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Synthesis , spectroscopic characterization and biological study of some new Schiff bases based on 2-hydroxybenzadehyde

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ABSTRACT

Four new Schiff bases were synthesized from condensation of aldehyde (2-hydroxy benzaldehyde) with aromatic amines (4-introaniline ; 4,4-oxydianiline ; 4,4-diaminodipleny sulfone and sulfanilamide) . These Schiff bases were characterized by IR, NMR , GC. mass and element analysis. Moreover, the Schiff bases were screened for their antibacterial and antifungal activity against various microorganisms and compared with standard compounds. In general , the results were indicated that some Schiff bases had good antimicrobial activity.

Keywords

Schiff base , antibacterial , antifungal , spectroscopic

Academic Discipline And Sub-Disciplines

chemistry

SUBJECT CLASSIFICATION

Application of chemistry

INTRODUCTION

In general Schiff bases are formed by condensation of primary amines or diamines with aldehydes or ketones. The chemistry of Schiff bases is an area of increasing interest [(1)]. Schiff bases are generally bidentate, tridentate , tetra dentate or polydentate ligands capable of forming very stable complexes with transition metals. They can only act as coordinating ligands if they bear a functional group, usually the hydroxyl, sufficiently near the site of condensation in such a way that five or six membered ring can be formed when reacting with metal ion [(2,3)] . Schiff bases derived from aromatic amines and aromatic aldehydes have a wide variety of applications in many fields , e.g. , biological , inorganic and analytical chemistry [(4,5)]. Many biological important Schiff bases have been reported in the literature processing , antimicrobial , antibacterial , antifungal , anti-inflammatory, anticonvulsant , antitumor and anti HIV activities [(6-9)] . Also , Schiff bases structure is used in transamination [(10)] . The aim of the present study , is to synthesis Schiff bases which are based on the condensation of 2-hydroxy benzaldehyde with aromatic mono and diamines , and investigate their effect on the different bacteria and fungus.

Subsequent Pages

Experimental:

Materials and reagents

All materials and solvents used in the present study are chemically pure grade. They included sulfanilamide , 2-hydroxybenzaldehyde , 4-aminophenyl ether (Merck Chemical Co.) Acetic acid , 4.4-diamino diphenylsulfone (Fluka Chemical Co.) and 4-nitroaniline (BDH.Chemical Co.) . The organic solvents used included ethanol , dimethylsulfoxide (DMSO) , cyclohexane , butanol and gasoline . All these solvents were spectroscopic pure grade solvents from BDH

Used instruments

Carbon, hydrogen and nitrogen were analyzed by elemental analysis apparatus (Euro Vector EA 3000A Italy) . Infrared spectra (4000–400 cm-1) were obtained with KBr disc technique using test scan Buck 500 Spectrophotometer . 1HNMR spectra were recorded using Varian 300 MHz NMR Spectrometer, using tetramethylsilane (TMS) as an internal standard in DMSO-d6 . 13C NMR spectra were recorded using Jeol ECA-500 , 125 MHz NMR Spectrometer, all the spectra were reported by employing TMS as internal reference and deuterated dimethylsulfoxide (DMSO) as solvent at ambient temperature. Mass spectra of the Schiff bases were recorded with the aid of Q 1000 EX GC–MS Shimadzu (Japan) spectrometer at 70 ev and 100 lA energy .

Synthesis of the Schiff Bases

Synthesis of the Schiff Base X1

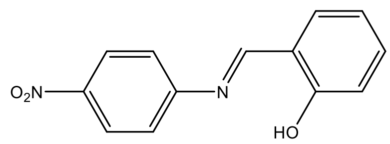
The Schiff bases were synthesized in a similar manner by following procedure (11): to a stirred solution of 1.22 g , 0.01 mole of 2-hydroxybenzaldehyde in ethanol (50 ml) was added dropwise an ethanolic solution (50 ml) of 1.38 g , 0.01 mole (4- Nitro Aniline). This mixture was then refluxed for 6 hrs. The mixture was cooled at room temperature , then cooled for 24 hrs at 5 °C . The solid was filtered and washed with cold ethanol and dried over silica .

Synthesis of Schiff bases X2, X3 , X4

These Schiff bases compounds are synthesized from reaction of 2-hydroxybenzaldehyde (0.02 mol , 2.44 g) with some diamines both alone (4,4- oxy dianiline (0.01 mol , 2.28 g) , 4,4- diamino diphenyl sulfone (0.01 mol , 2.36 g) or sulfanilamide (0.01 mol ,1.72 g) to give (X2 , X3 , X4) compounds respectively . These compounds are synthesized as a similar paper (12) in ethanol under reflux with a few drops of acetic acid as a catalyst .

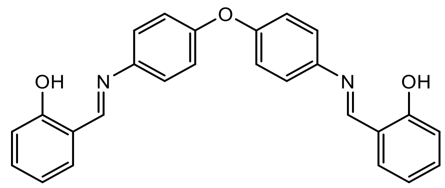
Results and Discussion:

The results of elemental analysis for synthesized Schiff bases show that the found percentages of carbon , hydrogen and nitrogen are equivalent to calculated values as show in Table (1) . The proposed structural representations of the synthesized Schiff bases are given in Figure (1) .



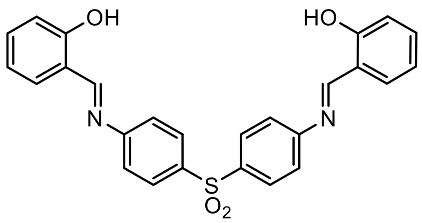
(*E*)-2-(((4-nitrophenyl)imino)methyl)phenol

X1



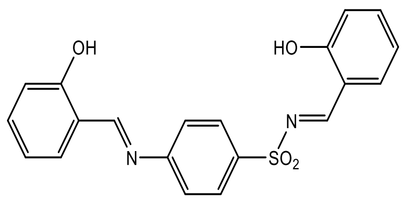
2,2'-((1*E*,1'*E*)-((oxybis(4,1-phenylene))bis(azanylylidene))bis(methanylylidene))diphenol

X2



2,2'-((1*E*,1'*E*)-((sulfonylbis(4,1-phenylene))bis(azanylylidene))bis(methanylylidene))diphenol

X3



N-((*E*)-2-hydroxybenzylidene)-4-(((*E*)-2-hydroxybenzylidene)amino)benzenesulfonamide

X4

Figure (1) : The structural formula of synthesized Schiff bases

Table (1): Some of the physical properties and elemental analysis of Schiff bases

Symbol	physical state	Color	Melting point (˚C)	Yield (%)	solvent used in recrystallization	%C Cal. Found	%H Cal. Found	%N Cal. Found
X1	Crystals	orange	160-161	73.0	Cyclohexane	64.45 63.91	4.16 4.25	11.56 12.07
X2	Crystals	Yellow	212-214	81.0	Butanol	76.45 77.30	4.93 4.70	6.85 6.59
X3	powder	yellow	269-270	89.5	gasoline	68.40 69.11	4.42 4.40	6.13 6.30
X4	powder	yellow	216-217	63.3	gasoline	63.14 63.40	4.24 4.10	7.29 7.17

Spectroscopic Studies

The IR spectra of Schiff bases shown in Figures (2- 5) exhibit different bands in the 400 – 4000 cm-1 region . The OH stretching frequency is expected in the 3300 – 3800 cm-1 region , however , this frequency is generally displaced to the 3230-3400 cm-1 region due to the internal hydrogen bridge OH…..N=C (13). Hydrogen bonds in these Schiff bases are usually very strong and the electron - donating groups on the phenolic ring increase the election density on the hydroxyl oxygen making the O-H bond stronger (14) .

The Schiff bases exhibit the characteristic C=N band in 1605 – 1610 cm-1 region as reported for some similar compounds (15) . In the 1500 – 1595 cm-1 region , the observed bands were attributed to aromatic C=C vibrations . Also it was observed that the C-N stretching frequency for these Schiff bases occurs in the 1290 – 1305 cm-1 region . In addition, bands were appear in spectra of Schiff bases such as (1000 – 1280 cm-1) , (1100 – 1180 cm-1) and (1090 – 1430 cm-1) belonged to C-O-C (X2) , C-S-C (X3) and C-S-N (X4) respectively (16,17).

The results of 1HNMR , 13CNMR and mass spectra for synthesized Schiff bases were corresponded with each others as shown in Figures (5-15) and Tables (2-4).

For the above, the structures of the prepared Schiff bases were proved .

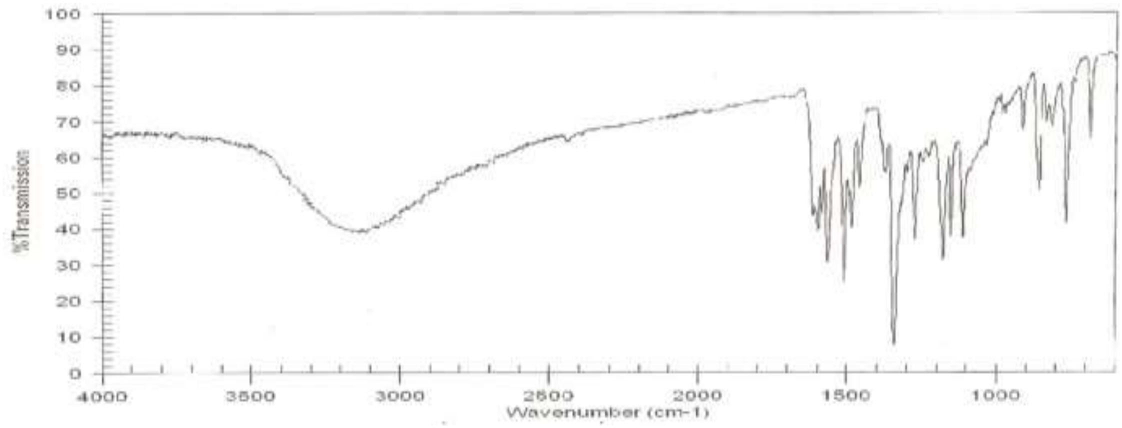


Figure (2) : IR spectrum of Schiff base X_1

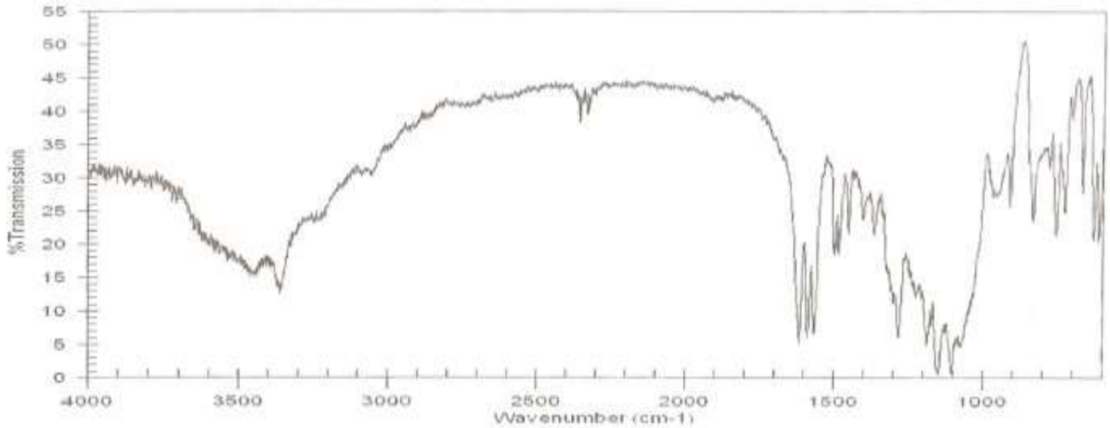


Figure (3) : IR spectrum of Schiff base X2

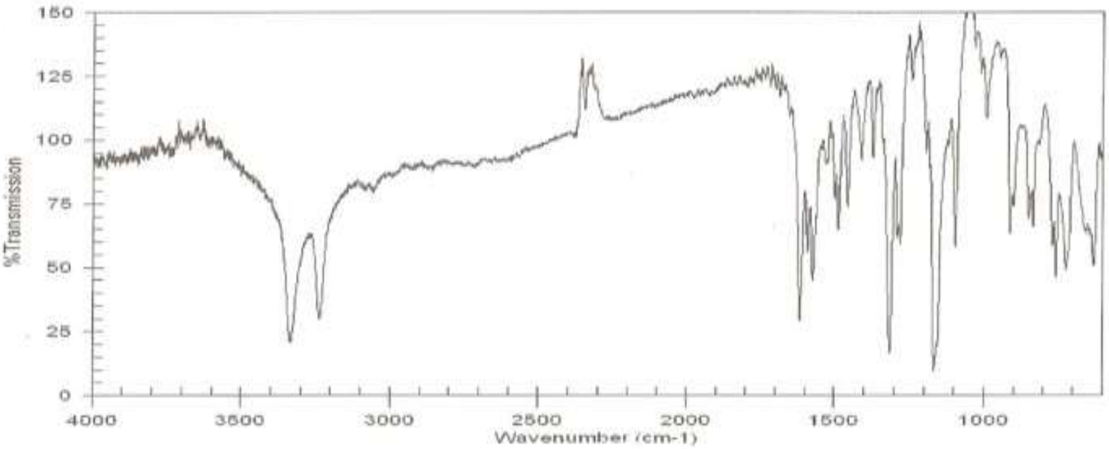


Figure (4) : IR spectrum of Schiff base X3

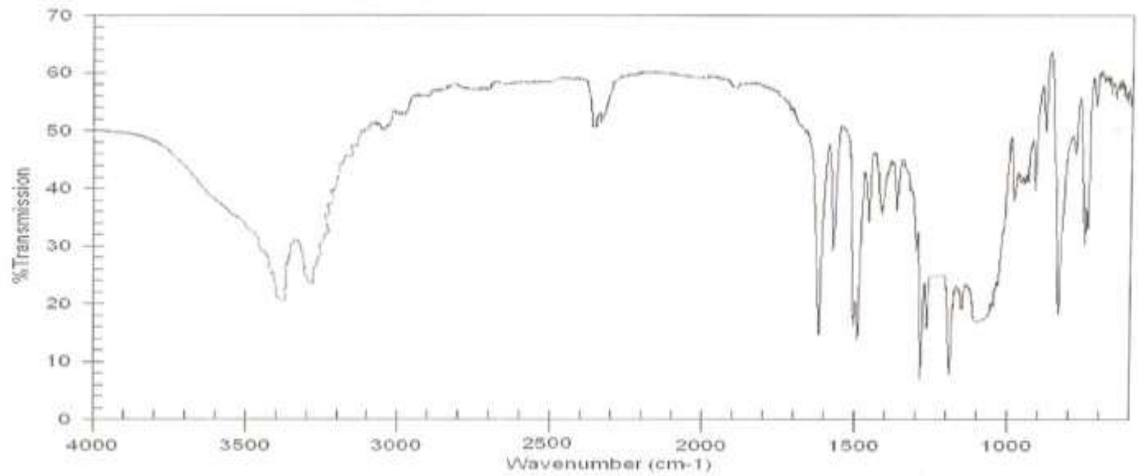


Figure (5) : IR spectrum of Schiff base X4

Table (2) : 1HNMR data of Schiff bases in DMSO

Symbol	molecular formula	Chemical shift δ (PPM)
X_1	$C_{13}H_{10}N_2O_3$	6.945-8.309 (m, 8H, Ar-H), 8.986 (S, 1H, HC = N)
X_2	$C_{26}H_{20}N_2O_3$	6.986-7667 (m, 16H, Ar, H), 8.986 (S, 2H, HC = N), 13.144 (S, 2H, OH)
X_3	$C_{26}H_{20}SN_2O_4$	12.48 (S, 2H, OH), 8.955 (S, 2H, HC = N), 6.972-8.069 (m, 16H, Ar-H)

m : Multiplet   S : Singlet

Table (3) : ^{13}CNMR data of Schiff bases in DMSO

Symbol	molecular formula	Chemical shift δ (PPM)
X_1	$C_{13}H_{10}N_2O_3$	166.059 (S,1C,C-OH), 166.059 (S,1C,C-OH), 155.023-117.230 (m,11C,Ar-C)
X_2	$C_{26}H_{20}N_2O_3$	163.226 (S,2C,C-OH), 160.662 (S,2C, C=N), 156.069-117.040 (m,22C,Ar-C)
X_3	$C_{26}H_{20}SN_2O_4$	166.075 (S,2C,C-OH), 160.678 (S,2C,C=N) 153.603-117.196 (m,22C,Ar-C),

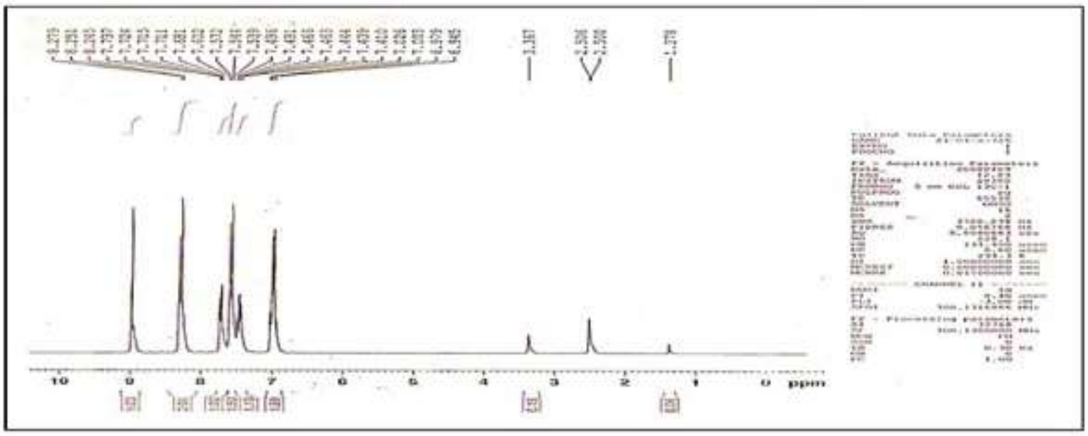


Figure (6) : ^{1}HNMR spectrum of Schiff base X_1

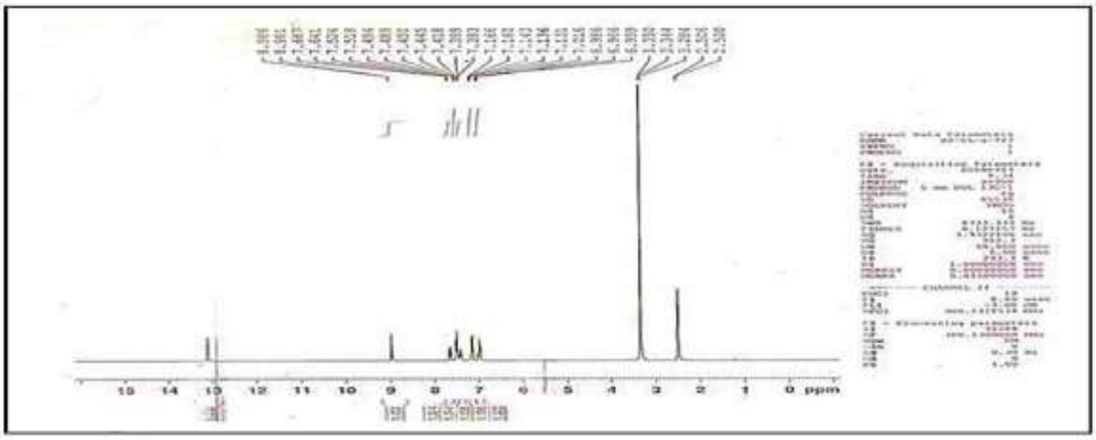


Figure (7) : [1]HNMR spectrum of Schiff base X_2

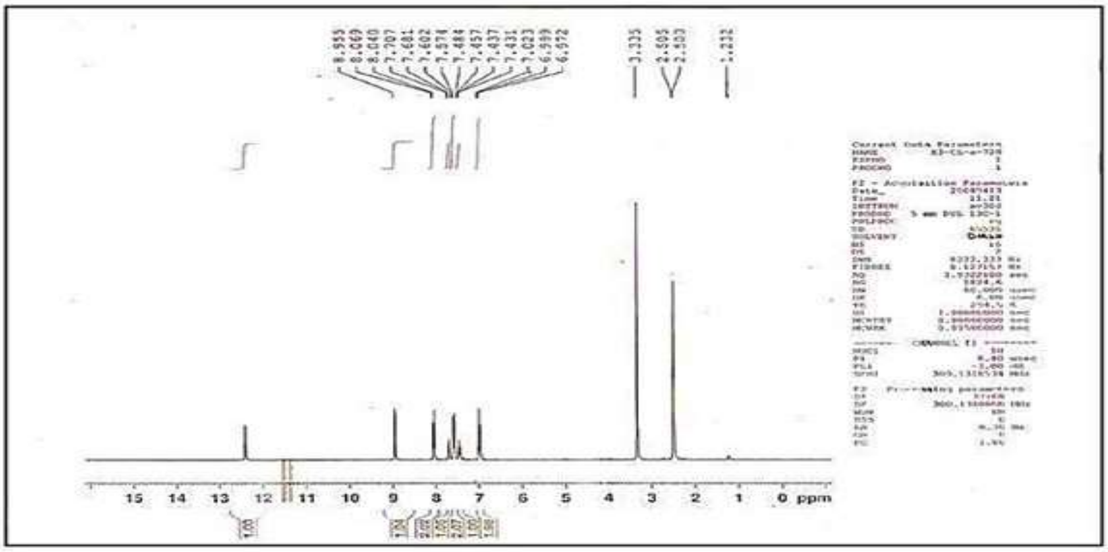


Figure (8) : [1]HNMR spectrum of Schiff base X_3

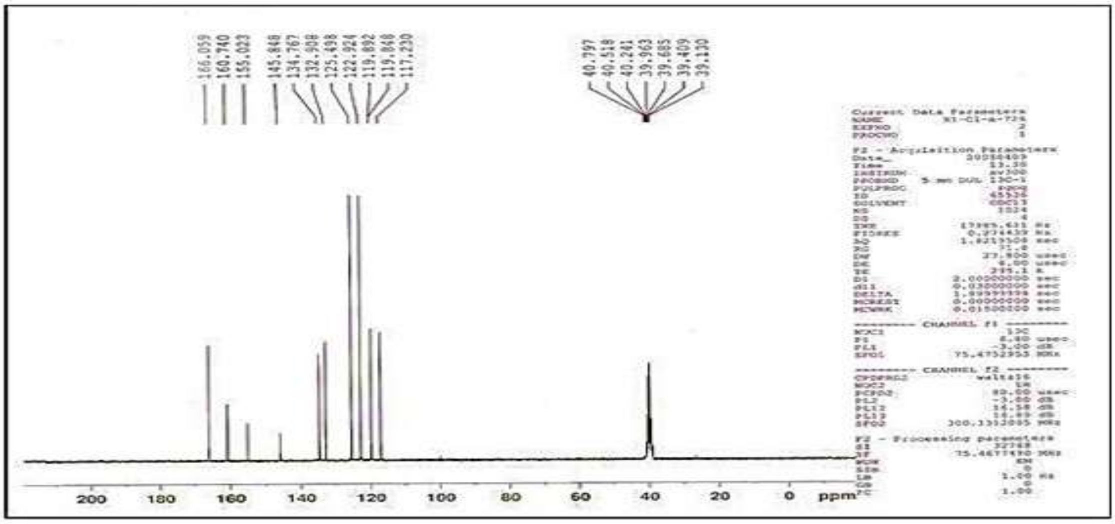


Figure (9) : 13CNMR spectrum of Schiff base X1

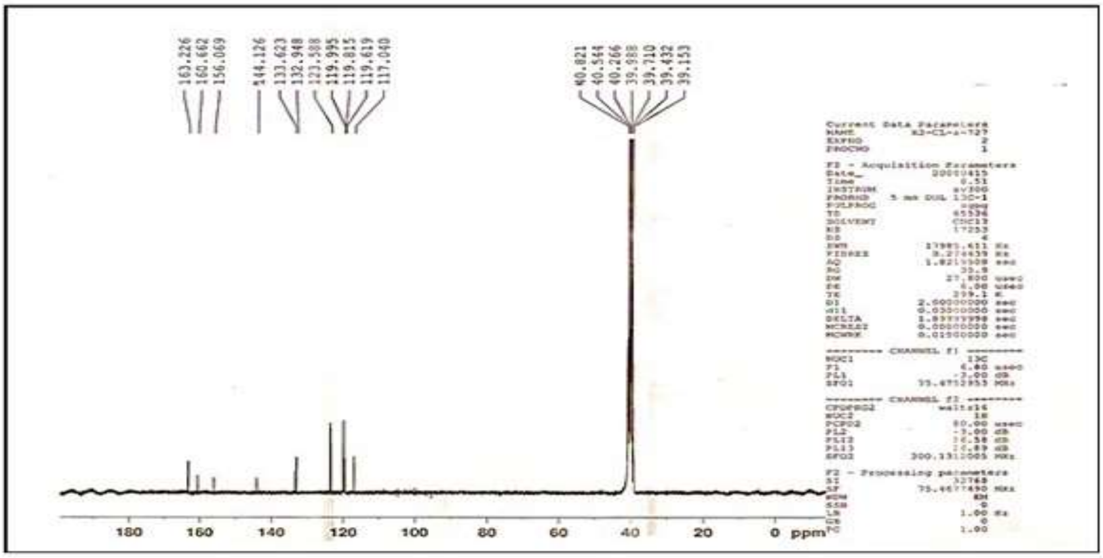


Figure (10) : 13CNMR spectrum of Schiff base X2

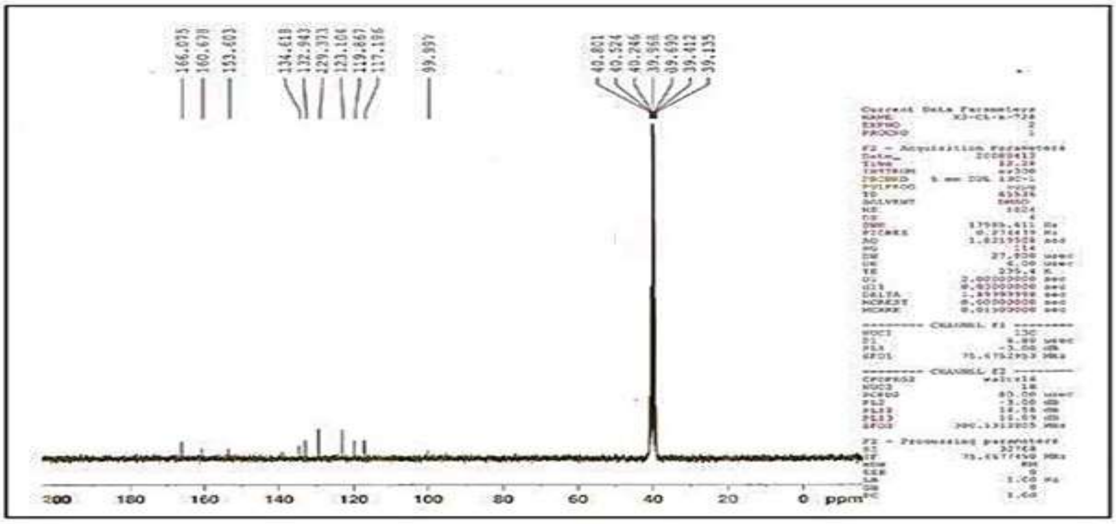


Figure (11) : 13CNMR spectrum of Schiff base X3

Table (4) : Mass spectra data of Schiff bases

Symbol	(m/z)	Relative abundance %	fragment
	243	6.95	$[M+1]^+$
	242	58.44	$M\ (C_{13}H_{10}N_2O_3)^+$
	167	33.44	$[M-C_6H_3]^+$
X_1	120	41.25	$[M-C_6H_4NO_2]^+$
	77	87.50	$[M-C_6H_5]^+$
	63	100.00	$[M-C_{13}H_9N]^+$
	408	2.38	$M(C_{26}H_{20}N_2O_3)^+$
	85	35.00	$[M-C_{25}H_{13}]^+$
	71	37.14	$[M-C_{26}H_{11}N]^+$
X_2	69	47.86	$[M-C_{26}H_{13}N]^+$
	57	79.05	$[M-C_{26}H_{11}N_2]^+$

	55	100.00	$[M-C_{26}H_{13}N_2]^+$
X_3	458 195 120 108 92 65	4.63 14.75 16.75 26.13 40.00 100.00	$M(C_{26}H_{20}SN_2O_4)^+$ $[M-C_{13}H_{12}SNO_3]^+$ $[M-C_{19}H_{14}SNO_3]^+$ $[M-C_{19}H_{12}SN_2O_3]^+$ $[M-C_{20}H_{16}SN_2O_3]^+$ $[M-C_{26}H_{19}N_2O]^+$
X_4	380 119 103 81 77 69	16.79 17.91 27.99 26.87 29.86 100.00	$M(C_{20}H_{16}SN_2O_4)^+$ $[M-C_{13}H_{11}SNO_3]^+$ $[M-C_{13}H_{11}SNO_4]^+$ $[M-C_{20}H_{15}N_2O]^+$ $[M-C_{14}H_{11}SN_2O_4]^+$ $[M-C_{20}H_{11}N_2O_2]^+$

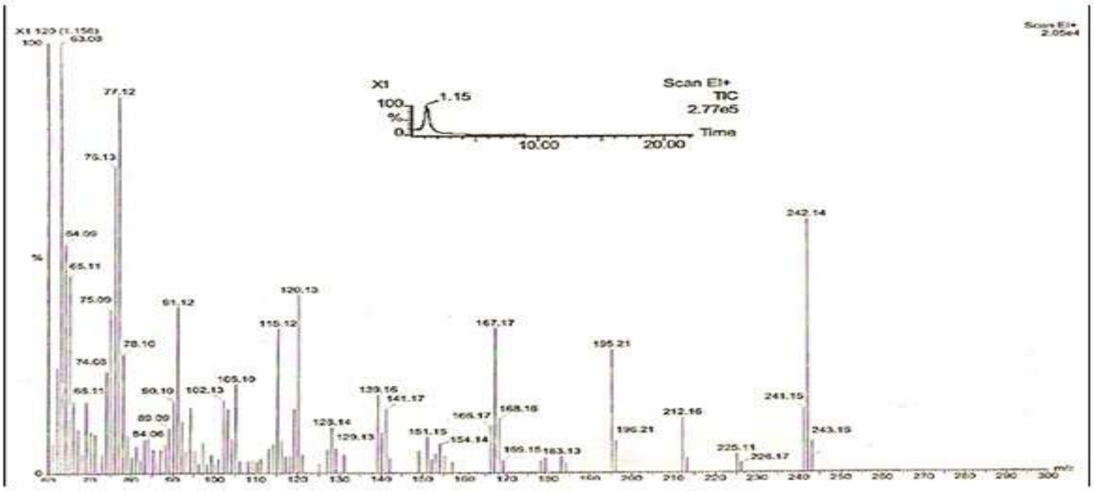


Figure (12) : Mass spectrum of Schiff base X_1

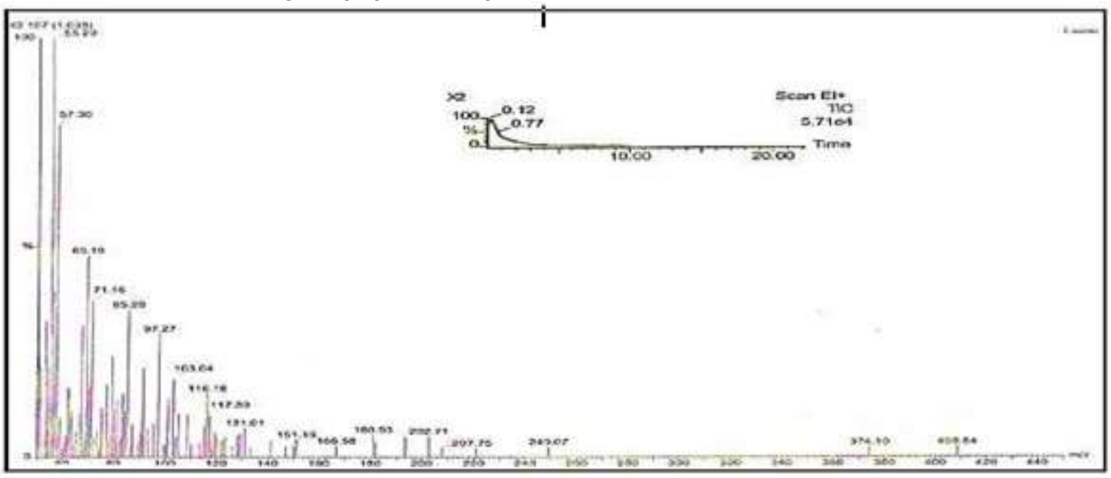


Figure (13) : Mass spectrum of Schiff base X_3

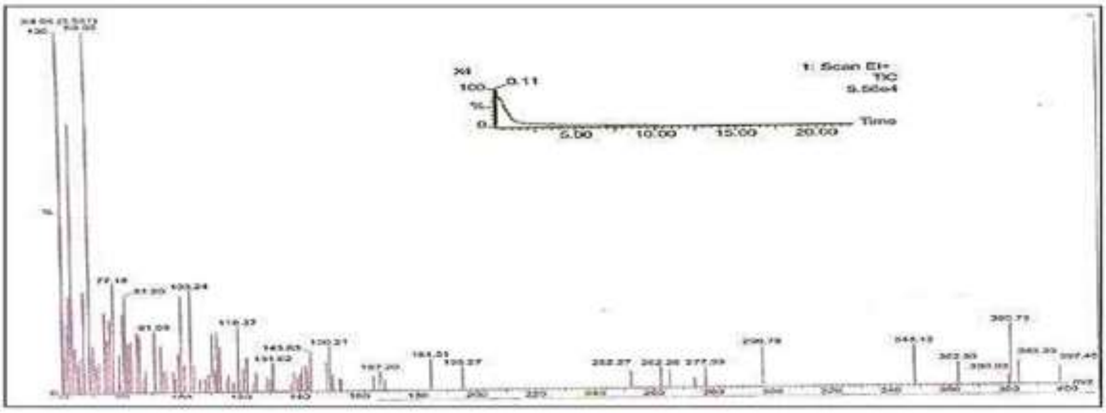


Figure (14) : Mass spectrum of Schiff base X4

Biological Study

All synthesized Schiff bases were screened for antibacterial activity against positive staphylococcus aureus (ST) and negative Escherichia coli (E.coli) by the standardized disk-diffusion method (18) . These Schiff bases were dissolved in DMSO which has no inhibition activity to get different concentrations .

The effect of the Schiff bases X1, X2, X3, and X4 on ST and E.coli were demonstrated in Figure (16) and Table (5) . The data showed that all Schiff bases accept (X2) at concentration (0.0005,0.001,0.005,0.01 g/ml) had antibacterial effect. This effect decrease with decreasing concentration . The antibacterial effect is due to the presence of azomethine (imine) group and some functional group (SO_2, NO_2) which have chelating properties. These properties may affect bind the bacterial cell at specific site and thus inhibit their growth (19).

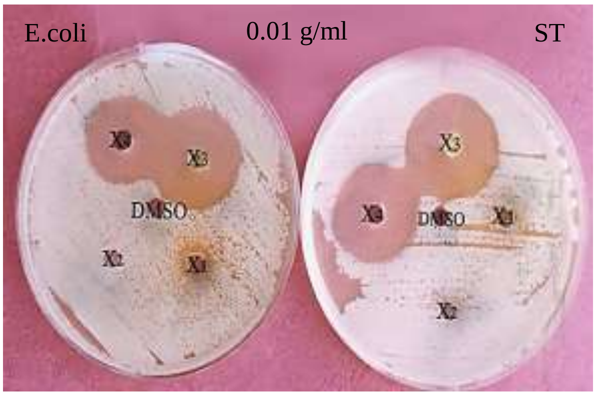
Comparison between Schiff bases containing substituent NO_2 (X1) and those containing SO_2 (X3, X4) on the bacteria were studied and it was found the Schiff base X3 had higher antibacterial effect at all concentrations on the positive and negative bacteria. In addition, X1 showed no antibacterial effect on bacteria with decreasing its concentration .

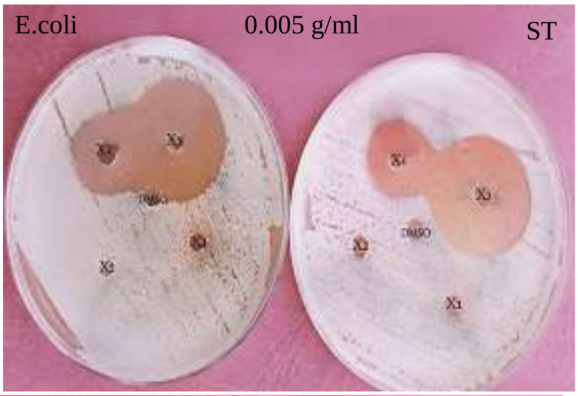
The antibacterial activity of Schiff bases (X3, X4) was compared with standard compounds (AK3 and Cl30) and primary amines (MX3 and MX4) at concentration 30 µg/ml in DMSO. The data shown in Table (6) and figure (17) show that (X3) only have good antibacterial activity against both St and E-Coli. .

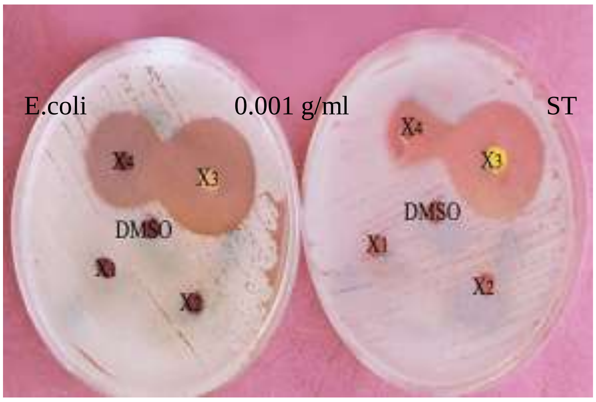
On the other hand. The antifungal activity of all the synthesized Schiff bases at concentration 0.05 g/ml were carried out against Aspergillus fumigates (ASP) and panicillium (PAN) . The antifungal activity shown in Table (7) and Figure (18) were indicated that X1 only have inhibition ability because of presence of NO_2 groups and structural properties which increase activity explained by the chelation theory (20) . Schiff base X1 was compared with its primary amine (4-nitro amine, MX1) at concentration 0.005 g/ml and it was founded MX1 is more activity than X1 against Aspergillus while both compounds have not activity against panicillium .

Table (5) : Antibacterial activity results of the Schiff bases

Symbol of Schiff base	Diameter of inhibition zone (cm)							
	Bacteria species							
	S. aureus				E.coli			
	0.01 g/ml	0.005 g/ml	0.001 g/ml	0.0005 g/ml	0.01 g/ml	0.005 g/ml	0.001 g/ml	0.0005 g/ml
X_1	0.3	0.1	-	-	0.9	0.7	-	-
X_2	-	-	-	-	-	-	-	-
X_3	3.0	2.8	2.5	2.3	2.9	2.6	2.2	2.0
X_4	2.6	2.4	2.1	1.8	2.4	2.2	2.0	1.7







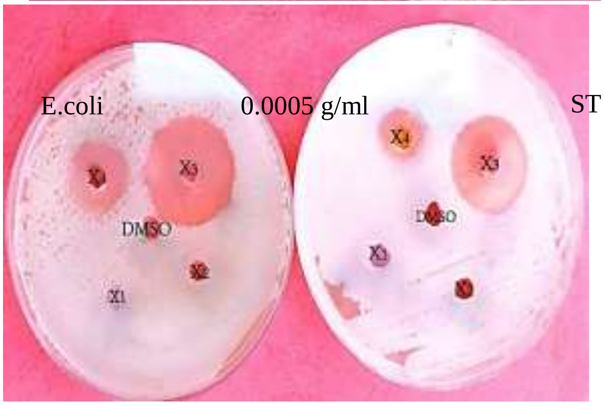


Table (6) : Comparison of antibacterial activity of some Schiff bases with standard compounds and primary amines

Symbol	Diameter of inhibition zone (cm)	
	Bacteria species	
	S. aureus	E.coli
	30 µg/ml	30 µg/ml
X_3	2.0	1.8
X_4	-	-
MX_3	-	-
MX_4	2.2	2.6
MK_{30}	2.2	2.1
CL_{30}	2.8	2.1

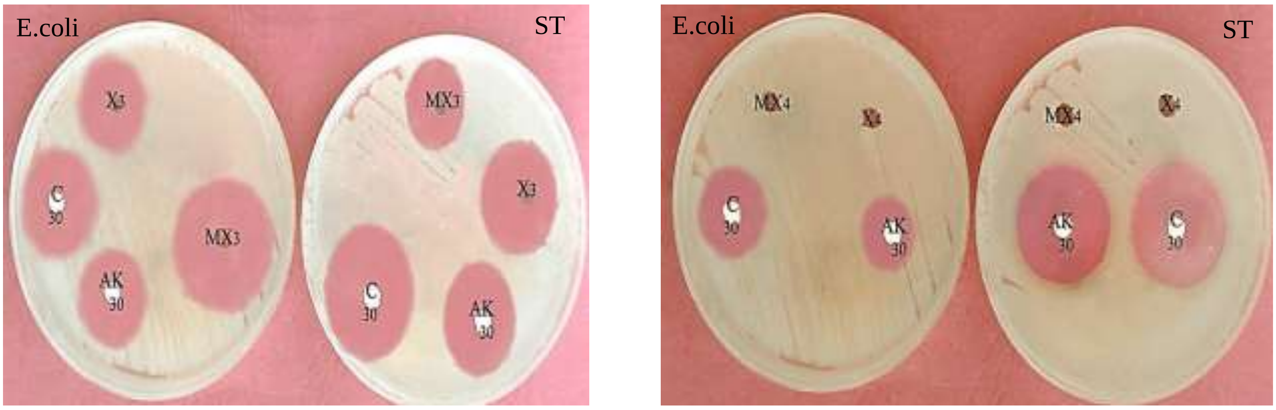


Figure (16) : Antibacterial activity of Schiff bases and standard compounds at concentration 30 μg/ml

Table (7) : Antifungal activity results of the Schiff bases

Symbol	Diameter of inhibition zone (cm)			
	Fungi species			
	Aspergillus		Panicillium	
	0.05 g/ml	0.005 g/ml	0.05 g/ml	0.005 g/ml
X_1	2.1	1.1	2.4	-
X_2	-	-	-	-
X_3	-	-	-	-
X_4	-	-	-	-
MX_1	not measured	not measured	1.3	-

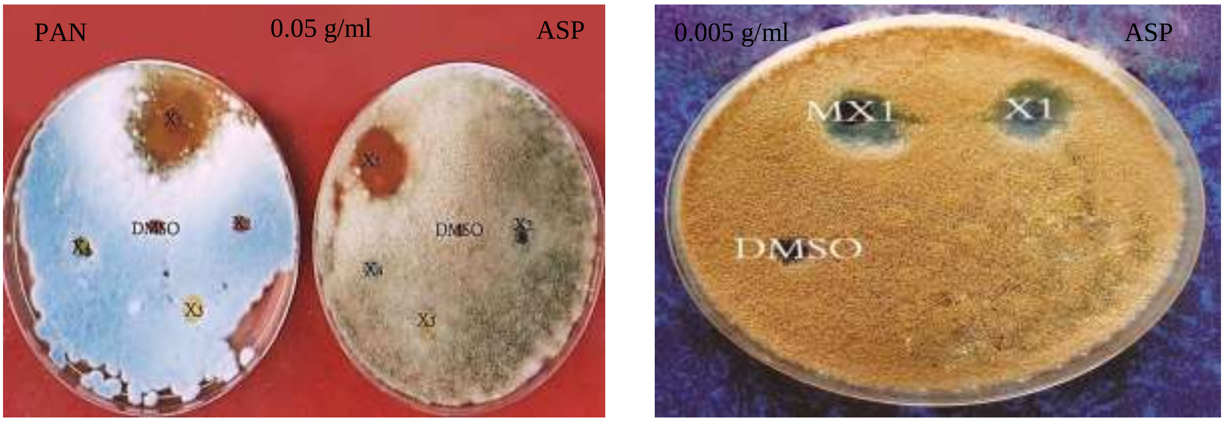


Figure (18) : Antifungal activity of Schiff bases and primary amines at different concentrations

Conclusion:

New Schiff bases X1, X2, X3, and X4 were synthesized and characterized. The structural properties of these Schiff bases were proposed based on elemental analysis and spectral studies. All synthesized Schiff bases accept X2 had good antibacterial activity against St and E-Coli while it was found that X1 only was acted as antifungal against Aspergillus and Panicillium.

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