Review Article

Coupling Reactions of Aryldiazonium Salt. Part-XI: Review on Coupling of Aryldiazonium Salts of Aminobenzothiazoles with Aromatic and Heterocyclic Components.

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ABSTRACT

The azo compounds synthesized from substituted 2-aminobenzothiazoles were scientifically significant for sensor, nano chemistry and pharmaceutically useful applications. Azo-dyes were very important and useful class of synthetic organic compounds, that have a huge variety of applications.

Keywords: 2-Aminobenzothiazole, azo dyes, diazotization, coupling, Biological Activity.

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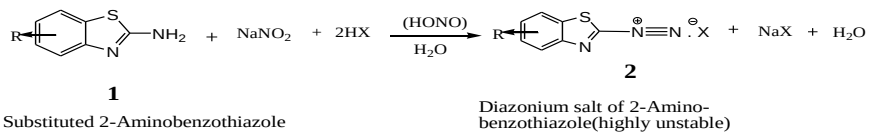
INTRODUCTION

Azo compounds have good fastness and high dyeing properties, also wide applications such as dyeing of textile fibers, cosmetics, plastics, paper, leather and bio-medical studies. Azo compounds were synthesized from aminobenzothiazole and different aromatic or heteroaromatic anilines or phenols. Azo class of compounds or dyes were peculiarly characterized by analysis of the azo group (–N=N–) in their skeleton with aromatic or hetero-aromatic systems. The physio-chemical properties and biological activities makes them useful in variety of applications and in analytical field.

Since, their discovery in 1858[1] many protruding named reactions associated with diazonium salts of arene moiety and have evolved throughout development of one century plus. In 1884, Sandmeyer found out that by treating with copper chloride, benzene diazonium salt was converted into chlorobenzene[2]. The azo compounds are also valuable in the pharmaceutical and medicinal fields[3] and possibly the azo-imine linkage would be accountable for biological activities showed by some Schiff bases as reported[4]. Preparation of most of the azo compounds includes diazotization of a primary (aromatic or heteroaromatic) amine, along with by coupling with coupling agents[5] viz. pentane-2,4-dione (or acetylacetone)[6], phenols[7-11].

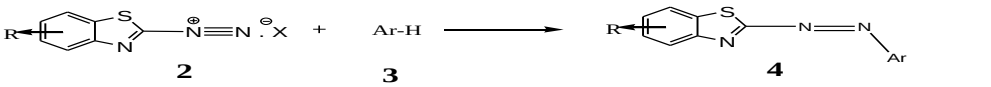
Literature shows studies on the derivatives in order to explain the newer aptitudes of similar type of compounds. Sometimes azo compounds are frequently described as a chromogen in the literature[11]. The hydroxy[7-11] or amino-[12] groups are common functional group of organic compounds used as coupling agents[13]. The appearance of various classes of synthetic dyes[14] containing azo dyes occurred due to constant effort. Recently, from our laboratory a review is published[15] pertaining to the reaction of varied diazonium salt with salicylic acid and phenolic compounds, coupling reactions of aryldiazonium salt of various substituted 2-aminobenzothiazoles with Aromatic or Heteroaromatic mofits formed azo dyes[16], the diazotization proceeds with easy processes and ecologically benign situations with high yields of the products[17].



1
Substituted 2-Aminobenzothiazole

2
Diazonium salt of 2-Amino-benzothiazole(highly unstable)

Scheme 1: Typical reaction Mechanism of Diazonium salt synthesis.



2
Diazonium salt of 2-Amino-benzothiazole(highly unstable)

3

4
Azo derivative of 2-Aminobenzothiazole

Scheme-2: Coupling Reaction of Diazonium salt with aromatic or hetero-aromatic compound.

Literature Survey:

Literature marked that the new azo dyes were synthesized[18] by diazotization of 2-amino benzothiazole and coupling with various aromatic compounds such as naphthol derivatives, N, N-dimethyl aniline and 8-hydroxy quinoline. The structures of the synthesized compound were confirmed by UV-Vis, FT-IR and ^{1}H NMR spectroscopic methods. Antimicrobial activity by well plate method of these synthesized compounds were studied. Antioxidant studies of the compounds were also accomplished by measuring the DPPH radical scavenging assay and metal chelating method. Some compounds exhibited much better antibacterial activity and having good antioxidant property.

Two series of related donor–acceptor conjugated heterocyclic azo dyes[19] have been prepared by azo coupling reaction. Their electrochemical, optical, and thermal properties have been studied. HRS in dioxane solutions with a fundamental wavelength of 1064 nm was employed to estimate their second-order nonlinear optical properties. These azo dyes exhibited Good to excellent thermal stabilities (235–317 °C). Study showed that modulation of the optical and electronic properties has been accomplished by insertion of the benzothiazole acceptor group in the thienyl pyrrole system to 2 or 6 position of the benzothiazole heterocycle.

New benzothiazole based azo dyes[20] and derivatives were prepared by diazotization of 2-amino-6-substituted benzothiazoles and coupled with 4-imino-3,4-dihydro-2H-pyrimido[2,1-b][1,3]benzothiazole-2-one in neutral media. These azo dyes were characterized by various spectroscopic methods like UV-Vis, FTIR, NMR and Mass Spectrometry. Newly synthesized compounds are screened for *in vitro* antimicrobial activities. The few azo compounds exhibited good anti-bacterial activity and anti-fungal activity.

Diazotization of 2-aminobenzothiazole by using sulfuric acid and sodium nitrite to give diazonium salt[21] which coupled with alkaline salicylaldehyde solution to form azo-aldehyde derivative. The resulting aldehyde was reacted with the various aromatic amines viz. 3-nitroaniline, 4-nitroaniline, 4-methoxyaniline, 4-hydroxyaniline, 4-bromoaniline, 2-methoxyaniline, 4-chloroaniline and 2,4-dichloroaniline using microwave irradiation technique in ethanol to yield eight imines of benzothiazole**.** The antibacterial activity of these compounds was studied in vitro by using two types of bacteria, *Staphylococcus aurous* (Gram-positive) and *Escherichia coli (Gram-negative)*. Newly prepared imidazolidines exhibited better activities than gentamycin against *Staphylococcus aurous* while, some compound showed better activities against *Escherichia coli* when compared with that of the control drug.

Diverse diazenyl derivatives were prepared[22] by reacting 6-substituted-2-aminobenzothiazole derivatives with 2-naphthol in presence of NaOH. These compounds were screened for antimicrobial activity against *P. mirabilis, S. aureus, C. albicans, E. coli, S. pyrogens* and *A. fumigates* using Amphotericin B and Ciprofloxacin as standard drugs. Few compounds exhibit mild to moderate antimicrobial activity.

Various hetarylazo disperse dyes were prepared and applied by exhaustion on cellulose acetate were estimated visually and instrumentally[23]. A suitable agreement amongst the visual and the instrumental evaluation of these properties was determined. The colour and dyeing properties, temperature range and rate of dyeing of the dyes were studied.

New azo compounds prepared, incorporated with ion of heterocyclic bioactive moiety. Diazo-coupling reaction of the 2-amino benzothiazole with different synthetic phenolic antioxidant[24] compounds like phloroglucinol, BHA, 2,4- and 2,6-di–tert-butylphenol. Their structure was confirmed by various spectroscopic techniques, such as UV–Vis, FT-IR, ^{1}H NMR, ^{13}C NMR and LC-(ESI). Their biological effectiveness of the azo compounds was assessed by antioxidant activities like reducing power activity and DPPH radical scavenging activity. Few of them exhibit efficient antioxidant ability. The substantial antibacterial activity showed by the azo compounds against human pathogenic organisms. In *vitro* anticancer and toxicity of some azo compounds were assessed by MTT cytotoxicity assay against lung cancer cell line and normal skin cell line. In silico molecular docking study determines the azo compounds owing several crucial interactions with EGFR protein.

Azo-phenol based receptors, having an azo core incorporated with naphthol[25] and substituted benzothiazole units were prepared and their complete optical properties have been examined. The nitro derivative displayed, promising optical behaviour in the absence and presence of various transition metal ions in aqueous-acetonitrile solution. It has revealed that greater sensitivity, for the detection of Hg^{2+} ion by greater fluorescence. The characterization of synthesized compounds by emission, absorption, FT-IR, and ^{1}H NMR spectroscopic methods that showed favourable coordination of Hg^{2+} metal ion with the phenolic oxygen atom, the azo nitrogen atom adjacent to the naphthol ring, and the thiazole nitrogen of benzothiazole ring. Azo-hydrazone type of tautomerism by the photoinduced proton transfer reaction and also metal induced (Hg^{2+} ion) proton transfer reaction from the hydrazone form in the existing organic molecular systems have been examined by photo-irradiation and fluorescence excitation methods, also by ^{1}H and ^{13}C NMR spectra.

Dyes with heterocyclic diazo components have received much attention because of their high tinctorial power and excellent brightness because the dyes prepared from 2-aminobenzothiazoles and 2-aminothiazoles have played a significant role in disperse dye[26] technology. Various dyes prepared from several heterocyclic amines with 2-amino-1,3,4-thiadiazoles, 5-amino-1,2,4-thiadiazoles, 5-amino-

isothiazoles, 2-aminoimidazoles3-amino-2,1-benzisothiazoles, 2-aminothiophenes, and 5-aminopyrazoles have been reported. Introducing newer method of preparation of heterocyclic diazo components, which are being used to prepare acid dyes for polyamide carpet fibres. Few offers excellent brightness of shade and they are commercially competitive with more expensive anthraquinone type. Also, few have the excellent levelling properties.

7-Amino-3-phenylazo-2-methyl-4*H*- pyrazolo[1,5-*a*] pyrimidine-5-one was synthesized[27] by the reaction of 5-amino-3-methyl-4-phenylazo- 1*H*-pyrazole and 2-aminobenzothiazole with ethyl cyanoacetate in acetic acid at 150°C. Four novel heterocyclic azo disperse dyes were prepared by the coupling of heterocyclic amines-based diazonium chloride with 7-Amino-3-phenylazo-2-methyl-4*H*-pyrazolo[1,5-*a*]pyrimidine-5-one. The solvatochromic behaviours of related dyes were studied in detail by using ultraviolet–visible absorption spectrometer also these were purified and characterized by elemental analysis, FTIR, and ^{1}H NMR. Experimental data was supported by density functional theory. The detailed analysis of predicted tautomeric structures was also reported.

The PUF grafted[28] with the organic compound Me-BTAP was successfully applied to the pre-concentration of cadmium and lead. The sorbent showed characteristics that are desirable for materials used in solid-phase extraction systems, such as resistance to swelling and changes in pH, low resistance to flow passage, and simplicity in preparation. On application to the preconcentration system, the solid phase provided a simple and sensitive method for the determination of cadmium and lead by FAAS. It is a good alternative to estimate these elements. Extractions of other elements were tested using this sorbent.

The isomer mixture of 5,6- and 6,7-dichloro-2-amino-benzothiazole[29] was used as the first component in the synthesis of a series of disazo disperse dyes. The influence of structural variations in the end and middle components on the colour of the dyes is evaluated.

The azo aldehyde was obtained by coupling process between 2-aminobenzothiazole diazonium ion[30] and 2-hydroxybenzaldehyde and transformed to the corresponding imines by treating with 3-bromoaniline, 2-chloroaniline, 2,4-dichloroaniline, 4-nitroaniline, and 3-nitroaniline to give imine derivatives[13]. These compounds were inserted in reaction with (NaN_3) to produce novel tetrazoles. The structures of tetrazoles were determined based on FT-IR, NMR, and Mass spectral data.

Some new acids benzothiazole azo dyes classified in groups, obtained from 2-aminobenzothiazoles[31] 6-substituted with $–CH_3$, $-OCH_3$, -Cl, $-NO_2$ groups which are the diazotizable constituent, coupled with 12 coupling constituents at temperatures of 0-5°C and pH of 1.0 – 1.5 are presented. The sulphonic groups in the dye molecules impart these proper solubilities for dyeing the protein supports such as chrome tanned leather and furs. The acid benzothiazole azo dyes were characterized by melting point, water solubility, and UV-Vis, MS, and FT-IR spectra.

Some benzothiazole azo compounds[32] were prepared and studied for their microbial activity. These compounds were prepared by the condensation of substituted phenyl urea with [4-(4,6-Dichloro-[1,3,5]triazin-2-yloxy)-2,6-dimethyl-quinolin-3-yl]-(6-methoxy-benzothiazol-2-yl)-diazene, which was prepared by the reaction between cyanuric chloride and 3-[(6-methoxy-benzothiazol-2-yl)-diazinyl]-2,6-dimethyl-4-hydroxyquinoline. 3-[(6-methoxy-benzothiazol-2-yl)-diazinyl]-2,6-dimethyl-4-hydroxyquinoline prepared by coupling of 2,6-dimethyl-4-hydroxyquinoline and diazotized 2-amino-6-methoxy benzothiazole and were characterized by elemental analysis and spectral methods.

The optical properties of a series of side-chain liquid crystalline polymers containing azo-benzothiazole[33] mesogen with different terminal substituents (–H, $–CH_3$, and $–OCH_2CH_3$) in four organic solvents of varying polarity have been examined by absorption and fluorescence spectral analysis. Solvatochromic studies of these compounds don't show any regular difference in the absorption and emission intensities with varying the polarity of the solvent. Theoretical studies were executed based on diverse solvent correlation methods such as Dimroth-Reichardt and Kamlet-Taft methods to examine the solute-solvent interactions. Both emission and absorption maxima of examined polymers were bathochromically shifted with the removal of 6 position hydrogen atom by electron-donating groups in benzothiazole moiety.

Azo dyes derived from 2-amino-6-(2-chloroethoxy) benzothiazole and 2-amino 4-(2-hydroxy ethoxy)-benzothiazole[34] were prepared by diazotization and coupling with different N, N-disubstituted anilines. The dyes were then quaternized with some alkylating agents, dimethyl sulphate, acrylamides, benzenesulfonic acid methyl ester, and epoxy compounds. The new benzothiazolic cationic dyes absorb in the region of 606-636 nm and have molar absorptivity of 40000--80000 L mol^{-1} cm^{-1}.

Several 2-, 4- and 7-substituted benzothiazole derivatives were synthesized[35] to inquire into the relationship between the fluorescence of metal chelates and their structures and to investigate their applications as analytical reagents. The color and fluorescence reactions of the metal ions with benzothiazole derivatives were examined by spot tests. When metal complexes are formed there was the color change of 2-substituted derivatives was more notable than that of 4- and 7-substituted. As fluorometric reagents for metal ions, though, 4-aminobenzothiazole derivatives were superior to 2-amino and 7-aminobenzothiazole derivatives.

The series of heterocyclic azo dyes were prepared with 4-hydroxy coumarin by diazo-coupling reaction[36]. The

structural aspect of the newly synthesized compounds was accomplished by various physicochemical techniques like UV-Vis, FT-IR, NMR, and mass spectrometry. The computational calculations and geometrical optimization of the synthesized azo dyes were examined with Gaussian software through the help of the DFT method using a 6-31G (d,p) basis set at the gaseous phase. Similarly, the quantum chemical parameters were estimated to know the structural activity concept of the dyes. The pharmacological efficiency of the azo dyes was examined by antitubercular, antimicrobial, DNA cleavage. The synthesized compounds exhibited significant inhibitory activity against tested microbes. Further, the in silico molecular docking displayed effective binding properties of the compounds against the RpsA target receptor.

The new azo derivative of 2,5-dihydroxy-3-undecyl-1,4-benzoquinone with 2-aminobenzothiazole was prepared[37]. The product formed a complex with Mn(III) chloride, nitrate, acetate, and perchlorate. These complexes were found to exhibit enhanced antibacterial, antifungal, and anthelmintic activity than the ligand.

The calamitic liquid crystals involving a benzothiazole ring inside the central core and two various linkage groups have been prepared. Their liquid crystalline properties were studied[38] and compared with those of the analogous series of imines. The effect of the linkage group inside the central core has been confirmed to determine the variety of mesomorphism showed by the compounds. The compounds with imine and azo linkages act similarly and show typical nematic and smectic C mesophases. Compounds incorporating an amide linkage show a poorer mesomorphism and mainly present a smectic C mesophase.

Perfluoroalkyls-substituted benzothiazolyl bisazo[39] dyes showed higher solubility and greater bathochromicity than the corresponding alkyl derivatives. These dyes exhibited good dichroism (order parameter S>0.75).

Aminothiazoles, benzothiazoles, thiadiazols and thiophenes were diazotised and coupled to N-p-cyanoethyl-N""-p-hydroxyethylaniline[40] to give dyes which coloured polyester in orange to blue hues. The colour of the dyes is discussed with respect to the nature of the heterocyclic ring and substituents therein. Solvent effects on the visible absorption maxima of some of the dyes are also reported.

The heterocyclic amines viz. 2-amino-6-methoxy and 2-amino-6-nitrobenzothiazole, 3-amino-5-nitro-[2,1]-benzothiazole, and 2-amino-3,5-dinitrothiophene were diazotized and coupled to substituted N-β-acetoxyethyl anilines to give dyes[41] which colored cellulose acetate in red to deep blue hues. Dyeing and fastness properties of the dyes on cellulose acetate are also reported.

The heteroaryl amines have been prepared from the reaction of aniline derivatives, potassium thiocyanate and bromine in acetic acid. Coupling of diazonium salts of corresponding amines with 2-methylindole led to hetaryl-azoindole dyes[42]. These dyes have been characterized by UV–Vis, FT-IR and ^{1}H-NMR spectroscopy. The solvatochromism properties of dyes have been investigated in various solvents. The antimicrobial activity of the synthesized dyes has been estimated against *Bacillus subtilis, Escherichia coli, Micrococcus leuteus* and *Pseudomonas aeruginosa* bacterial strains. The results exhibited that some of these dyes show good antibacterial activity.

New heterocyclic azo dyes prepared by the diazotization process by using 2-amino-6-ethoxybenzothiazole[43] with coupling compounds under suitable experimental conditions. characterization of these compounds has been done by the various analytical methods like UV-Visible absorption spectra, FT-IR, ^{1}H NMR, ^{13}C NMR, elemental analysis and mass spectrometry. Solvatochromism properties of the azo dyes was studied at varied solvents with increasing polarity. The electrochemical properties of the synthesized compounds were examined by using cyclic voltametric method.

Synthesized hydroxyls azo dyes[44] by dizotization and the proton dissociation constants (pKa) of the dyes in various organic solvent + water mixtures have been determined. The results found were discussed in terms of the solvent characteristic. Effects of H-bonding interactions and solvent basicity on the ionization process have been also examined. In a nutshell, the pKa values of the studied compounds were found to be mostly dependent on both the ratio and the nature of organic co-solvent. In addition, it was very important to identify which structures we are dealing in liquid solutions and how these structures effect physicochemical properties of distinct tautomer and their acidity constants. The theoretical calculations have been done in order to obtain an insight into structure features and physicochemical properties of the compounds under study.

Series of novel dichromophoric dyes based on 2-aminobenzothiazoles[45] and 3-amino-1,2,4-triazole have been synthesized in high yields. All the dyes were classified as disperse dyes. Also, their electronic spectroscopic properties i.e., high dye-uptakes on polyester, highly extinction coefficients, excellent fastness properties and broad solvatochromic effects have been showed in these new disperse dyes. These synthesized dyes were suitable as pH indicator in the range of 11-13.

Novel azo-benzothiazole dyes[46] have been synthesized by condensation of 2-nitrosobenzothiazole and 6- nitro-2-nitrosobenzothiazole with aniline, anthranilic acid, 3-hydroxymethylaniline, 2-, 3- and 4-chloroaniline, 4-fluoroaniline, 4-iodoaniline or 4-nitroaniline. The new synthetic method defined is beneficial over the classic diazotization process usually used for the preparation of related disperse dyes, subsequently the existence of an electron-donating group at the para-position of the coupling component is no more a pre-requisite for the completion of the condensation reaction.

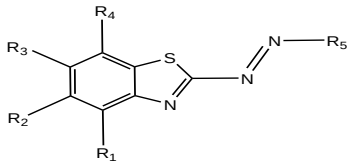
Novel azobenzothiazole dyes[47] obtained by condensation of 2-nitrosobenzothiazoles with several substituted anilines were synthesized and characterized. The effect of solvent polarity on absorption spectra was observed, also the relationship between dye structures and absorption in the UV–visible region examined. These dyes owning an aniline unit which had an o-electron donating group, showed unique absorption properties as exposed by a second, long wavelength absorption band.

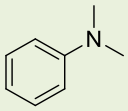
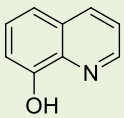
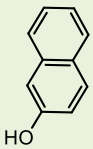
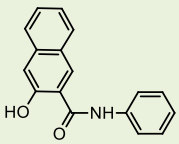
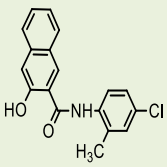
To identify a useful alternative to H_3PO_4, as a medium for diazoting heteroaromatic[48] amines, a number of organic acids having a similar ionization constant (Kt) were examined. The dichloroacetic acid was an effective solvent for both the diazotization of the synthesized compounds and the synthesis of vital commercial disperse dyes. Disperse Red 177 and Disperse Violet 52 dyes were easily formed in 85-90% yield and very pure form.

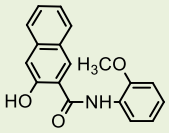
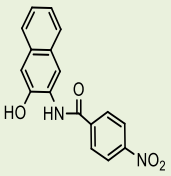
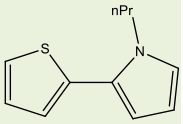
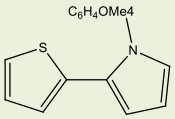
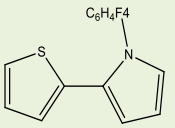
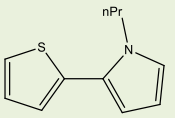
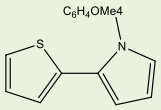
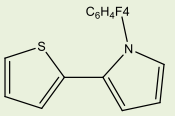
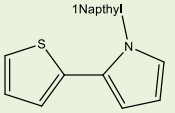
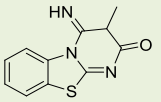
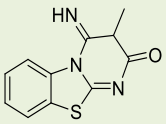
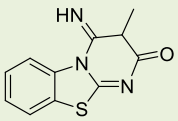
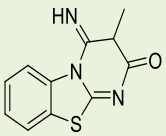
The azo compound[49] was synthesized and characterized by FT-IR, ^{1}H-NMR, ^{13}C-NMR spectral methods. The electrochemical behaviour of the azo compound and its complex with Fe (III) has studied at glassy carbon disk GCE electrode in dissimilar supportive electrolyte at concentration (1M) and scan rate (100mvs^{-1}). A linear correlation (0.1 – 4.0 µg. ml^{-1}) was shown between absorbance at λmax and concentration. The effect of diverse ions on the determination of Iron (III) to explore the selectivity of the process were also studied. The projected scheme was effectively useful to the analysis of blood samples.

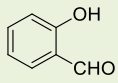
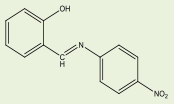
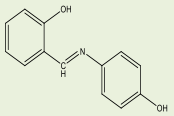
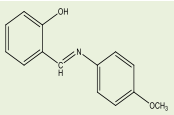
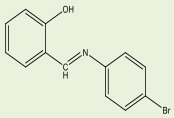
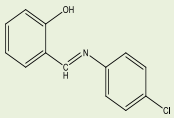
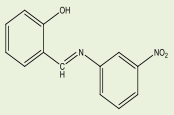
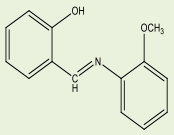
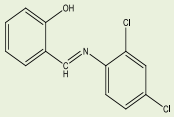
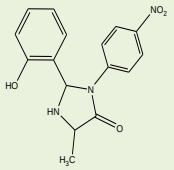
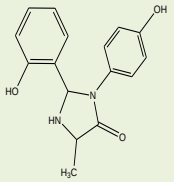
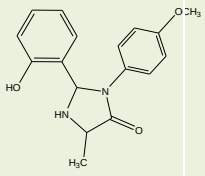
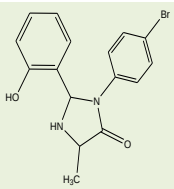
A series of 1-benzothiazolyl-3,5-diphenylformazans with substituents in the 6-position of the benzothiazole[50] ring were synthesized. The introduction of halogens and methyl and alkoxy groups into this position induces deepening of the color of the corresponding formazans as compared with the unsubstituted benzothiazolyl diphenylformazan. Benzothiazolylazo and 6-methylbenzothiazolylazophenylhydrazones of benzaldehyde were isolated along with formazans in the coupling of benzothiazoline diazonium and 6-methylbenzothiazolinediazonium sulfates with benzaldehyde phenylhydrazone.

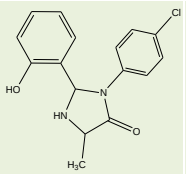
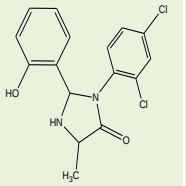
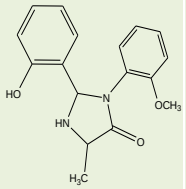
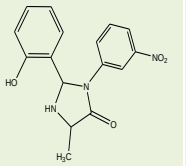
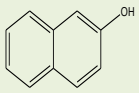
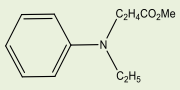
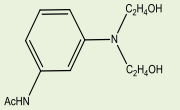
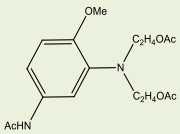
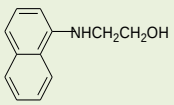
Table 1: Derivatives of aminobenzothiazole-azo compounds, their uses, metal complexes and the applications with references.

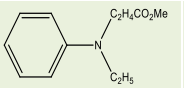
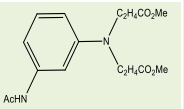
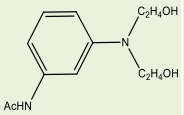
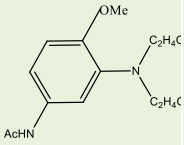
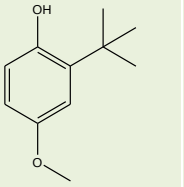
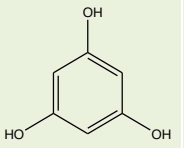
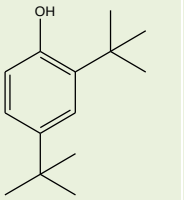
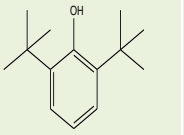
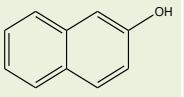
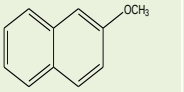


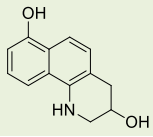
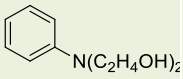
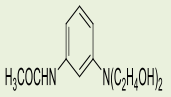
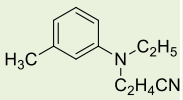
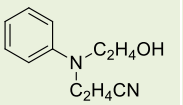
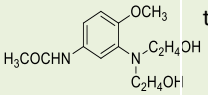
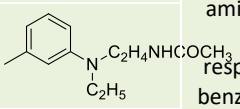
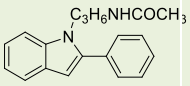
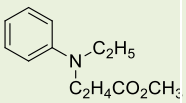
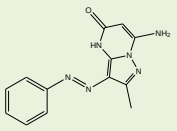
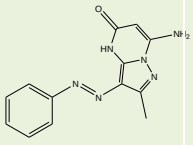
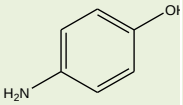
Sr. No.	R_1	R_2	R_3	R_4	R_5	Use	Bio	Studies made	Metal	Ref
1	H	H	H	H		Convenient, economical method for synthesis of azo dyes, coupled with naphthol derivatives 8-hydroxy quinolone and N, N-dimethyl aniline to obtain azo dyes.	The synthesized compounds proved to be safer up to upper most dosage and show a significant antimicrobial and in vitro antioxidant activity. Dyes showed a potential antimicrobial activity and antifungal activity against important pathogens like *A. Flavus C. Albicans* and *C. Keratinophilum,* they don't have good activity to the fungus when compare to clinically significant bacteria like *P. aeruginosa, E. coli and S. aureus.*	UV-Vis FTIR ^{1}H-NMR DPPH	-	18
2	H	H	H	H						
3	H	H	H	H						
4	H	H	H	H						
5	H	H	H	H						

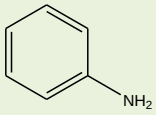
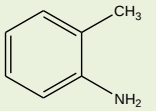
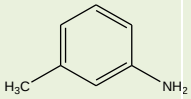
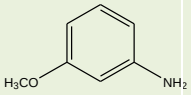
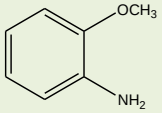
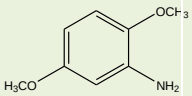
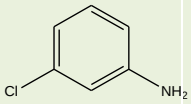
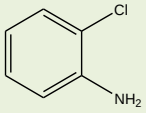
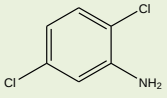
6	H	H	H	H						
7	H	H	H	H						
8	H	H	H	H		Series of new azo dyes with normal or reverse polarities are synthesised. By changing position of linkage of benzothiazole heterocycle (2 / 6) to azo bridge, the electrochemical properties and linear, nonlinear optical properties of this well-defined asymmetric push-pull π-conjugated systems can be readily tuned.	-	^{1}H NMR Electro-chemical Thermal properties	-	19
9	H	H	H	H						
10	H	H	H	H						
11	H	H	CH_3	H						
12	H	H	CH_3	H						
13	H	H	CH_3	H						
14	H	H	CH_3	H						
15	H	H	H	H	 **10a**	Due to interaction of polar solvents and hetero or H atom present in compounds, very strong solvatochromic performance, which was studied in different polar solvents. H bond formation mainly affects chromo tropic phenomenon.	Compound **10b** and **10d** showed better antibacterial activities than others. MIC of synthesized compounds **10c** against *A. flavus,* extremely inhibited organisms were reported in compound **10b** showed good MIC 100 µg/mL against *C. albicans.*	UV-Vis IR ^{1}H-NMR Mass Spectrometry	-	20
16	H	H	NO_2	H	 **10b**					
17	H	H	H_3CH_2CO	H	 **10c**					
18	H	H	H_3CO	H	 **10d**					

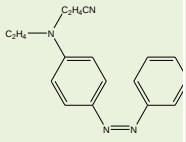
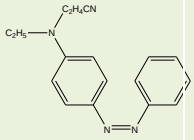
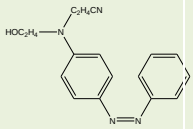
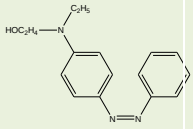
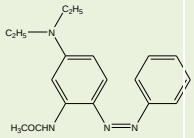
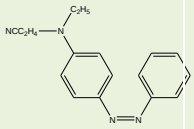
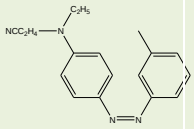
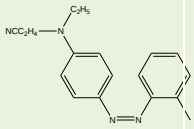
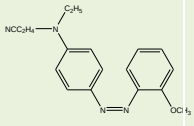
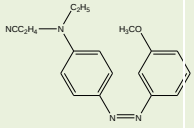
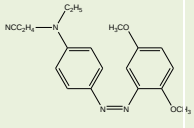
19	H	H	H	H		Imidazolidines also known as tetrahydroimidazoles are biologically active N containing heterocyclic moiety which have been described to shown wide display of significant biological activities.	Newly prepared imidazolidines showed greater activities than gentamycin against Gram-positive bacteria and some compounds also showed better activities against Gram-negative bacteria when compared with that of the control drug (Gentamycin).	FTIR, ^{1}H-NMR UV-Vis	-	21
20	H	H	H	H						
21	H	H	H	H						
22	H	H	H	H						
23	H	H	H	H						
24	H	H	H	H						
25	H	H	H	H						
26	H	H	H	H						
27	H	H	H	H						
28	H	H	H	H	 **11a**					
29	H	H	H	H	 **11b**					
30	H	H	H	H	 **11c**					
31	H	H	H	H	 **11d**					

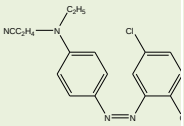
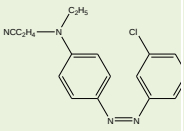
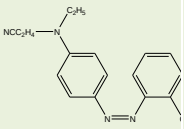
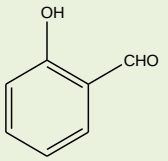
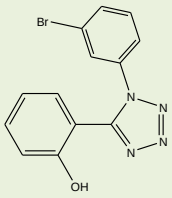
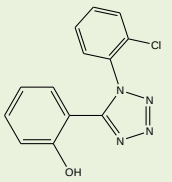
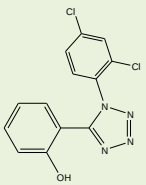
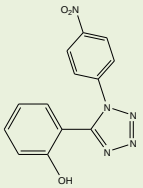
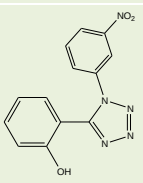
32	H	H	H	H	 **11e**					
33	H	H	H	H	 **11f**					
34	H	H	H	H	 **11g**					
35	H	H	H	H	 **11h**					
36	H	H	H	H		6-Substituted-2-aminobenzothiazole can be a lead and strong molecule targeted to introduce new antimicrobials	These compounds were screened for *in vitro* antimicrobial activity against four pathogenic bacteria viz. *S. aureus, S. pyrogens, E. coli* and *P. mirabilis* using Ciprofloxacin as standard drug. In *vitro* antifungal activity of these compounds was screened against pathogenic fungi *C. albicans, and A. fumigatus* using Amphotericin B as standard drug.	TLC FT-IR NMR M.P.		22
37	H	H	CH_3	H						
38	H	H	OCH_3	H						
39	H	H	Cl	H						
40	H	H	NO_2	H						
41	H	H	CH_3O	H		Relation between the hues of dyeing (ho) values and absorption maxima (λmax) of methanol solutions of dyes.	-	UV-Vis εmax ΔE	-	23
42	H	H	CH_3O	H						
43	H	H	CH_3O	H						
44	H	H	CH_3O	H						

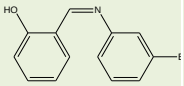
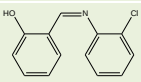
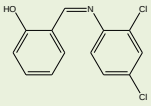
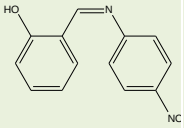
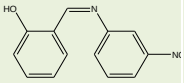
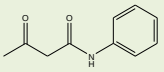
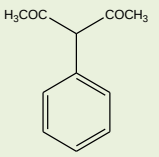
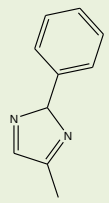
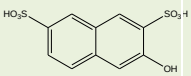
45	H	H	NO_2	H						
46	H	H	NO_2	H						
47	H	H	NO_2	H						
48	H	H	NO_2	H						
49	H	H	H	H		In silico molecular dock ing study has described that new azo compound bearing variability of tight interactions with effective binding sites of EGFR protein in lung cancer tissues, which supports to design the potent chemotherapy agent. The anticancer effectiveness of new bio effective azo compounds was explored by cytotoxicity activity against lung cancer cell line and observed that both are anticancer active.	Antioxidant activity such as DPPH radical scavenging and reducing power activities showed the new azo compounds includes considerable antiradical property, especially 2-(benzo[d]thiazol-2-yldiazenyl) −6-(tertbutyl) −4-methoxyphenol and 2-(benzo[d]thiazol-2-yldiazenyl)benzene-1,3,5-triol azo compounds showed significant antioxidant efficiency. As same in antibacterial evaluation, azo compounds 2-(benzo[d]thiazol-2-yldiazenyl) −6-(tertbutyl) −4-methoxyphenol and 2-(benzo[d]thiazol-2-yldiazenyl)benzene-1,3,5-triol shows notable bacterial resistant effect on human pathogens.	UV–Vis FT-IR ^{1}H-NMR ^{13}C-NMR LC-MS	-	24
50	H	H	H	H						
51	H	H	H	H						
52	H	H	H	H						
53	H	H	H	H		An efficient and cost-effective chemo sensor was developed that able to detect Hg^{2+} ion selectively, in aq. medium and on a test paper strip. The chemo sensor was acted as a real time, sensitive, and naked-eye visible colorimetric sensor for Hg^{2+} ion.	-	UV-Vis FT-IR, ^{1}H-NMR ^{13}C-NMR	-	25
54	H	NO_2	H	H						
55	H	CH_3	H	H						
56	H	OCH_3	H	H						
57	H	NO_2	H	H						

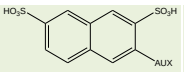
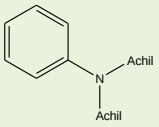
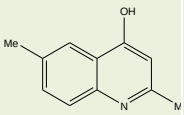
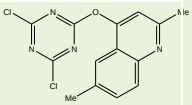
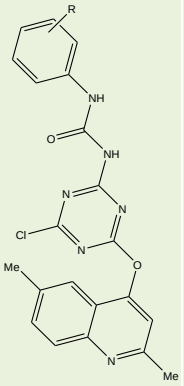
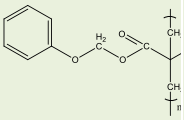
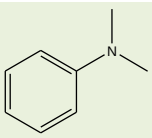
58	H	H	CH_3O	H		Azo dyes seem to offer no advantages over the Z-amino isomers. Blue dyes are reported, 3-amino-2-nitro-4-cyano-5-Methyl mercapto thiophene when diazotized and coupled to N,N-diethyl-Inmino acetanilide 3-Aminobenzo thiophenes and 3-amino-pyridines. which are 3-aminothiophenes containing respectively fused benzo and pyridino rings, give orange to red dyes with common aniline-type couplers.	-	-	-	26
59	H	H	CH_3O	H						
60	H	H	NO_2	H						
61	H	H	CH_3SO_2	H						
62	H	H	CH_3NHO_2S	H						
63	H	H	NO_2	H						
64	H	H	CH_3	H						
65	H	H	CH_3O	H						
66	H	H	NO_2	H						
67	H	H	H	H		New heterocyclic azo dyes were Prepared and solvatochromic behaviours of dyes were studied by using ultraviolet–visible absorption spectrometer. The experimental data were supported by density functional theory using b3lyp/cc-pvtz level calculations, and a detailed analysis of predicted tautomeric structures was made	-.	UV-Vis Elemental analysis FTIR ^1H NMR	-	27
68	H	H	OMe	H						
69	H	H	Me	H		The sorbent showed characteristics that are desirable for materials used in solid phase extraction systems, such as resistance to swelling and	-	FT-IR Differential thermal analysis (DTA) Thermogravimetric analysis (TGA)	Zn(II) Hg(II) Cd(II) U(VI) Ag(I)	28

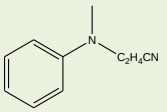
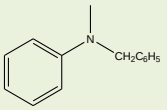
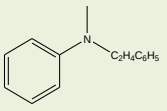
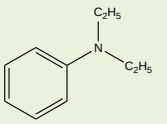
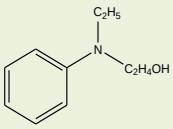
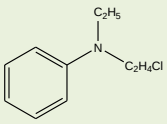
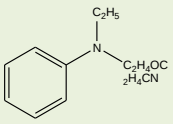
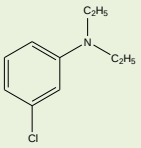
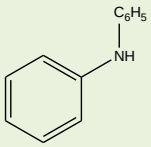
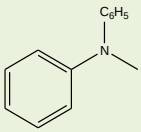
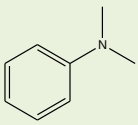
						variations in pH, low resistance to flow passage and simplicity in preparation. Also, when applied to preconcentration system, solid phase providing a simple and sensitive method for determination of cadmium and lead by FAAS. The synthesized material is a good alternative for the determination of these elements.				
70	H	Cl	Cl	H		Estimation of substituent effects on colour of dyes. Diazotisation - coupling process of mono azo intermediates retaining essentially aqueous phase systems suitable for 4-aminoazobenzene based dis azo some dyes were unsatisfactory,	-	UV-Vis, Mass Spectra, Column Chromato graphy	-	29
71	H	Cl	Cl	H						
72	H	Cl	Cl	H						
73	H	Cl	Cl	H						
74	H	Cl	Cl	H						
75	H	Cl	Cl	H						
76	H	Cl	Cl	H						
77	H	Cl	Cl	H						
78	H	Cl	Cl	H						

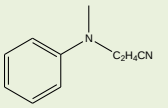
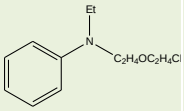
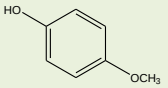
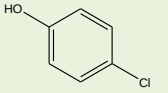
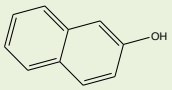
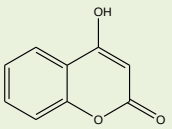
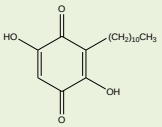
79	H	Cl	Cl	H					
80	H	Cl	Cl	H					
81	H	Cl	Cl	H					
82	H	Cl	Cl	H					
83	H	Cl	Cl	H					
84	H	Cl	Cl	H					
85	H	Cl	Cl	H					
86	H	Cl	Cl	H					
87	H	Cl	Cl	H					
88	H	Cl	Cl	H					
89	H	Cl	Cl	H					

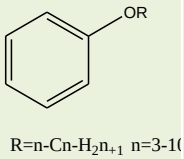
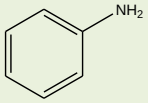
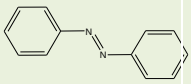
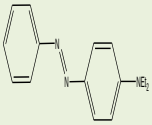
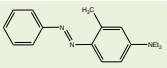
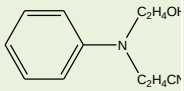
90	H	Cl	Cl	H		The azo dyes were synthesized by coupling of diazonium ion with salicylaldehyde, then imines were prepared by reaction with various aniline. These imines were inserted in reaction with NaN_3 to form tetrazoles. Reactions rates of these tetrazoles were increased with decreasing the electron withdrawal caused by substituent in benzene.	-	^{1}H-NMR Mass spectra FT-IR		30
91	H	Cl	Cl	H						
92	H	Cl	Cl	H						
93	H	H	H	H						
94	H	H	H	H						
95	H	H	H	H						
96	H	H	H	H						
97	H	H	H	H						
98	H	H	H	H						

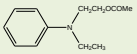
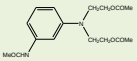
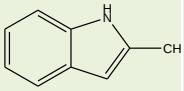
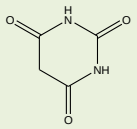
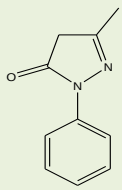
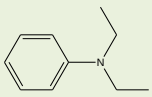
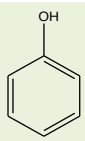
99	H	H	H	H						
100	H	H	H	H						
101	H	H	H	H						
102	H	H	H	H						
103	H	H	H	H						
104	H	SO_3H	Me	H		Number of new acids benzothiazole azo dyes were prepared. The sulphonic groups in dyes impart these proper solubilities for dyeing protein supports such as chrome tanned leather and furs.		M.P. UV-Vis Mass spectra FTIR	-	31
105	H	SO_3H	OMe	H						
106	H	SO_3H	Cl	H						
107	H	SO_3H	NO_2	H						
108	H	SO_3H	Me	H						
109	H	SO_3H	OMe	H						
110	H	SO_3H	Cl	H						
111	H	SO_3H	NO_2	H						
112	H	SO_3H	Me	H						
113	H	SO_3H	OMe	H						
114	H	SO_3H	Cl	H						
115	H	SO_3H	NO_2	H						
116	H	SO_3H	Me	H						
117	H	SO_3H	OMe	H						
118	H	SO_3H	Cl	H						
119	H	SO_3H	NO_2	H						
120	H	SO_3H	Me	H						
121	H	SO_3H	OMe	H						

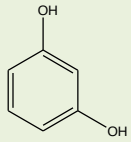
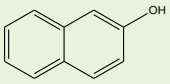
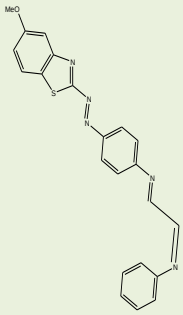
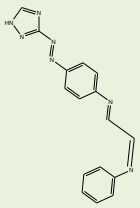
122	H	SO_3H	Cl	H	 AUX=OH, NH_2				
123	H	SO_3H	NO_2	H					
124	H	SO_3H	Me	H	 Achil = Me. Et				
125	H	SO_3H	OMe	H					
126	H	SO_3H	Cl	H					
127	H	SO_3H	NO_2	H					
128	H	H	OMe	H		Synthesized molecules were toxic against the bacteria. The comparison of antibacterial and antifungal activity of these molecules with standard drugs shows that the presence of methoxy and halogen (-Cl) groups in the phenyl ring increases the antimicrobial activity. Their potency has been found to be lower than that of standard drugs, but their acute toxicity is significantly lower.	Synthesized compounds were screened for antifungal activity against *C. albicans, A. Niger* by plate diffusion method and antibacterial activities of compounds were studied against Gram-negative bacteria *E. coli* & *S. typhi* and Gram-positive bacteria *S. pyogenes* & *S. aureus*	FT-IR, ^{1}H NMR Mass spectra	-	32
129	H	H	OMe	H					
130	H	H	OMe	H	 R= Me, OMe, OEt, Cl, H				
131	H	H	H	H		Solvatochromic studies were made of these compounds and they did not show any regular variation on the absorption and emission intensities with varying the polarity of solvent.	-	^{1}H NMR ^{13}C NMR UV-Vis and Fluorescence	-	33
132	H	H	CH_3	H						
133	H	H	OCH_2CH_3	H						
134	H	H	ClC_2H_4O	H		The synthesised dyes were quaternized with various alkylating agents and molar	-	-	UV-Vis NMR FTIR Elemental	34

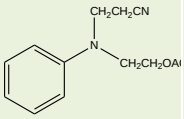
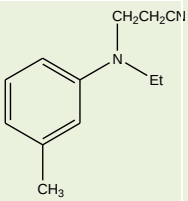
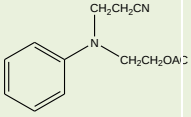
135	H	H	ClC_2H_4O	H		absorptivity of these dyes were evaluated.			Analysis
136	H	H	ClC_2H_4O	H					
137	H	H	ClC_2H_4O	H					
138	H	H	ClC_2H_4O	H					
139	H	H	ClC_2H_4O	H					
140	H	H	ClC_2H_4O	H					
141	H	H	ClC_2H_4O	H					
142	H	H	ClC_2H_4O	H					
143	H	H	ClC_2H_4O	H					
144	H	H	ClC_2H_4O	H					
145	HOC_2H_4O	H	H	H					

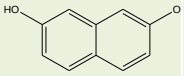
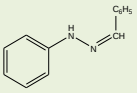
146	HO C_2H_4O	H	H	H						
147	HO C_2H_4O	H	H	H						
148	H	H	H	H		The colour and fluorescence reactions of metal ions with benzothiazole derivatives were studied through spot tests. On formation of metal complexes in solution, colour change of 2-substituted derivatives was more notable than that of 4- and 7-substituted. As fluorometric reagents for metal ions, though, 4-aminobenzothiazole derivatives were superior to 2-amino and 7-aminobenzothiazole derivatives.	-	-	Co II Mn II Cu II Zn II Ni II Hg II Cd II Bi III Ag I Pb II	35
149	H	H	H	H						
150	H	H	H	H						
151	H	H	OC_2H_5	H		The computational calculations and geometrical optimization of the newly synthesized azo dyes were studied. Also, the quantum chemical parameters were evaluated to understand the structural activity concept of the dyes.	Newly prepared compounds were able to show significant inhibitory activity against tested microbes. In silico molecular docking showed effective binding properties of the compounds against RpsA target receptor	UV-Vis FT-IR NMR Mass spectra DFT	-	36
152	H	H	H	H		new azo compounds of embelin with 2-aminobenzothiazol was synthesised. The prepared compound 6-(2'-benzothiazolylazo) embelin (H2ABTE) (I) was complexed with Mn(III) by using chloride, nitrate, acetate	The synthesized complexes were screened for antibacterial, antifungal and anthelmintic activities and the complexes were found to exhibit enhanced activity than the ligand.	-	Mn (III)	37

						and perchlorate as counter anions.				
153	H	H	n-$C_{10}H_{21}$	H	 R=n-Cn-H_2n_{+1} n=3-1(	Mesomorphic properties of the dyes were studied and a comparative studied of the influence of the linkage group on the mesomorphism of the materials.	-	^{13}C-NMR ^{1}H-NMR Elemental analysis	-	38
154	H	H	C_4H_9	H		Synthesised dyes showed higher solubility and greater bathochromicity than corresponding alkyl derivatives, also these dyes showed good dichroism.	-	UV-Vis ^{1}H NMR Mass spectra Elemental analysis	-	39
155	H	H	C_4H_9	H						
156	H	H	H	H						
157	H	H	C_4H_9	H						
158	H	H	C_4F_9	H						
159	H	H	C_6F_{13}	H						
160	H	H	$C_4F_9CH_2CH_2S$	H						
161	H	H	C_4F_9S	H						
162	H	H	C_4H_9	H						
163	H	H	C_4F_9	H						
164	H	H	H	H		The synthesized dyes provide good coloration of polyester and maximum light fastness was apparent in dyes prepared from diazo components involving nitro substituents.	-	M.P. FT-IR ^{1}H NMR Elemental analysis	-	40
165	Cl	H	H	H						
166	H	H	Cl	H						
167	Br	H	H	H						
168	H	H	Br	H						
169	F	H	H	H						
170	H	H	F	H						
171	SO_2Me	H	H	H						
172	H	H	SO_2Me	H						
173	H	H	CN	H						
174	CF_3	H	H	H						
175	H	H	CF_3	H						
176	NO_2	H	H	H						
177	H	H	NO_2	H						
178	H	H	SCN	H						
179	H	H	OMe	H						
180	H	H	Me	H						
181	H	H	NHAc	H						
182	NO_2	H	NO_2	H						

183	NO_2	H	SO_2Me	H						
184	CF_3	H	NO_2	H						
185	H	H	OMe	H		Dyeing and light fastness properties of these dyes were discussed and estimated. These dyes were medium to high uptake on cellulose acetate, excellent wash fastness, and moderate to high light fastness depends on heterocyclic moiety and depth of dyeing.	-	UV-Vis ^{1}H NMR Elemental analysis	-	41
186	H	H	NO_2	H						
187	H	H	OMe	H						
188	H	H	NO_2	H						
189	H	H	H	H		Solvatochromic properties of synthesized dyes were examined in different solvents, also the antimicrobial activity of these dyes was studied.	The antimicrobial activity of prepared dyes was evaluated against M. leuteus, B. subtilis, E. coli and P. aeruginosa bacterial strains. The results exhibited that some of these dyes are potential antibacterial compounds.	UV-Vis FT-IR ^{1}H NMR	-	42
190	H	H	Me	H						
191	H	H	OMe	H						
192	H	H	Cl	H						
193	H	H	Br	H						
194	H	C_2H_4		H						
195	H	H	EtO	H		Synthesized dye shows excellent colouring properties due to presence of chromophores in their skeleton and acts as good electron exchange mediators in redox reactions. Electrochemical behaviour of azo dyes was studied at glassy carbon electrode by using cyclic voltametric method.	-	UV-Vis FT-IR ^{1}H NMR ^{13}C NMR Elemental analysis	-	43
196	H	H	EtO	H						
197	H	H	EtO	H						
198	H	H	H	H		The pKa (Proton dissociation constants) values of synthesized compounds were	-	Dihedral angle Dipole moment (D)	-	44

199	H	H	H	H		determine in aqueous buffer solutions containing changing proportions of organic solvents of various polarities. Effects of H-bonding interactions and solvent basicity on ionization process were also discussed.		Electronic absorption spectra		
200	H	H	H	H						
201	H	H	OMe	H		Solvatochromic effects of various solvents were studied and dyes were excited at 279-355 nm and showed fluorescence emission at a broad range i.e., 428–573 nm with low and medium intensities. Fastness properties of these dyes are good to excellent and three derivatives of 3-azo-1,2,4-triazoles are used as pH indicators in the pH range of 11-13.	-	UV-Vis FT-IR ^{1}H-NMR Elemental analyses	-	45
202	H	H	H	H						
203	H	H	OMe	H						
204	H	H	H	H	C_6H_6	New synthetic method was helpful for classic diazotization process used for preparation of disperse azo dyes, the presence of an electron-releasing group at para-position, or equivalent, of the coupling compound is no more a pre-requisite for completion of condensation reaction.	-	M.P. UV-Vis	-	46
205	H	H	H	H	2-Cl-C_6H_5					
206	H	H	NO_2	H	3-CH_2OH-C_6H_5					
207	H	H	NO_2	H	C_6H_6					
208	H	H	NO_2	H	2-CO_2H-C6H5					
209	H	H	NO_2	H	2-Cl-C_6H_5					
210	H	H	NO_2	H	3-Cl-C_6H_5					
211	H	H	NO_2	H	3-CH_2OH-C_6H_5					
212	H	H	NO_2	H	4-F-C_6H_5					
213	H	H	NO_2	H	4-Cl-C_6H_5					
214	H	H	NO_2	H	4-I-C_6H_5					
215	H	H	NO_2	H	4- NO_2-C_6H_5					
216	H	H	NO_2	H	4- NO_2-C_6H_5	New 2-nitrosobenzothiazo	The effect of solvent polarity on absorption	^{1}H NMR ^{13}C NMR	-	47
217	H	H	H	H	2-Cl-C_6H_5					

218	H	H	H	H	2-Cl-C_6H_5	les use as synthons to access New azo benzothiazole dyes through condensation with various aromatic amines, mostly those that containing electron withdrawing groups at the coupling component was extended successfully. Hence, six new azo benzothiazole dyes having electron releasing groups at aniline coupler were synthesized in moderate to good yields.	spectra were studied.	Mass spectra FTIR UV-Vis		
219	H	H	H	H	3-Cl-C_6H_5					
220	H	H	H	H	4-Cl-C_6H_5					
221	H	H	H	H	3-Cl-C_6H_5					
222	H	H	H	H	4-I-C_6H_5					
223	H	H	H	H	3-CH_2OH-C_6H_5					
224	H	H	H	H	4-F-C_6H_5					
225	H	H	H	H	4- NO_2-C_6H_5					
226	H	H	H	H	4- $NHCOCH_3$-C_6H_5					
227	H	H	H	H	2- $NHCOCH_3$-C_6H_5					
228	H	H	H	H	2-OCH_3-C_6H_5					
229	H	H	H	H	4-OCH_3-C_6H_5					
230	H	H	H	H	2-SCH_3-C_6H_5					
231	H	H	H	H	4-SCH_3-C_6H_5					
232	H	H	NO_2	H	2-Cl-C_6H_5					
233	H	H	NO_2	H	2-Cl-C_6H_5					
234	H	H	NO_2	H	3-Cl-C_6H_5					
235	H	H	NO_2	H	4-Cl-C_6H_5					
236	H	H	NO_2	H	3-Cl-C_6H_5					
237	H	H	NO_2	H	4-I-C_6H_5					
238	H	H	NO_2	H	3-CH_2OH-C_6H_5					
239	H	H	NO_2	H	4-F-C_6H_5					
240	H	H	NO_2	H	4- NO_2-C_6H_5					
241	H	H	NO_2	H	4- $NHCOCH_3$-C_6H_5					
242	H	H	NO_2	H	2- $NHCOCH_3$-C_6H_5					
243	H	H	NO_2	H	2-OCH_3-C_6H_5					
244	H	H	NO_2	H	4-OCH_3-C_6H_5					
245	H	H	NO_2	H	2-SCH_3-C_6H_5					
246	H	H	NO_2	H	4-SCH_3-C_6H_5					
247	H	H	NO_2	H		The 2-amino-6-nitrobenzothiazole was diazotized in a medium having 85% aq. Halo acetic acid and conc. Sulphuric acid followed by coupling with different amines to form azo dyes. To find a beneficial alternate to Phosphoric acid, as a medium for diazotising heteroaromatic amines, a number of organic acids	-	^{1}H NMR Mass spectra M.P.	-	48
248	H	H	NO_2	H						
249	H	H	H	H						

						having a similar ionization constant (Kt) were studied				
250	H	H	H	H		Electrochemical properties of azo reagent and complex with Fe (III) was studied. The azo reagent was a maximum absorption at 440 nm reacts with $FeCl_3.6H_2O$ at room temperature to give a colored complex at pH 6. The effect of pH on absorption of complex formed by reaction of reagent with Fe(III) was studied at various pH.	-	FT-IR ^{1}H-NMR ^{13}C NMR	Fe (III)	49
251	H	H	H	H		Benzothiazolyl azo and 6-methyl benzothiazolyl azo phenylhydrazones of benzaldehyde were prepared with formazans in the coupling of benzothiazoline and 6-methyl benzothiazoline diazonium sulfates with benzaldehyde phenylhydrazone. The synthesized compound form stable complexes with different metals.	-	M.P. Elemental Analysis	Cu Ni Zn Co	50
252	H	H	Me	H						

Abbreviations:

B. subtilis	*: Bacillus subtilis*
E. coli	*: Escherichia coli*
P. aeruginosa	*: Pseudomonas aeruginosa*
S. aureus	*: Staphylococcus aureus*
S. pyogenes	*: Streptococcus pyogenes*
C. albicans	*: Candida albicans*
FTIR	: Fourier Transform Infrared Spectroscopy
UV-Vis	: Ultra Violet Visible
NMR	: Nuclear Magnetic Resonance
TGA	: *Thermogravimetric Analysis*
SAR	: Structural Activity Relationship
SmC	: Smectic C
N	: Nematic
SmA	: Smectic A
DFT	: Density Functional Theory
TD-DFT Theory	:Time Dependent Density Functional

CONCLUSION

The synthesized azo compounds from the 2-aminobenothiazole are beneficial for many applications. The colours of dyes of azo compounds have different shades and hence used for dyeing of animal textile fibres, for the chelation. Pharmaceutically acceptable and readily soluble salts, polymeric biodegradable prodrug, antifungal, anthelmintic activities and their dyeing ability, for antioxidant activities. In basic solution azo compounds formed normally from easily dissolvable salts with strong color. Azo derivatives also used as prodrugs. Similarly, these compounds also served as building block for many other applicable final products, now-a-days in pharmaceutical field. The present review paper gives an overview or detailed account of azo-benzothiazole synthesized and its use in various reactions.

The compounds synthesized from the azo derivatives of azo- benzothiazole were valuable for many applications dying industry, for the ion-exchanging properties of polymers. The antibacterial, antifungal and antioxidant activities.

Thus, this review may be beneficial for many researchers for further developments of azo- benzothiazole and their different reactions to give various applied derivatives in near future.

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