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Synthesis and Assessment of New Azo Reactive Dyes Based From Quinazolinone and their Application on Cotton Fabric

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Abstract

New monoazo reactive dyes with quinazolinone moiety was synthesized starting with the preparation of 6,7-dimethoxy-2-phenyl-4H-benzo[d][1,3]oxazin-4-one from 2-amino-4,5-dimethoxybenzoic acid and fusing with different di-amino compounds to give dye intermediates B, 4-amino-4'-(6,7-dimethoxy-4-oxo-2-phenylquinazolin-3(4H)-yl)-[1,1'-biphenyl]-2,2'-disulfonic acid (B), which was diazotized, followed by azo coupling with various cyanurated coupling components such as H-acid, gamma acid and J-acid. All the reactive dyes were characterized by their percentage yield, UV-Vis spectroscopy, IR spectroscopy and dyeing performance on cotton fabric have been assessed. The UV-visible spectrophotometric investigation of the synthesized dyes was carried out in different solvents to obtain the absorption maxima, molar coefficients and solvatochromic effects of the dyes. The synthesized reactive dyes were applied on cotton and the percentage exhaustion and fixation of the dyes were evaluated and usage properties of the dyes also examined. The percentage of dye bath exhaustion on the fibre is reasonably good and acceptable. The dyeing performance of all dyes on cotton fabric gave moderate to good light fastness, good to very good wash fastness and fair to very good fastness to perspiration – acid and alkaline. The dyes gave colour ranges from purple to red to pink shade. The successful synthesis and application of these novel quinazolinone-based azo reactive dyes demonstrate their promising potential for vibrant, durable cotton dyeing, paving the way for more efficient and eco-friendly textile coloration methods.

Key words: Reactive Dyes, Synthesis, Diazotization, Cotton, Fastness properties

Introduction

Reactive dyes are coloured compounds which contain one or two groups capable of further establishing covalent bond between carbon phosphorus atom of the dyes and oxygen, nitrogen or sulphur atom of the substrate [1]. These dues are commonly applied on expensive clothes which are generally mercerized [2]. Reactive dyes, though a late entry into the field of synthetic dyes, have immediately achieved a commercial status due to their brilliancy, variety of hues, high wet fastness, convenient handling and high applicability. Such covalent bonds are formed with the hydroxyl group of the protein fibre and with the amino groups of polyamides [3].

Reactive dyes are anionic compounds soluble in water due to the presence of the sulfonic group in the molecule as diazonium salts. Due to the presence of reactive group, they are covalently fixed to textile fibres macromolecules on which they are applied forming etheric, thiothermic, aminic or amidic bonds. After dyeing, the dye molecules and the textile macromolecules from uniquely coloured molecules with very good resistances to wet treatment [4]. Reactive dyes though late entrant into the field of synthetic dyes, very soon attained a commercial status. Several new reactive systems have been introduced from time to time which covers the subject of innumerable patents and publication. current reactive dyes utilized a chromophore, which is attached to a reactive group that will covalently bond to an appropriate chemical moiety on the polymer backbone of the substrate. To increase the exhaustion reactive dyes to substrate, large amount of salt (NaCl) are added. The salt helps to mask the inherent negative charge on the substrate and aid in adsorption of substrate. Traditional dyeing recipes 50-80 g/L of salt and considerable amount of times, energy and money are spent to remove the salt through water treatment, the salt will be in plant effluent.

Globally, 2.7 billion grammes of salt are discharge from reactive dye baths annually [5] all of which is detrimental to plant and animal life. Azo dyes containing formyl functional group on aryl rings have attained commercial importance for dyeing of textile substrate. However, anionic dyes containing formyl group have been examined as potential reactive dyes for polyamides fibres. The reactive between the aldehyde function and the fibric considered to be the formation of Schiffs base kind of reaction involving the free amino group contained in the wool of keratin. It is further mentioned that various types of functional groups in the wool keratin including amino, thio, quadine, thiol carboxylic acid and phenolic groups are capable of participating in reaction with two neighbouring like side chain of the wool keratin, it is possible for new crosslinks to be formed.

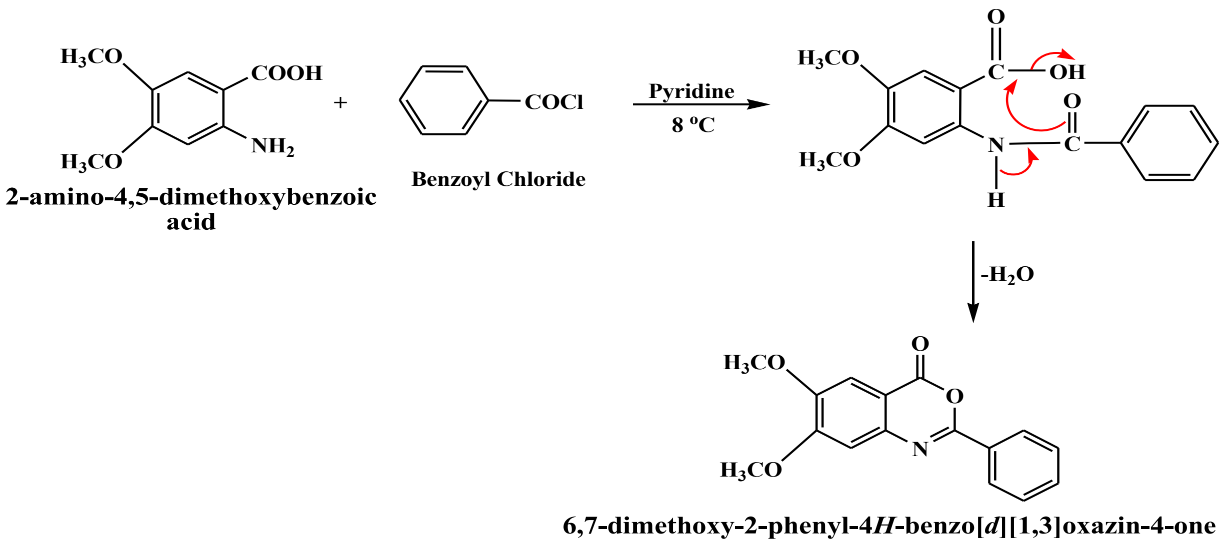
Thus, the dye is not held on the fibre by electrostatic interactions between the ionic centers of the polyamide and the dye but also by a strong covalent bond between the dye and the fibres well as possible crosslink [6]. In recent years, reactive dyes have been most commonly used due to their advantages such as better dyeing processing condition and bright colours. Moreover, the use of reactive dyes is rapidly growing due to the increase use of cellulose fibres. Generally, reactive dyes contain functional group such as azo, anthraquinone, phthaloccyanine, formazin and oxazine as chromophore. The research is aim at synthesis and characterization of some mono azo reactive dyes derive from quinazolinone and their application on cotton fabric. The diazotization of the synthesized quinazolinone intermediates followed by coupling with various cyanurated acid coupling components gave corresponding monoazo reactive dyes. These dyes gave a wide range of fast shades like purple, orange and pink shade on cotton fabric. This type of dye synthesis is generally convenient and economical for use. The dyeing performance of all dyes on cotton fabric gave moderate to good light fastness, good to excellent wash fastness and moderate to good fastness to perspiration – acid and alkaline.

Materials and Methods

All commercial products were purchased from Sigma-Aldrich. Melting points were determined by the open capillary method using the Gallenkamp melting apparatus. The visible absorption spectra were measured using Agilent CARY 300 UV/Vis spectrophotometer; IR was measured and recorded in KBr pellets using the Agilent CARY 630 Fourier Transform Infra-red Spectrometer.

Synthesis of 6,7-dimethoxy-2-phenyl-4H-benzo[d][1,3]oxazin-4-one [8]

2-amino-4,5-dimethoxybenzoic acid (39.41g, 0.2mol) was dissolved in pyridine (100 ml) and stirred. Thereafter, benzoyl chloride (23.22 ml, 0.2mol) was added dropwise with constant stirring to the solution, maintaining the temperature near 0-5°C for one hour. The reaction mixture was stirred for another one hour at room temperature until a solid product was obtained. At the end of the reaction, the solid mass obtained was filtered, washed successively with saturated sodium bicarbonate solution, to remove unreacted acid, and finally washed with water, dried and recrystallized from pure ethanol. The percentage yield was calculated and the melting point determined.

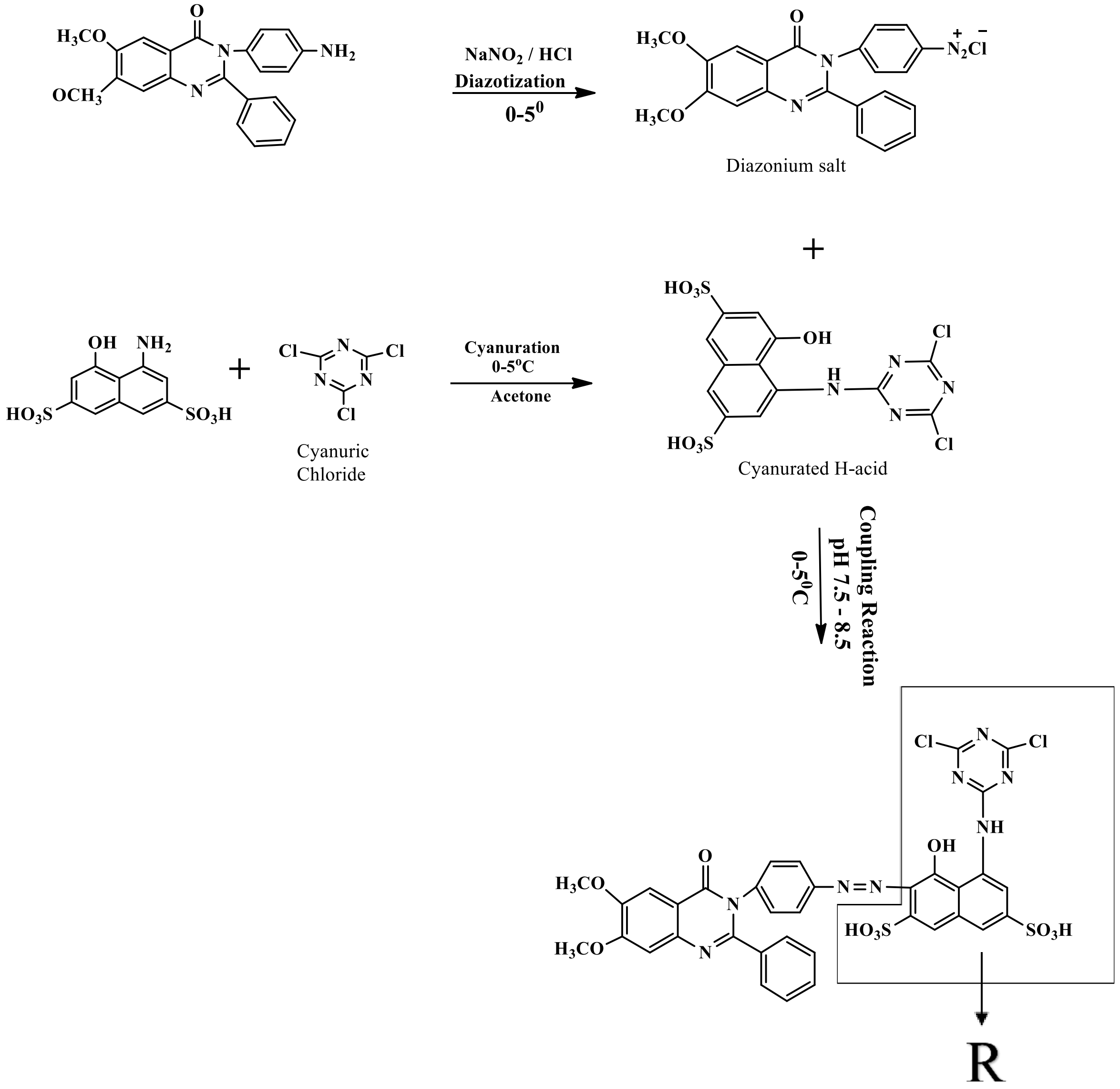


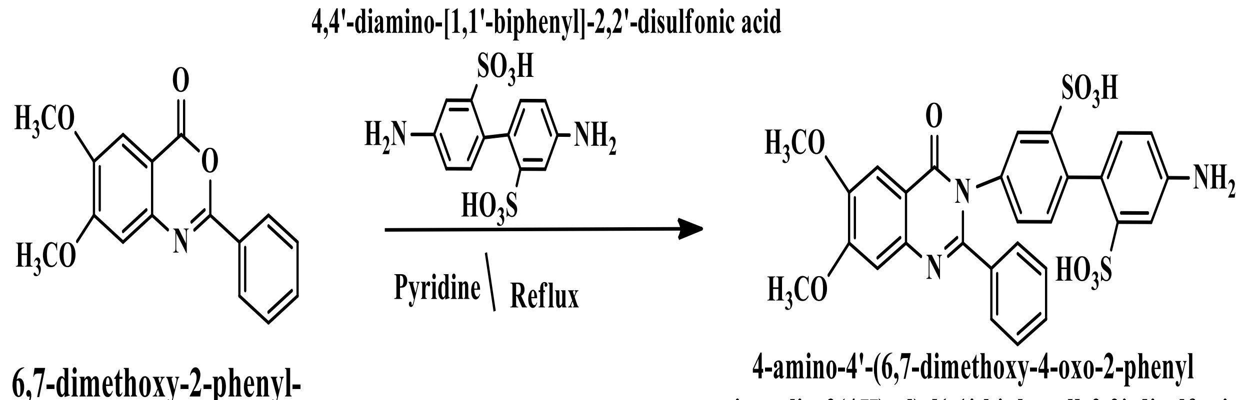
Synthesis of the dye intermediate : 4-amino-4'-(6,7-dimethoxy-4-oxo-2-phenylquinazolin-3(4H)-yl)-[1,1'-biphenyl]-2,2'-disulfonic acid [8]

4-amino-4'-(6,7-dimethoxy-4-oxo-2-phenylquinazolin-3(4H)-yl)-[1,1'-biphenyl]-2,2'-disulfonic acid (3.05g, 0.005mol) was dissolved in water (60 ml), and hydrochloric acid (20 ml, 0.015 mol) was added dropwise to the suspension formed and stirred thereafter it was gradually heated up to till a clear solution was formed and then the solution was cooled to 0–5°C in an ice bath. A solution of $NaNO_2$ (0.6 g) in water (4 ml) previously cooled to 0°C, was added for 5 min with stirring. The stirring also was continued for an hour, maintaining the same temperature, for diazotization to occur. A clear diazo solution 'B' at 0– 5°C was obtained and used for the subsequent coupling reaction.

Diazotization of the Intermediates B [8]

3-(4-aminophenyl)-6,7-dimethoxy-2-phenylquinazolin-4(3*H*)-one (Intermediate B) (0.75g, 0.002mol) was dissolved in water (60 ml), and hydrochloric acid (10 ml, 0.008 mol) was added dropwise to the suspension formed and stirred, thereafter it was gradually heated up to form a clear solution and then the solution was cooled to 0–5°C in an ice bath. A solution of $NaNO_2$ (0.6 g) in water (4 ml) previously cooled to 0°C, was added for 5 min with stirring. The stirring also was continued for an hour, maintaining the same temperature, for diazotization to occur. A clear diazo solution of 'B' at 0– 5°C was obtained and used for the subsequent coupling reaction.





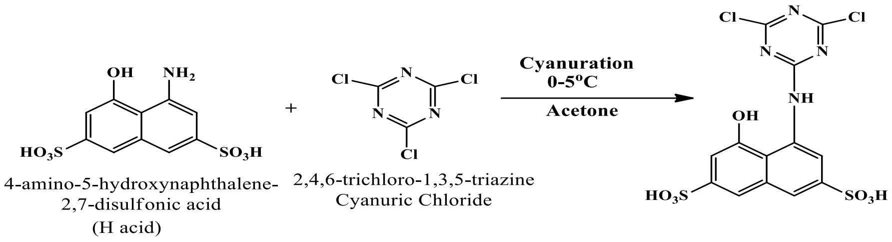
6,7-dimethoxy-2-phenyl-4*H*-benzo[*d*][1,3]oxazin-4-one

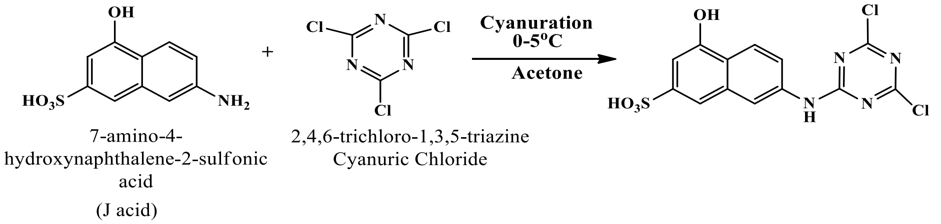
4-amino-4'-(6,7-dimethoxy-4-oxo-2-phenyl quinazolin-3(4*H*)-yl)-[1,1'-biphenyl]-2,2'-disulfonic acid

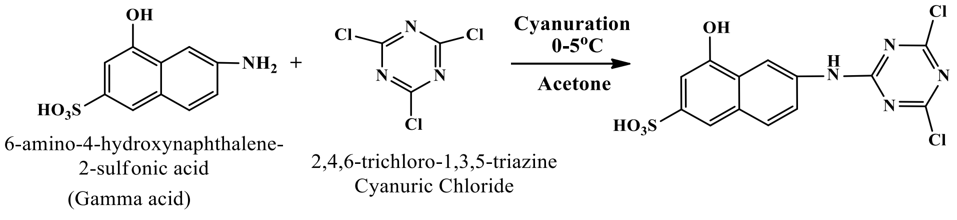
Synthesis of coupling components [9]

H-acid (3.19 g, 0.01mol) was dissolved in water (15 ml) at pH 7.5, using 20% (w/v) Na_2CO_3. A solution of cyanuric chloride (1.85 g, 0.01mol) was stirred in acetone (25 ml) at a temperature of 0-5°C and was added dropwise to the stirred H-acid solution at 0-5°C. After 10 min, the solution was adjusted to a neutral pH by adding 20% (w/v) Na_2CO_3, and the reaction was continued for about 4 hours at 0-5°C to obtain a clear solution. The cyanurated H-acid solution thus obtained was used for coupling reaction

The same procedure and condition were used for other coupling components; J-acid and Gamma acid.







Purification of the Dyes

The dyes were purified through the same process of recrystallization as highlighted above for the intermediates. Some of the dyes required the mixed solvent of ethanol, methanol /DMF (9/1 solvent mixture) according to a procedure suggested by Karci [12]. The purity of each synthesized dyes were confirmed by melting point.

Percentage Yield of Dyes and Intermediates [13]

The percentage yield of the synthesized dyes and intermediates were determined using the formula shown below [13].

$$\%\text{Yield} = \frac{MP}{MMP} \div \frac{MR}{MMR} \times 100 \text{ ------(Eqn 1)}$$

Where:

MP is the mass of the product
MMP is the molar mass of the product
MR is the mass of the reactant
MMR is the molar mass of the reactant

Melting point of the dyes

The melting point of each dye was determined using Gallenkamp melting apparatus. Small amount of each dye was filled into a capillary tube each placed in to the apparatus, the melting point of each dye was obtained by consistently focusing on the apparatus as the apparatus gradually heat the dye in the tube where the melting point is obtained.

Dyeing of cotton Fabric

The fabric was introduced into the dyebath at 30°C and the temperature was raised to 70°C, over 30 min. at 2°C/min, as soda ash (Na_2CO_3) solution (10% v/v) was be added to bring about fixation and the dyeing will be continued for 50 min more at the same temperature. The material was then removed, rinsed with cold water and dried.[10]

Application of dyes solution

A solution was prepared by dissolving about 1g of dried dye powder in 100 mls of distilled water. To determine the qualities required for the experiment the following prameter was utilized.

Number of ml of stock solution required

$$= \frac{W \times P}{C} \text{ --------------------------(Eqn 2)}$$

Where W = weight (in grams) of sample to be dyed

P = percentage of dye to be used

C = concentration (%) of stock solution [12].

General procedure of dyeing chrome tanned leather

1 % of dye (on weight of the materials)
50 + 2°C dyeing temperature
0.1 % of formic acid on weight of the dye
Time of dyeing: one hour
Liquor ratio 20:1

Determination of dye bath exhaustion

Dye uptake was determined by measuring the absorbance of diluted dye bath samples at the wavelength of the maximum absorption. The bath was sampled before and after dyeing. A 1ml aliquot was taken from the bath and diluted in 20ml of distilled water. This is to ensure that the absorbance falls within the readable range of 1.5. The percentage dye bath exhaustion (%E) for each substrate was calculated using the equation below [13].

$$\% E = \frac{A_o - A_1}{A_o} \times 100 \text{ ------------(Eqn 3)}$$

Where A_o and A_1 are the absorbance at λ_{max} of the dye bath prior to dyeing and after dyeing respectively.

Determination of dyed fixation and fixation efficiency

The term fixation ratio refers to the radio of the amount of dye absorbed (which is covalently bonded to the fibre) to the hydrolyzed dye on the surface of the surface.

Percentage fixation = $\frac{OD_1-OD_2-OD_3}{OD_{1-OD_2}} \times 100$ ---------------------------------(Eqn 4)

Where OD_1 = optical density of the dye before dyeing

OD_2 = optical density of the dye after dyeing

OD_3 = optical density after stripped

Each dyed fabric was stripped in a 25% (w/w) pyridine in water solution (100 ° C IR 10:1) for 30 minutes and the part of the solution was taken to the spectrophotometer to give OD_3; the optical density after stripping.

Optical overall fixation efficiency value (T) is related to the original amount of dye applied. A simple relationship exist between % T % F, and % E (dye bath exhaustion) given by:[14]

% T = $\frac{\% F \times \% E}{100}$ -------------------(Eqn 5)

Light fastness of dyed substrates (Fastness to Sunlight) SLT 401 (IUF 401)

This test was carried out in accordance with the Society of Leather Technology and Chemists . The test is carried out on the dyed samples under daylight facing south sloping at an angle 45° from the horizontal. The procedures involved aligning both the eight dyed wool standards together with a. 2 cm x 2cm cut pieces of the dyed samples on a card and covering one third of the setup with opaque cover.

Exposure is carried with regular inspection noting when the non-exposed part and exposed part of each dyed sample had contrast equivalent to grade 4 of ISO grey scale after which and opaque cover was placed covering part of the exposed sample part, exposure was continued till the blue standard 7 faded. The rating of the dyed samples is taken to be those equivalents to- that of standard dyed blue wool samples, which faded to the same extent as the specimen at the same time

Wash fastness of the dyed substrates

This is to assess the leather resistance to prolong action of water. 2 x 2 cm of the dyed leather was dipped into solution made by 5 g (0.5 %) of detergent powder into 200 cm^3 of distilled water. This was placed in water bath and the temperature allowed to rise to 40 ºC. This was vigorously stirred for about 30 min and the leather was transferred to 100 cm^3 distilled water for washing and rinsing was done five times and dried. The change in colour was assessed by the blue wool scale.

Fastness to Perspiration

This test measures the resistance of the colour of textile fabrics of all kinds to perspiration in all forms. Perspiration was carried out under acidic and alkaline solutions.

Acidic solution: Sodium chloride (NaCl 5 g/l), disodium hydrogen orthophosphate dehydrate ($Na_2HPO_4.2H_2O$ 2.5 g/L), histidine monohydrochloride monohydrate ($C_6H_9O_2N_3HCl.H_2O$ 0.5g/L), brought to pH 5.5 with 0.1N sodium hydroxide (NaOH) in a liquor ratio of 20:1.

Alkaline solution: Sodium chloride (NaCl 5 g/l), disodium hydrogen orthophosphate dehydrate ($Na_2HPO_4.2H_2O$ 2.5g/L), histidine monohydrochloride monohydrate ($C_6H_9O_2N_3HCl.H_2O$ 0.5 g/L), brought to pH 8 with 0.1N sodium hydroxide (NaOH) in a liquor ratio of 20:1

Procedure:

A composite sample was made by sand witching the dyed sample measuring (5x5) cm between two pieces of un-dyed bleached cotton fabric measuring (5x5) cm. The composite specimen was thoroughly wetted in this solution (acidic and alkaline) at room temperature for 30mins. At the end of 30mins, the composite specimen was removed from the solution and the composite sample placed between two glasses plates measuring about 7.5 x 6.5 cm under a force of about 4.5 kg. The apparatus containing the treated composites was then placed in a perpirometer at 37 + 2°C for 4 hours. After 4 hours, the specimens were removed from the perspirometer and dried at room temperature. The change in colour of the specimen and the staining of the white cloth were assessed using greyscale.

Results and Discussion

Table 1: Physical properties of the intermediates

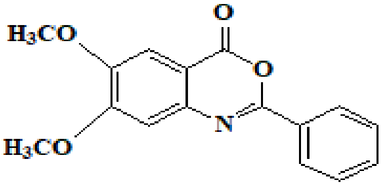
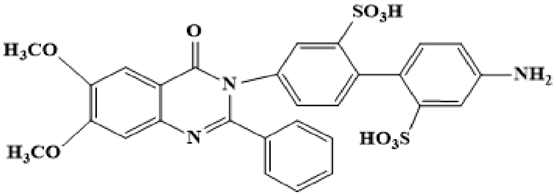
Intermediates	Structures	Molecular Formulae	Molecular Weight (g/mol)	Melting Point °C	Yield %
3[H]		$C_{16}H_{13}NO_4$	283	225-227	78
X		$C_{28}H_{23}N_3S_2O_9$	609	235-237	55

Table 2: FT-IR spectra of the intermediates

Intermediate	FT-IR (KBr) : $v\ (cm^{-1})$
3[H]	1751 (C=O), 1612 (C=N), (C-O-C), 3071 (C-H), 1273 (C-O)
X	1612 (C=O), 1512 (C=N), 1388 (S=O), 3363 (N-H), 3140 (C-H), 1157 (C-O)

The various dyes 1X, 2X, and 3X were successfully synthesized using diazotization and coupling reaction and the structures and properties are shown below in **Table 3.**

Table 3: Synthesised dyes structures

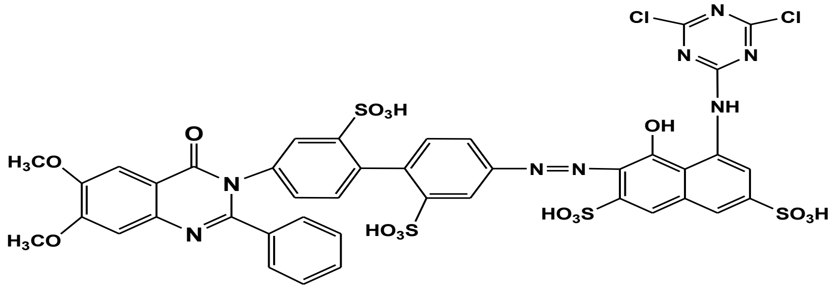
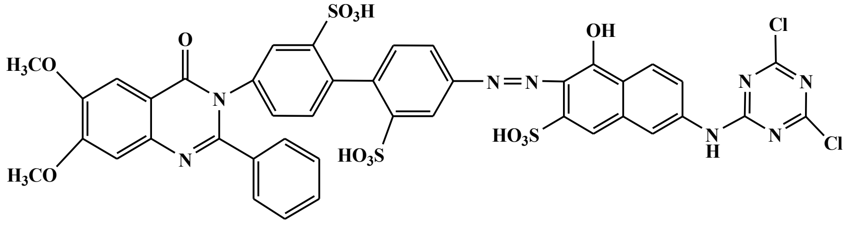
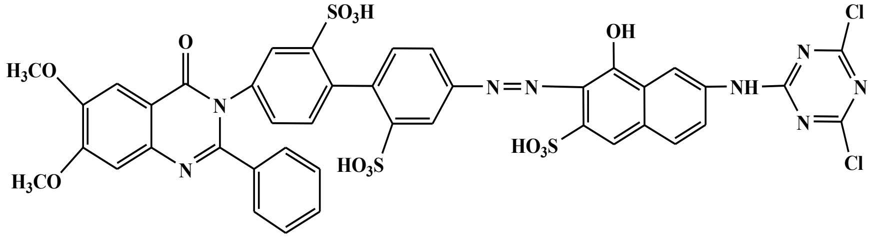
1X	
2X	
3X	

Table 4: Physical properties of synthesize dyes

Dyes	Molecular Formulae	Molecular Weight (g/mol)	Melting Point °C	Yield %	Physical Appearance (Colour)
1X	$C_{41}H_{28}N_8S_4Cl_2O_{16}$	1087	319-321	80	Light pink
2X	$C_{41}H_{28}N_8S_3Cl_2O_{13}$	1007	340-344	74	Deep pink
3X	$C_{41}H_{28}N_8S_3Cl_2O_{13}$	1007	278-280	65	Deep pink

Table 5: FT-IR spectra of the dyes

Dye No.	FT-IR (KBr): $v\ (cm^{-1})$
1X	1728 (C=O), 1451 (-N=N-), 3449 (O-H), 1211 (C-N), 3279 (N-H), 1371 (S=O), 3055, 2924 (C-H aromatic, aliphatic), 864 (C-Cl)
2X	1735 (C=O), 1450 (-N=N-), 3557 (O-H), 1203 (C-N), 3271 (N-H), 1342 (S=O), 3047, 2924 (C-H aromatic, aliphatic), 840 (C-Cl)
3X	1743 (C=O), 1450 (-N=N-), 3518 (O-H), 1204 (C-N), 3279 (N-H), 1327, 1126 (S=O), 3048, 2768 (C-H aromatic, aliphatic), 880 (C-Cl)

Table 6: The wavelength of maximum absorption and Molar extinction coefficient of the dyes

Dye No.	$\varepsilon_{max}\ in\ DMF \times 10^4 lmol^{-1}cm^{-1}$	H_2O λ_{max}(nm)	DMF λ_{max}(nm)	Methanol λ_{max}(nm) a	Methanol + HCl λ_{max}(nm) b	Change in λ_{max}(nm) (b-a)
1X	0.62	535	531	532	536	+4
2X	1.14	495	496	487	495	+8
3B	1.06	508	506	494	508	+14

Table 7: Exhaustion and fixation of reactive dyes on cotton

Dyes	Colour	Exhaustion (%)	Fixation (%)
1X	Light pink	86	70
2X	Deep pink	89	75
3X	Deep pink	87	73

Table 8: Fastness properties of the synthesized dyes

Dyes	Washing Fastness		Light Fastness	Fastness to Perspiration	
	Colour change	staining		[Acid]	[Alkaline]
1X	3-4	4	3	3	4
2X	4	4	4	4	3
3X	3-4	4	4	3	4

Synthesis of 6,7-dimethoxy-2-phenyl-4*H*-benzo[*d*][1,3]oxaxin-4-one

2-amino-4,5-dimethoxybenzoic acid was dissolved in pyridine and reacted with benzoyl chloride at a temperature near 0-5°C to obtain a white solid product after recrystallization. The yield and melting point was 78%, and 225-227°C respectively. The infra-red (IR λ_{max} cm^{-1} Appendix A1) spectrum shows absorption at 1751 this is due to the C=O stretch. The signal at 1612 indicates C=N stretch. The signal at 3071 is attributed to the C-H stretch. The signal 1273 shows the (C-O) stretch, as shown in Table 1.

Synthesis of dye intermediate (B); 4-amino-4'-(6,7-dimethoxy-4-oxo-2-phenylquinazolin-3(4H)-yl)-[1,1'-biphenyl]-2,2'-disulfonic acid

4,4'-diamino-[1,1'-biphenyl]-2,2'-disulfonic acid and 6,7-dimethoxy-2-phenyl-4H benzo[d][1,3]oxazin-4-one was dissolved in pyridine and heated under reflux to give an off white solid product after recrystallization. The yield and melting point was 55% and 235-237°C respectively. The infra-red (IR $vmax\ cm^{-1}$ Appendix A3) spectrum shows absorption at 1612 which is responsible for C=O stretch. The signal at 1512 is due to the C=N stretch. The signal at 1388 indicates S=O stretch. The signal at 3363 is attributed to the N-H stretch. The signal at 3140 is due to the C-H stretch. The signal 1157 indicates the C-O stretch, as shown in Table 1.

Synthesis of dye 1X

4-amino-4'-(6,7-dimethoxy-4-oxo-2-phenylquinazolin-3(4H)-yl)-[1,1'-biphenyl]-2,2'-disulfonic acid was diazotized and coupled with cyanurated H-acid to give light pink dye **1B**. The yield and melting point was 80% and 319°C

The infra-red (IR $vmax\ cm^{-1}$ Appendix A8) spectrum shows absorption at 1728 which indicate C=O stretch. The signal 1451 is responsible for -N=N- stretch. Signal 3449 indicate O-H stretch. The signal at 1211 is due to the C-N stretch. The signal 3279 is attributed to the N-H stretch. The signal at 1371 is due to the S=O stretch. The signal at 3055 and 2924 indicate C-H stretch for aromatic and aliphatic. The signal 864 is due to the C-Cl stretch as shown on Table 1.3.

Synthesis of dye 2X

4-amino-4'-(6,7-dimethoxy-4-oxo-2-phenylquinazolin-3(4H)-yl)-[1,1'-biphenyl]-2,2'-disulfonic acid was diazotized and coupled with cyanurated J-acid to give deep pink dye **2B**. The yield and melting point was 74% and 340-344°C.

The infra-red (IR $vmax\,cm^{-1}$ Appendix A9) spectrum shows absorption at 3047 and 2924 which is due to C-H stretch for aromatic and aliphatic. The signal at 1735 indicates the presence of a C=O stretch. The signal at 1450 is due to -N=N- stretch. The signal at 3557 is responsible for the O-H stretch. The signal at 1203 and 3271 indicate C-N and N-H stretch. The signal at 1342 is due to the S=O stretch. The signal 840 indicate a C-Cl stretch. as shown on Table 1.3

Synthesis of dye 3X

4-amino-4'-(6,7-dimethoxy-4-oxo-2-phenylquinazolin-3(4H)-yl)-[1,1'-biphenyl]-2,2'-disulfonic acid was diazotized and coupled with cyanurated Gamma-acid to give deep pink dye **3B**. The yield and melting point was 65% and 278-280°C

The infra-red (IR $vmax\,cm^{-1}$ Appendix A10) spectrum shows absorption at 1743 which is due to C=O stretch. The signal at 1450 indicates -N=N- stretch. The signal at 3518 is responsible for the O-H stretch. The signal 1204 is due to the C-N stretch. The signal 3279 is attributed to the N-H stretch. The signal 1327 and 1126 indicate S=O stretch. The signal at 3048 and 2768 correspond to the C-H stretch for aromatic and aliphatic. The signal at 880 is due to the C-Cl stretch. as shown on Table 3

Visible Absorption Spectra and Molar Extinction Coefficient of the Dyes

Absorbance is the measure of the amount of light absorbed. The visible absorption properties were measured in water, dimethylformamide (DMF) methanol and methanol+HCl. The result is summarized in Table 1.6. The colour of the reactive monoazo dyes depends on the nature of both the diazo and coupling component. The wavelength of the maximum absorption of the quinazolinone based dyes ranges from 470 – 540 in water, 460 – 550 in DMF, 470 – 540 in Methanol and 490 – 540 in Methanol+HCl.

The molar extinction coefficient (ε) of the dyes was calculated based on the concentration in dimethylformamide (DMF) as a solvent and are also listed in Table 6.

The λ_{max} shifts in solvents are brought about by the solvatochromic effect resulting from changes in the dielectric constant of the solvent. The measurement of λ_{max} in methanol, water and DMF showed that the λ_{max} of the intramolecular charge transfer bonds exhibits a marked redshift on transfer from non-polar to polar solvent. This behaviour indicates that the polar excited states of the synthesised dyes are stabilized by polarization interaction forces as the polarizability of the solvent is increased.

Solvent effect on the UV-Vis spectra (Solvatochromism)

Solvatochromism is due to various solute-solvent interactions in both the ground state and the excited states. Effect of solvent polarity on the maximum absorption wavelength of dyes i.e. the ability of a chemical substance to change colour due to change in solvent polarity was studied. With the increasing polarity of the solvent, the absorption maximum is shifted to a longer wavelength [11].

The bathochromic shift observed on changing to a more polar solvent suggests that the dye molecule has a more polar excited state than the ground state and this will lower the energy of the transition. The energy difference between the ground and the excited states is reduced leading to a bathochromic shift of the visible band. On the other hand, those dyes with hypsochromic shift (negative solvatochromism) mean that the dyes molecules have a more polar ground state than the excited state.

And when 0.1 M HCl was added to the dye solution in methanol, dye 1B and 3B showed a bathochromic shift (positive halochromism). This showed that these dyes exist in the cationic form in an acidic methanolic solution. Dyes 2B show negative halochromisn on the effects of acids in the dye solution in methanol, this may be due to an electron-withdrawing strength of the substituent, if the electron-withdrawing strength of the substituent is sufficiently high, negative halochromism can be observed.

Wash fastness properties

Coloured fabric must withstand condition which it may encounter during processing following colouration and their subsequent daily use. If the dye is not covalently bonded to the fabric, it may be lost during washing. Wash fastness properties of the synthesized dyes were generally moderate to very good for all dyes, as all the dyes fall between 3-5 as shown in Table 8. This is because the dyes containing reactive groups are compatible with the fibre and were covalently bonded with the reactive sites in the fibre. The fastness rating of 4, 4-5 shows that the binding forces between the dye and the fibre are secure. This means the formation of a covalent bond between the reactive sites in the dye and the fibre is relatively strong as there is little or no staining on the adjacent fabric. However, some exhibited good to moderate values of 3, 3-4 an adjacent fabric due to poor uptake of the dye into the fibre [14].

Fastness to light

Light fastness is the resistance of dyes to the effect of sun, heat and light energy. The light fastness was fair, moderate to fairly good, as value ranges from 3-5 for all the dyes applied on cotton as seen in Table 8. The poor light fastness of 3 may be due to the poor planarity of the dyes. Many factors can affect light fastness, some of them are depth of shade, the presence of foreign substances and inherent photo-stability of the dye chromophore and how this stability is affected by the chemical nature of the fabric.

Generally, reactive dyes have moderate resistance to light. Also, darker depths of shades show good resistance to light whereas brighter/lighter shades of dyes show poor resistance to light. The electron mobility of brighter shades dyes is high and so the electrons can easily move to the excited state causing breakage in the chromophore system of the dye which results in fading. Generally, factors that affect the colour fastness of textiles are internal and external. Internal factors may include the dye and the fibre type while external factors are products imposed by external forces or conditions [12].

Fastness to perspiration

The perspiration produced by the human body is a chemical fluid that can have adverse effects on a coloured fabric in regular contact with it. All perspiration contains common salt which can affect some dyes but can vary in acidity or alkalinity according to a particular individual (S.D.C, 1991). Two chemical solutions which approximate human perspiration was used, one being slightly acidic and the other being slightly alkaline [13]. The fastness to perspiration carried out in both acidic and alkaline solutions of histidine is summarized in Table 1.8. All the dyes had a very good fastness to perspiration of values between 3-5.This result shows that the dyed cotton samples had good fastness to perspiration in alkaline than in acid medium.

Conclusion

The diazotization of the synthesized quinazolinone intermediates followed by coupling with various cyanurated acid coupling components gave corresponding monoazo reactive dyes. These dyes gave a wide range of fast shades like purple, orange and pink shade on cotton fabric. This type of dye synthesis is generally convenient and economical for use. The dyeing performance of all dyes on cotton fabric gave moderate to good light fastness, good to excellent wash fastness and moderate to good fastness to perspiration – acid and alkaline.

The presence of the triazine group of the dye molecule improves the exhaustion, fixation and fastness properties. Thus, the exhaustion and fixation of these dyes are very good; this indicates that the dyes have good affinity and solubility with the fabric. The remarkable degree of levelness and brightness after washing indicates the good penetration and affinity of these dyes to the fabric. The colour difference may be attributed to both the nature and position of the substituent. The dyes gave a satisfactory performance for percentage exhaustion and fixation on cotton fabric. The fastness properties to washing, fastness properties to light and fastness properties to perspiration – acid and alkaline of the dyes on cotton showed good to excellent performance The remarkable degree of levelness after washing indicates the good penetration and affinity of these dyes to the various fabrics.

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