 2 % shade for both the hues. The % of vapor shading overhauls with increase in shading temperature for mixed open hues. At higher temperature, cotton fiber opens and empowers the shading particles to trade easily. The shading particles are joined to hydroxyl social event of cellulosic cotton material. In this way, shading particles enter the fiber. The % of exhaustion increases with increase in temperature and it is according to engine speculation. Dynamic theory communicates that rate of invention reaction enhances with increase in temperature. The hues used as a piece of this investigation work showed awesome fixation and exhaustion esteems at 70 °C and 80 °C. Both the hues seemed more than 60-70 % exhaustion esteems. The % of fixation was in like manner noted. It was also 60-70 %.

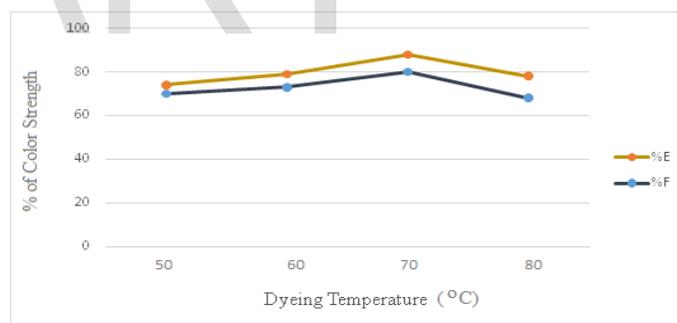


Figure 3.4 Effect of exhaustion (%E) and fixation (%F) values at different dyeing temperature for dye NM-1.

4 Consequences

4,4-diamino biphenyl stilbene - 2,2-disulphonic destructive based open hues (one) were joined by using consecutive walks of development, diazotization and coupling reactions. In these three phases, coupling parts were H-destructive (1-amino-8-hydroxynaphthalene-3,6-disulphonic destructive), J-destructive (6-amino-1-naphthol-3-sulphonic destructive) and gamma-destructive (6-amino-1-naphthol-4-sulphonic destructive) separately. 4,4-diamino biphenyl stilbene - 2,2-disulphonic clusters had been unequivocally annexed as the essential responsive structure for cellulosic materials. The shade of orchestrated hues balanced with acids i.e. with H-destructive are purple and with J-destructive are orange to red. 4,4-diamino biphenyl stilbene - 2,2-disulphonic destructive based responsive hues were picked and coordinated in light of breathtaking shades, splendid speed prop-

erties and sweeping applications. The manufactured structure and a couple of spectroscopic segments of orchestrated azo responsive hues were directed by using methodical procedures like FT-IR resulting to applying physical and compound refinement strategy to the hues. General sufficient subjective concurrences with spectroscopic data were refined.

One of the primary goals of this investigation work was to check particular shading conditions to watch their absorbance affinity towards cotton materials. Both orchestrated hues were associated with 3 % shading game plans on plant scoured, colored and desized cellulosic materials. Their application qualities were moreover thought about. The consumption framework was utilized for shading cotton surfaces. These strategies drive shading molecules inside the surface for better scattering and empties plenitude shading. Significant shades were expert by using exhaustion shading system at fitting shading conditions i.e. 70-80 %. It exhibits that hues set up well on cellulosic surfaces. The level of fixation and exhaustion of both the hues on cotton material was mulled over and get acceptable % E/% F esteems in view of their high substantively. The shading speed imagined by standard dim scale and other physico-blend test, both orchestrated hues were extremely sufficient and better in examination with the related business hues.

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REFERENCES

[1] Khanmohammadi, H. & Erfantalab, M. (2012). Synthesis, characterization and spectroscopic studies of new 1,2,4-triazole based azo-azomethine dyes. *Spectrochimica Acta*, 86, 39-43.

[2] Javaid, M., Saeed, R., Naeem, M., Aleem, M. A., Yasmien, A., Siddiqui, Q. & Iqbal, M. (2013). Dye fixation and decolorization of vinyl sulphone reactive dyes by using dicyanidamide fixer in the presence of ferric chloride. *Journal of Saudi Chemical Society*, 17, 23-28.

[3] Ogugbue, C. & Sawidis, T. (2011). Bioremediation and detoxification of synthetic waste water containing triarylmethone dyes by aeromonas hydrophila isolated from industrial effluent. *Journal of Biotechnology Research International*, 7, 327-335.

[4] Gregory, P. (1986). Structure and carcinogenicity relationship in azo dyes. *Dyes and Pigments*, 7, 45-56.

[5] Pieme, C. A., Penlap, V. N., Ngogang, J. & Costache, M. (2010). In vitro cytotoxicity and antioxidant activities of five medicinal plants of malvaceae family from Cameroon. *Environmental, Toxicological and Pharmacological*, 29, 223-228.

[6] Mahoney, T. O., Guibal, E. & Tobin, M. J. (2002). Reactive dye biosorption by rhizopusarrhizus biomass. *Enzymes and microbial technology*, 31, 456-463.

[7] Georgiou, D., Melidis, P., Aivasidis, A. & Gimouhopoulos, K. (2002). Degradation of azo reactive dyes by ultraviolet radiation in the presence of hydrogen peroxide. *Dyes and Pigments*, 52, 69-78.

[8] Patel, D. R. & Patel, K. C. (2011). Synthesis and characterization of reactive dyes based on 2-phenyl -3- [4-(4-aminophenyl sulphonamido)] phenyl-4-(3H)-quinazolinone-6-sulphonic acid. *Arab Journal of Chemistry*, 4, 279-285.

[9] Patrick, L. G. F. & Whiting, A. (2002). Synthesis and application of some polycondensable fluorescent dyes. *Dyes and Pigments*, 52, 137-143.

[10] Patel, H. M. & Dixit, B. C. (2011). Synthesis, characterization and dyeing assessment of novel acid azo dyes and mordent acid azo dyes based on 2-hydroxy-4-methoxybenzophenone-5-sulfonic acid on wool and silk fabrics. *Journal of Saudi Chemical Society*, 77, 1551-1560.

[11] Gu, Y., Song, P., Li, T. & Sui, W. (2011). Synthesis and characterization of carboxymethyl polyamine chitosan and its adsorption behaviour toward reactive dye. *Carbohydrate Research*, 346, 769-774.

[12] Bello, K. A., Ezeribe, A. I., Adamu, H. M., Boryo, D. E. A. & Omar, P. G. (2013). Synthesis and dyeing properties of novel bifunctional reactive dyes via 4-(4-nitrophenyl)-1,3-thiazole-2-amine,4-(4methylphenyl)-1,3-thiazol-2-amine and H-acid on nylon fabrics. *The International Journal of Engineering and Science*, 2, 28-36.

[13] Jiang, L. & Zhu, Z. (1998). Studies of synthesis and application properties on new reactive dyes having two vinyl sulfone groups. *Dyes and Pigments*, 36, 347-354.

[14] Lewis, D. M., Renfrew, A. H. & Siddique, A. A. (2000). The synthesis and application of a new reactive dye based on disulfide bis ethylsulfone. *Dyes and Pigments*, 47, 151-167.