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Research Article

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Synthesis of some novel heterocyclic azo dyes for acridine derivatives and evaluation of their antibacterial activities

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ABSTRACT

Five new azo dyes for acridine derivatives were synthesized using different approaches depending on the position of functional groups. The synthesis started with a commercially available unsubstituted acridine that was converted by nitration and amination to compounds that was useful building block in supramolecular chemistry by diazotization of 4(2,4-dichloro-δ-triazin)aniline DCTA . the structures of newly synthesized compounds were characterized by NMR, Mass, FT-IR spectra data and elemental analysis. All the synthesized compounds were screened for their antibacterial activities.

Keywords: acridine, azodyes, antibacterial activity.

INTRODUCTION

The development of natural and synthetic fiber production requires the study and implementation of new type of dyes with improved properties and superior results in term of yield. For many years, the azo comounds have been the main class of dyes used in various applications such as textile fibers dyeing, colouring of different materials and advanced organic synthesis. The synthesis and dyeing properties of azo compounds are described in many papers [1-6]. They are synthetic compounds and account for more than 50% of all the dyes produced annually, showing largest spectrum of colors [6-9]. Nearly all the dyestuffs used by the textile industry are azo dyes, and they are also widely used in printing, food, paper making and cosmetic industries. The more industrialized the society, the greater the use of azo dyes, and hence the greater the risk of their toxic effects affecting the society. It has already been noted that [10-11]. Bae and Freeman (2007) already demonstrated the biological toxicity of the the direct azo dyes used in the textile industry[8]. Various azo dyes have been shown the produce positive toxic results for different parameters [12].

Azo dyes are usually designed to resist biodegradation under aerobic conditions, the recalcitrance of these compounds being attributed to the presence of sulfonate groups and azo bonds [13], hence the development of non genotoxic dyes and investment in research to find effective treatments for effluents and drinking water is required, in order to avoid environmental and human exposure to these compounds and prevent the deleterious effects they can have on human and aquatic organisms [14]. In this work we tried the construction of supramolecular architectures with favorable properties and fascinating structures has drawn great attention. On the other hand, the early discovery of the biological effect of the acridine derivatives encouraged us to continue our interest in studying the spectral behavior of azo compounds for acridine.

EXPERIMENTAL SECTION

Double distilled water and chemicals of highest purity were in all experimental, which supplied by fluka and BDH.

2-1 Experimental Procedure

Synthesis of azo dyes 1C- 5C have been prepared in similar manner the procedure is as follow.

2-1-1 preparation of (2,4-Dichloro-6-yl-δ-triazin)-anilino [15] (I).

Cyanuric chloride (1.84g, 0.01mol.) was stirred with acetone (30ml) and ice (20g) for 1 hr to form a fine suspension. The solution was cooled to 0-5^{o}C in an ice bath and a neutral (pH=7). Solution (0.93g, 0.01mol) aniline in water and sodium hydroxide (20% w/v, 10mL) was added at such a rate that the temperature of the mixture and did not rise above 5^{o}C. The reaction mixture was stirred for 4 to 5 hrs. at 0-5^{o}C, finally poured into ice sold separation-washed-dried and recrystalized alcohol m.p. 240-241, 86%yield.

2-1-2 preparation of mono – dinitro acridine [16] (1a – 5a)

Synthesis of nitro acridines have been prepared in similar manner the procedure unless the different ratio H_2SO_4/HNO_3. In 125 mL Erenmeyer Flask cool 1 mL of concentred H_2SO_4 to 0^{o}C and then 0.179g of acridine. Again cool the mixture to (0 – 10)^{o}C . now add dropwise using a Pasteur pipette, a cooled mixture of 1 mL of concentrated HNO_3. During the addition of the acids swirl the mixture frequently and maintain the temperature of reaction mixture in the rang of (5-15) ^{o}C, when all the HNO_3 has been added warm the mixture to room temperature and after (25-45) min. pour it on 10g of cracked ice in 250ml beaker, neutralized with 10% NaOH. Isolate the sold product by filtration using a Buchner funnel and wash well with water then recrystallized product 3a should have mp 190-192, 60% yield.

2-1-3 preparation of mono – diamino acridine [17] (1b – 5b)

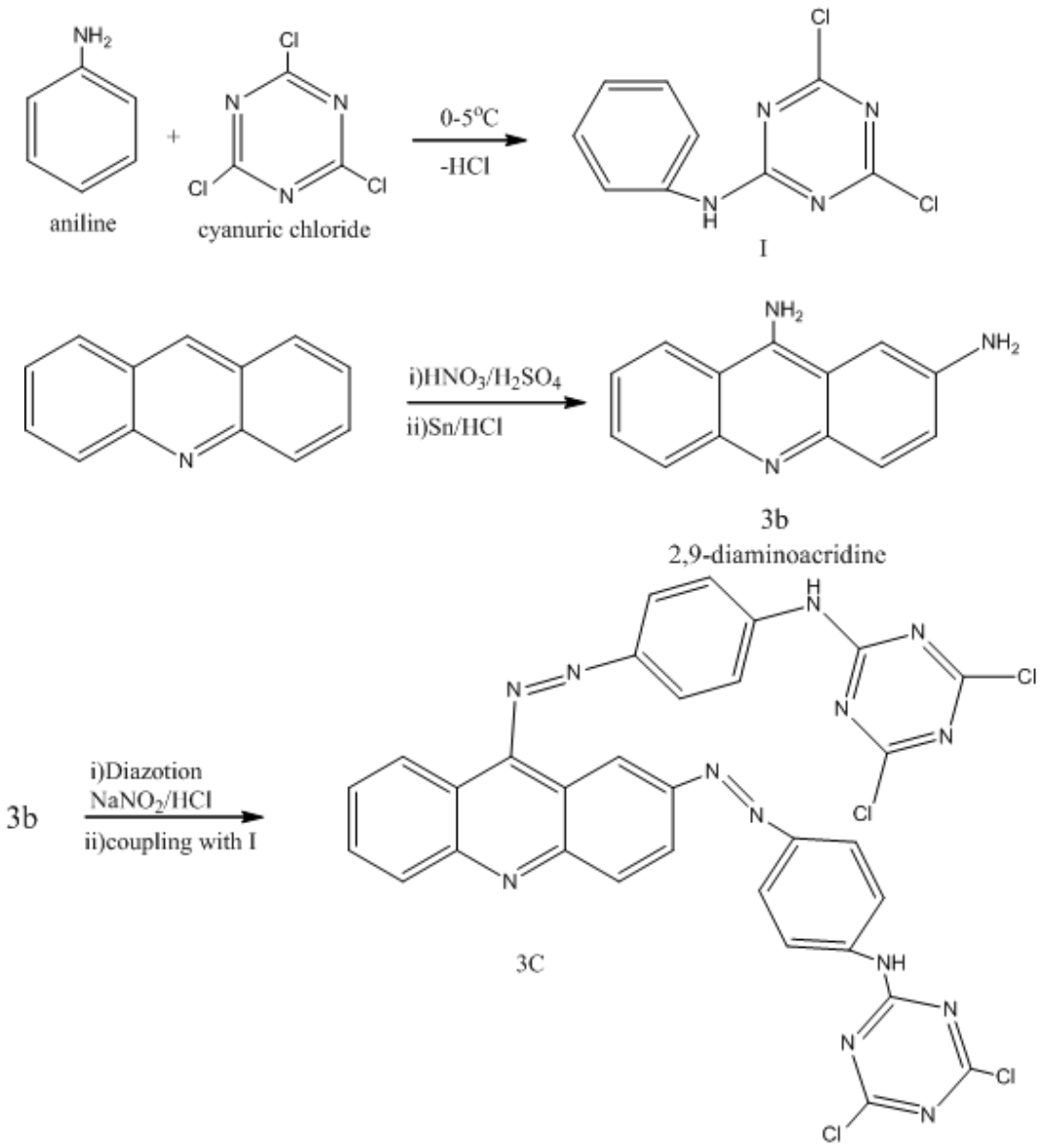
Synthesis of amino acridines have been prepared in similar manner the procedure.

0.269g of dinitroacridine dissolved in ethanol 6ml, 0.5g tin and 2ml 36% of concentrate HCl. This mixture was refluxed for (1-3)hr., after cooling and neutralized with Base 20% NaOH, the solvent was removed uder reduced press and resiudo was recrystallized product 3b should have mp=241-242, 30% yield.

2-1-4 Synthetic procedure[18] (1c – 5c)

2,9-diamino acridine 3b was diazotized by adding 1.2ml of 30% HCl and 4ml water to a solution of 0.209g, 0.001 mol of 3b in aqueous $NaNO_2$ 0.138G, 0.002 mol at (0-5) ^{o}C.

On completion of diazotization (1-2) hr, the diazoniun mixture was added dropwise to a solution of 0.482g , 0.002mol of (2,4-Dichloro-6-yl-δ-Triazine)-anilino in 10% NaOH. On completion of coupling (1-5) hr the precipitate was filtered off and washed with a hot chloroform and acetone to give 3C mp= 220-222, 72% yield. Show the scheme1



Scheme 1 : Structural formula of bisazo dyes 3C

RESULTS AND DISCUSSION

In present investigation we have prepared azo dyes by acridine as shown in Table 1. In which prepared for three steps as shown in scheme 1.

IR and ^{1}HNMR data reveals the structure of molecules of newly synthesized azo dyes 1C-5C. In IR, structure was confirmed by functional group identification. Amino group gave its peak at 3267.41 – 3257.77 cm^{-1}, and appearance of the weak absorption band at 1514.12 – 1577.77 cm^{-1} was due to the stretching band of azo group. The bands at 820 - 860 cm^{-1} and 1382 - 1388 cm^{-1} correspond to para disubstituted ring and -C-N-C stretching, respectively. The band at 731-734 cm^{-1} was due to the stretching band of C-Cl group. Figure1.

In ^{1}HNMR spectra of the azodyes 1C-5C showed the following signals: in Table2. Figure2.

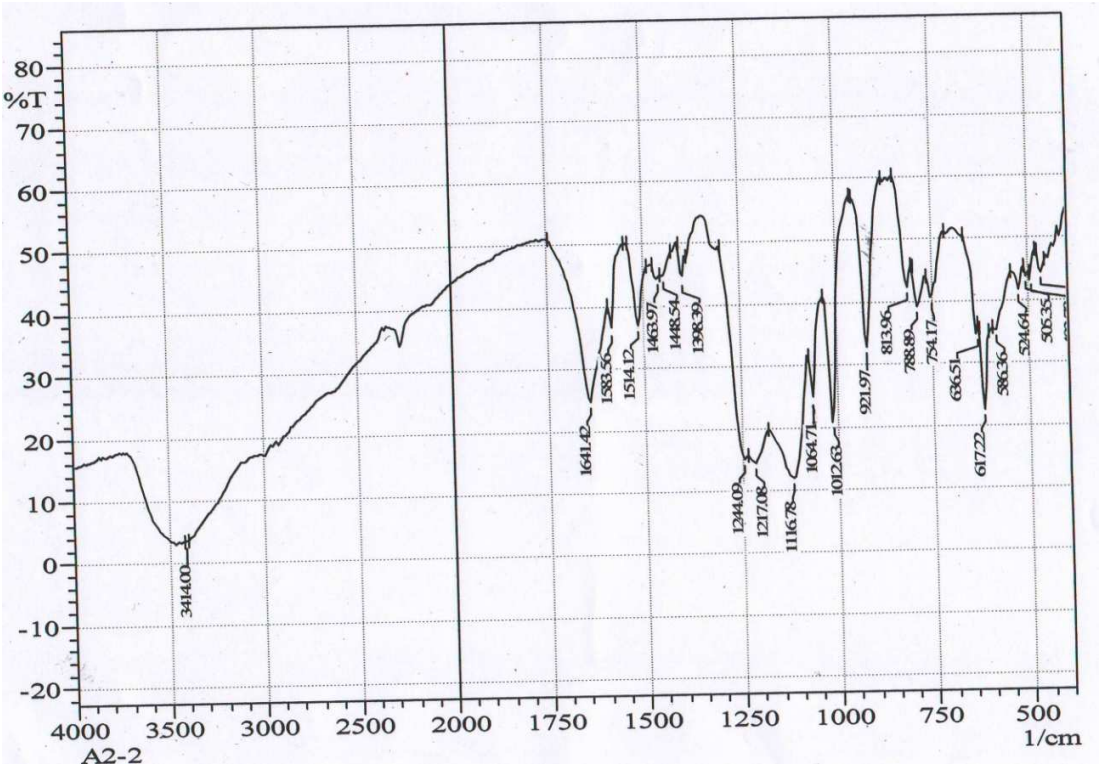


Figure1: IR Spectrum of compound 2c

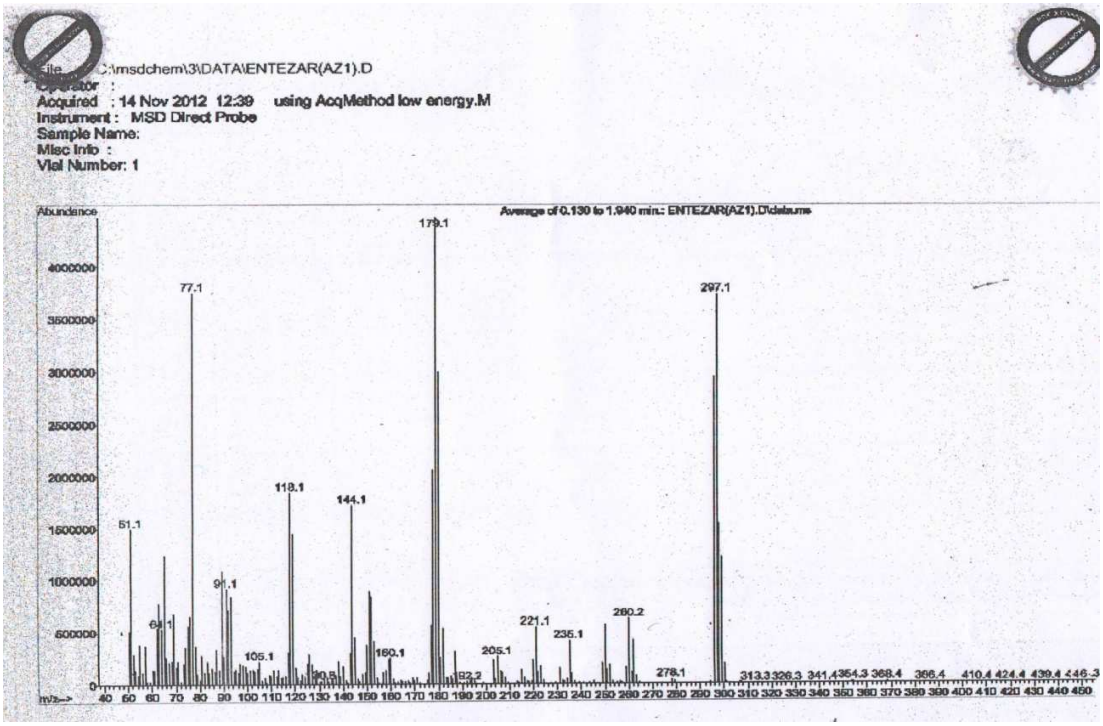


Figure2: The mass Spectrum of compound 1c

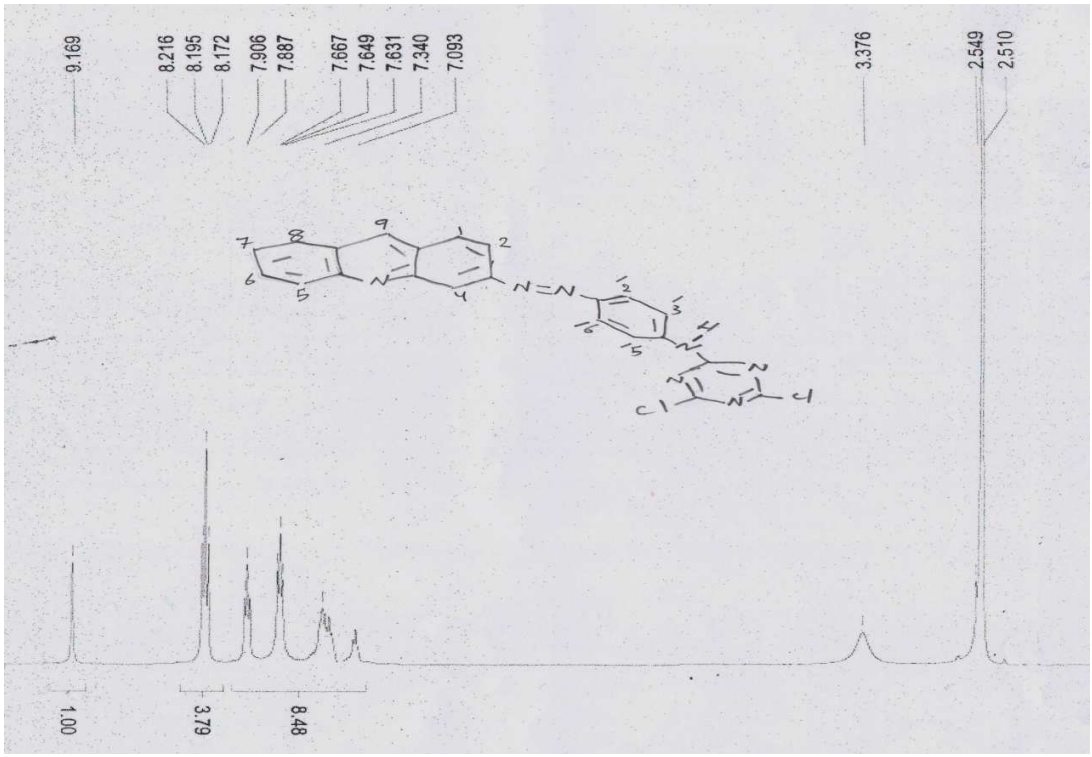


Figure3a: Proton NMR Spectrum of compound 1c

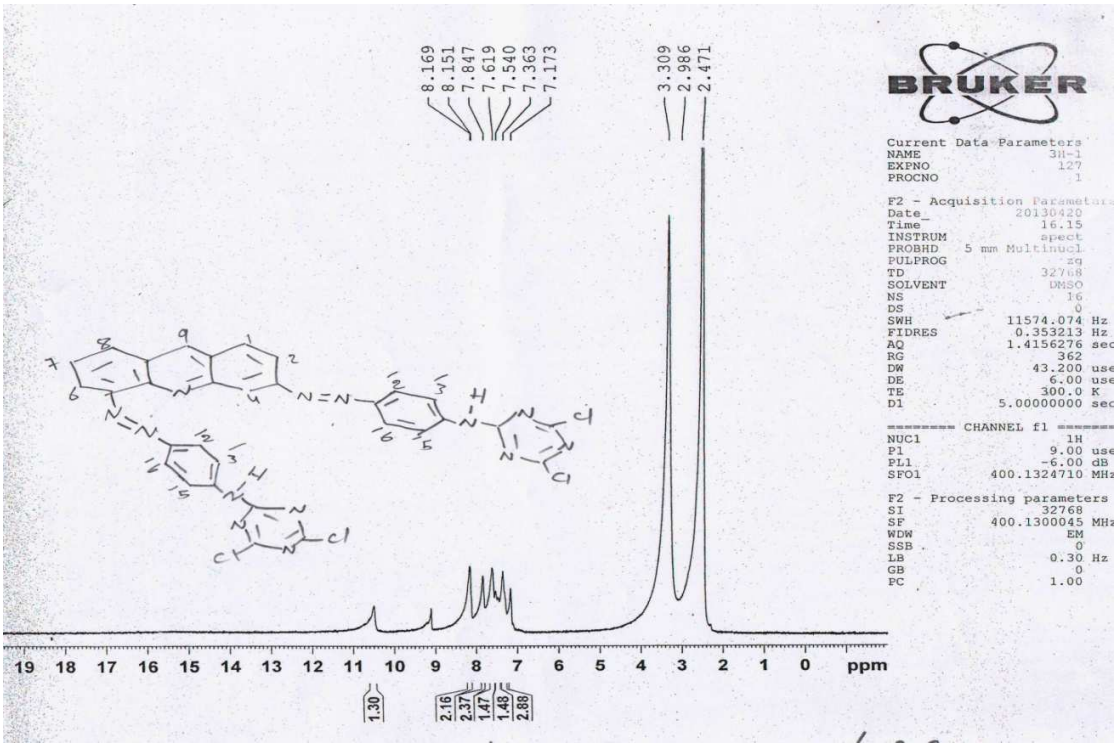


Figure3b: Proton NMR Spectrum of compound 2c

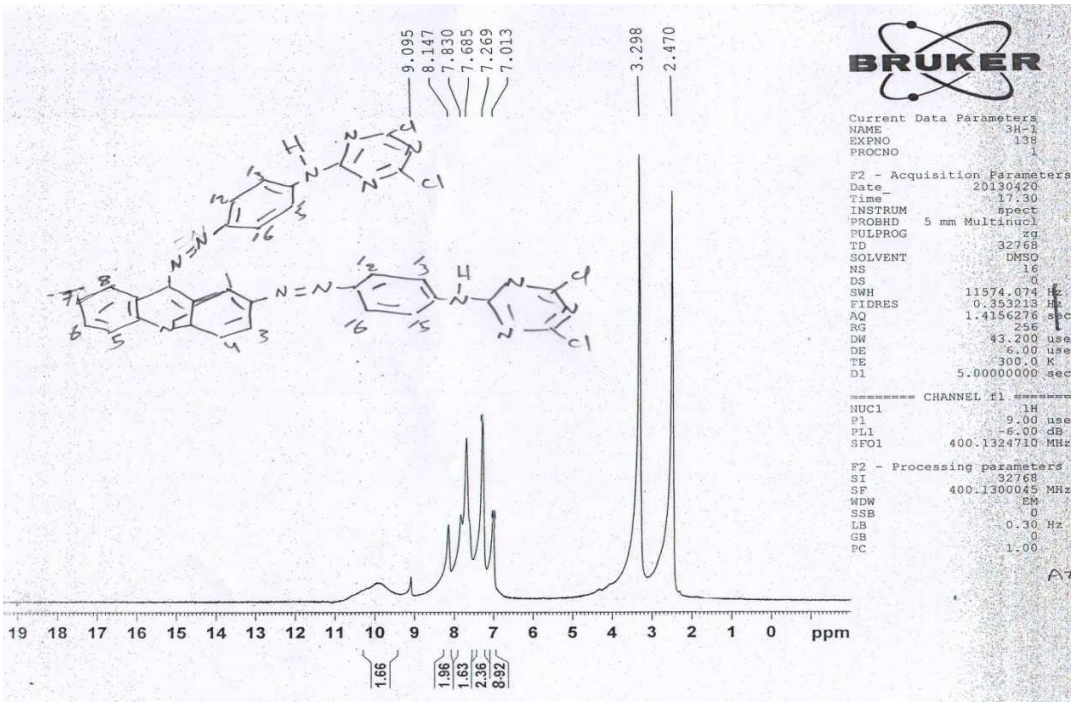


Figure3c: Proton NMR Spectrum of compound 3c

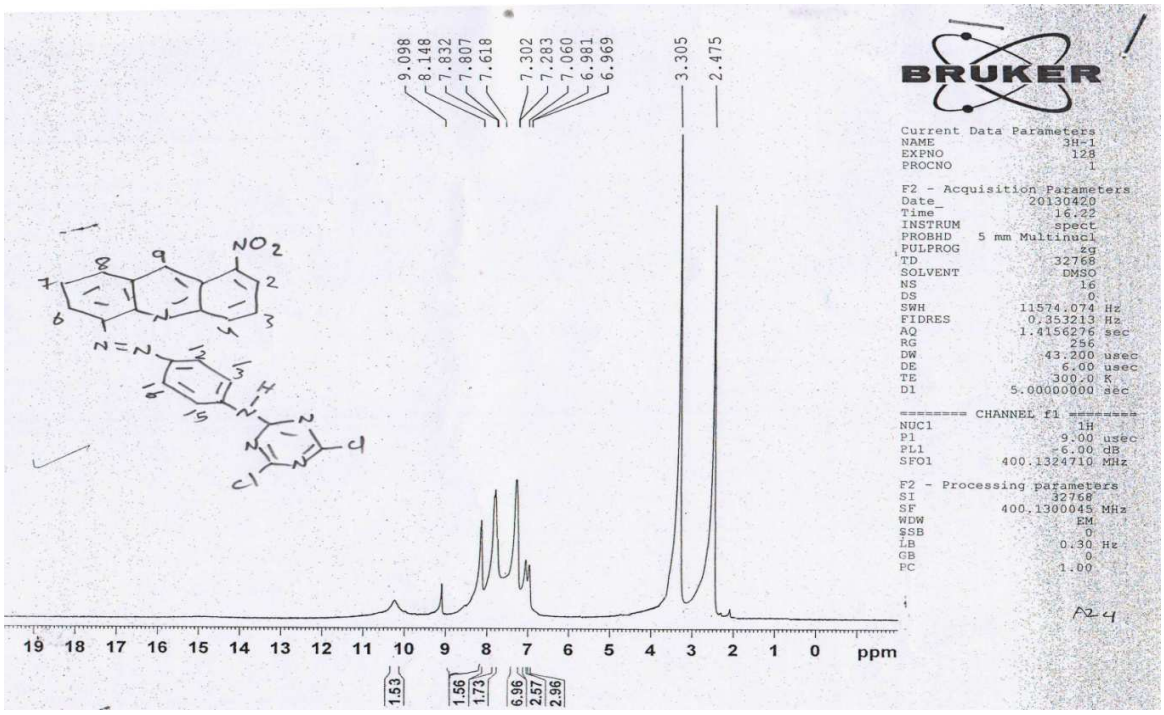


Figure3d: Proton NMR Spectrum of compound 4c

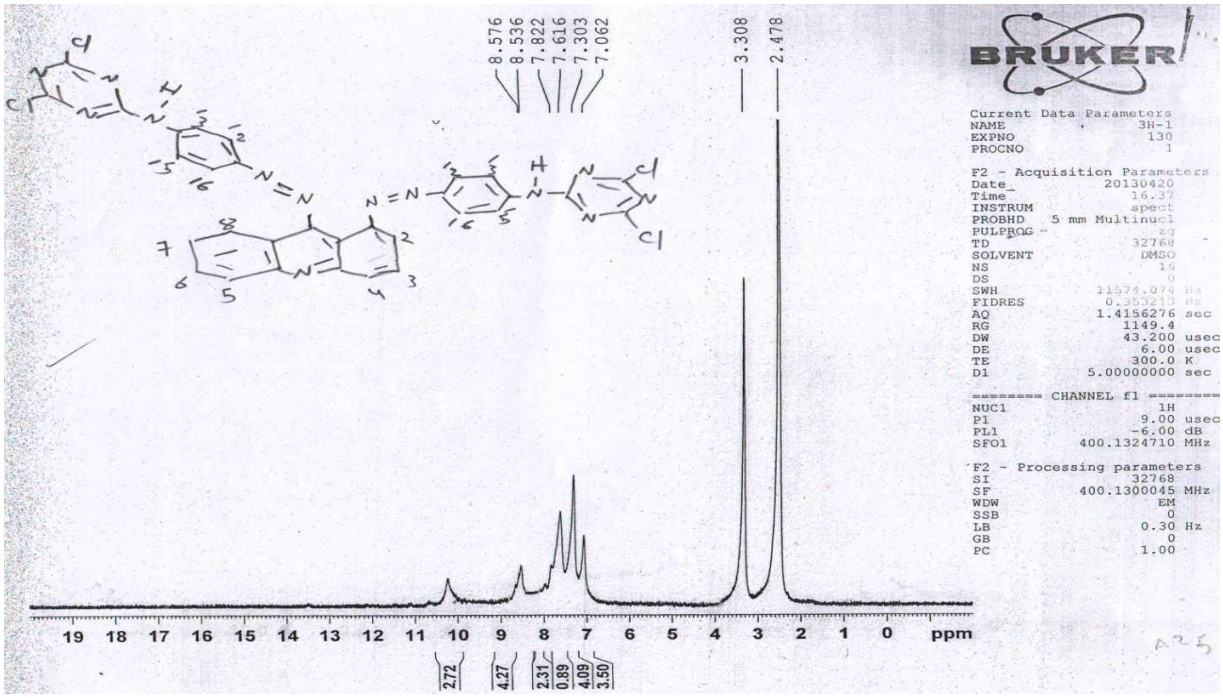


Figure3d: Proton NMR Spectrum of compound 4c

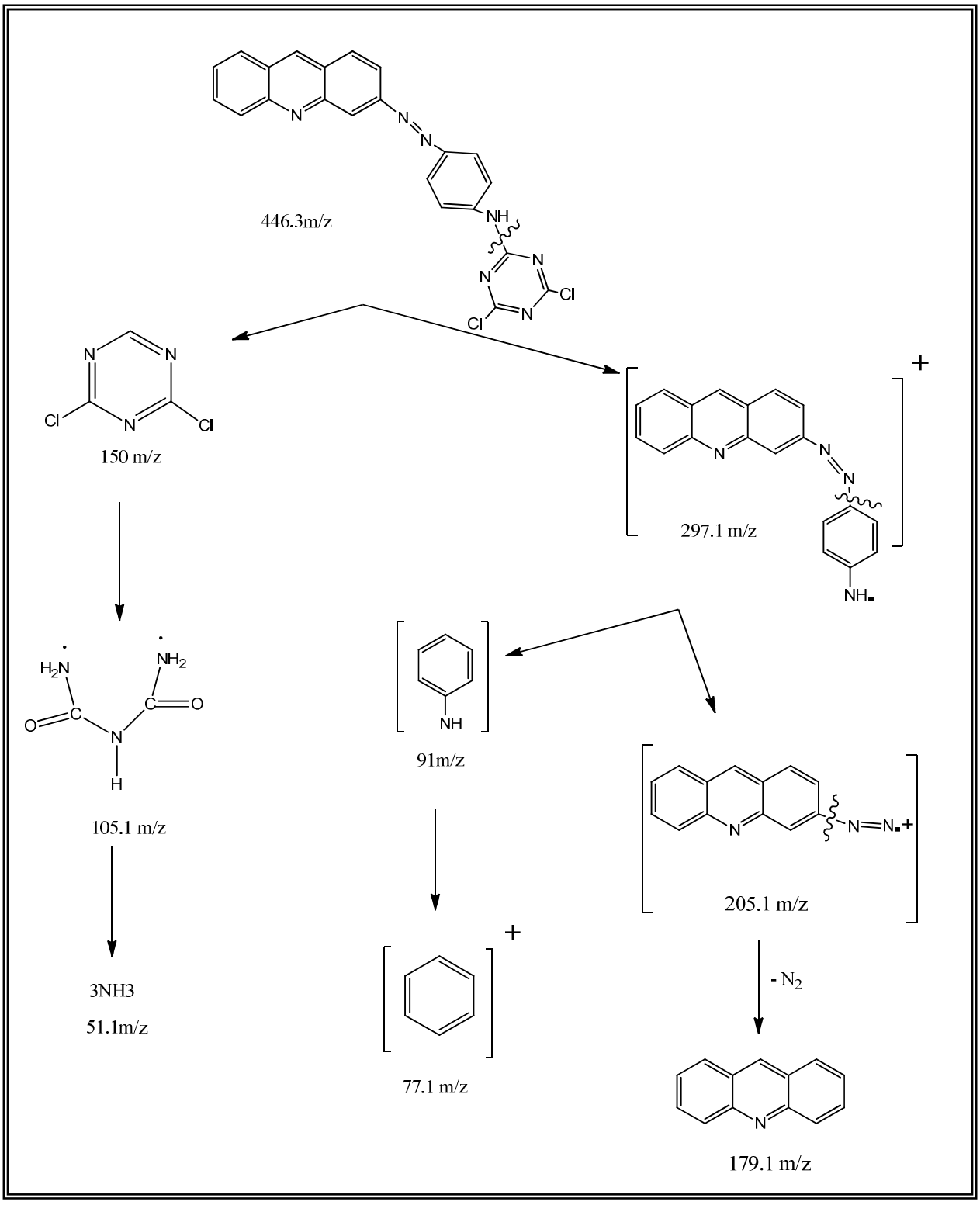
Table1. Physical data of azo dyes 1C – 5C

Sample No.	Formula	Color	Yield%	Mp °C	Calculated (found)			
					%C	%H	%N	Rf value
1C	$C_{22}H_{13}N_7Cl_2$	Pale yellow	45	190-192	59.247 (59.200)	2.940 (2.920)	21.984 (21.920)	0.8
2C	$C_{31}H_{17}N_{13}Cl_4$	Yellowish green	72	255-257	52.222 (52.219)	2.405 (2.250)	25.539 (25.520)	0.70
3C	$C_{31}H_{17}N_{13}Cl_4$	Yellow	58	220-222	52.222 (52.219)	2.405 (2.25)	25.539 (25.52)	0.69
4C	$C_{22}H_{12}N_8O_2Cl_2$	Dark yellow	64	130-132	53.817 (53.23)	2.465 (2.44)	22.822 (22.720)	0.64
5C	$C_{31}H_{17}N_{13}Cl_4$	red	30	260-262	52.222 (52.219)	2.405 (2.25)	25.539 (25.52)	0.71

Table2. The NMR spectra 0f the azo dyes 1C-5C

Sample No.	Chemical shift (δ in ppm)	Multiplicities	relative of proton	Assignment
1C	9.169	br,s	1	-NH
	7.093-7.340	m	4	Ar-H
	7.631-8.216	m	7	Acr-H
	8.216	s	1	H4
2C	10.50	br,s	2	-NH
	7.173-7.540	m	8	Ar-H
	7.619-8.169	m	6	Acr-H
	9.105	s	1	H4
3C	10.00	br,s	2	-NH
	7.013-7.269	m	8	Ar-H
	7.685-8.140	m	6	Acr-H
	9.095	s	1	H1
4C	10.201	br,s	1	-NH
	6.969-7.060	m	4	Ar-H
	7.283-8.147	m	6	Acr-H
	9.098	s	1	H9
5C	10.20	br,s	2	-NH
	7.062-7.303	m	8	Ar-H
	7.616-8.576	m	7	Acr-H

The mass spectra of the azo dyes 1C-5C are shown in figures 1 to 5.



Scheme 2: The major fragmentation paths of azo dye of acridine 1C

All the compounds exhibit parent peaks, and the base peaks of azo dyes of acridines are dependent on the derivatives of amino acridine. All the spectra of azo dyes of acridines compounds show similar fragmentations pattern.

The presence of the ion M^+ -179.1 and M^+ -297.1 could be taken as evidence of the molecular acridine ring and the molecular amino acridine, as shown in scheme2.

Further fragmentation of the azo dyes of acridines showed fragmention peak at m/z = 77 related to the phenyl ion as shown in scheme 2.

Each spectrum, which refers to the fragmentation, involved loosing of NH_3 group at m/z = 51. Respectively as shown in scheme2. Figure3.

4- Biological evaluation

4.1 Evaluation of antibacterial Activity

The in-vitro antibacterial of azo dyes of acridine (1C-5C) were determined by agar cup plate method [19], the results of which are summarized in Table 3

Table 3 : Antibacterial data of compound (1C-5C).

C	Zon of inhibition in mm							
	S. aureus				*E.Coli*			
	50µg	100 µg	150 µg	200 µg	50µg	100 µg	150 µg	200 µg
1C	R	R	MS	MS	R	R	R	MS
2C	R	R	MS	MS	R	R	R	MS
3C	R	R	MS	MS	R	R	R	R
4C	R	R	MS	S	R	R	R	MS
5C	R	R	MS	MS	R	R	R	MS

R= Resistance
MS=Middle sensitive

The antibacterial data in table 3 clearly showed that the halogen (chloro) and nitro groups have an inhibition zone dimeter larger than other azo dyes compounds. From the results, we concluded that all compounds showed good activity against s-aureus and E.coli. however, the tested azo dyes compounds were less active in comparision to cefotaxime standard drug.

CONCLUSION

In conclusion, the results of this investigation revealed that observed increase in antibacterial activities are attributed to presence of acridine ring that contain N-H and azo group. Obviously, the comparative evaluation of active compounds will required further studies, the data reported in this article may be helpful guide for the medicinal chemist who are working in this area. So, the color of a dye is deep and dull when the number of azo groups increases in the molecular structure of the dye[20].

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