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Epoxy Aldehyde Schiff Bases: Synthesis and Antimicrobial Study

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ABSTRACT

Some new Schiff bases have been synthesized from epoxy aldehyde and their characterization was done by IR, NMR and mass spectral data. The antibacterial activity of these compounds has also been studied against some Gram positive and Gram negative bacteria in DMF and DMSO solutions. It is observed that in DMF, *P. mirabilis* is the most resistant bacteria whereas in DMSO, *S. aureus*, *K .Pneumoniae* and *S. typhimurium*are the most resistant strains. Overall, nitro group is most effective substitution for inhibiting the studied bacteria.

KEYWORDS

Epoxy aldehyde, Schiff bases, Antimicrobial activity DMF, DMSO.

INTRODUCTION

The chemistry of the carbon-nitrogen double bond plays an important role in the progress of chemistry.[1]Schiff base compounds have been used as intermediates for the synthesis of various bioactive compounds,[2,3]as corrosion inhibitor,[4] as analytical agent,[5] as complexing agent[6] etc. Further, this class of compounds are known to possess a wide range of biological activities, such as analgesic[7,8]anti-inflammatory[9], anti-convulsant,[10,11] anti-cancer,[12,13]antifungal,[14] anti ulcer,[15] anti bacterial[16]etc.Thus, in the present work, some new schiff bases have been synthesized from epoxy aldehyde and then antimicrobial activity was evaluated against some gram positive and gram negative bacteria in DMF and DMSO.

MATERIALS AND METHODS

The reagents and solvents used in this study were of analytical grade and used without any purification. All chemicals were purchased from Spectrochem Pvt. Ltd, Mumbai.

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The IR spectra of synthesized Schiff bases were scanned on SHIMADZU-FTIR 8400 spectrophotometer over the frequency range 4000-400 cm^{-1} 1H NMR spectra were scanned on Bruker Spectrometer (400 MHz) by using deuterated DMSO as a solvent. The Mass spectra were scanned on GCMS-SHIMADZU-QP2010.

EXPERIMENTAL

The Schiff bases were synthesized by the following method.

Synthesis of Schiff bases

Epoxy aldehyde (0.01M), substituted aromatic amines (0.01M) and few drops of concentrated HCl in 1,4 dioxane was refluxed for 9-10 h. After the completion of reaction, reaction mass was cooled to room temperature, poured in crushed ice and crude product was isolated. The product was crystallized in methanol and dried. The reaction scheme and Physical constants such as molecular formula, molecular weight, melting point, % yields, and R_f values along with the solvent system of all these Schiff bases are given in Table: 1 and Figure: 1 respectively.

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Table 1: Physical Constant of Synthesized Schiff Bases

Code	R	M.F.	M.Wt. g/mol.	R_f* Value	M.P. °C	Yield %
BKC-1	4-CH_3-C_6H_4-	$C_{17}H_{17}NO_2$	267.32	0.39	217	65
BKC-2	4-OCH_3-C_6H_4-	$C_{17}H_{17}NO_3$	283.32	0.46	241	64
BKC-3	4-Cl-C_6H_4-	$C_{16}H_{14}ClNO_2$	287.74	0.44	223	70
BKC-4	4-NO_2-C_6H_4-	$C_{16}H_{14}N_2O_4$	298.29	0.41	258	76

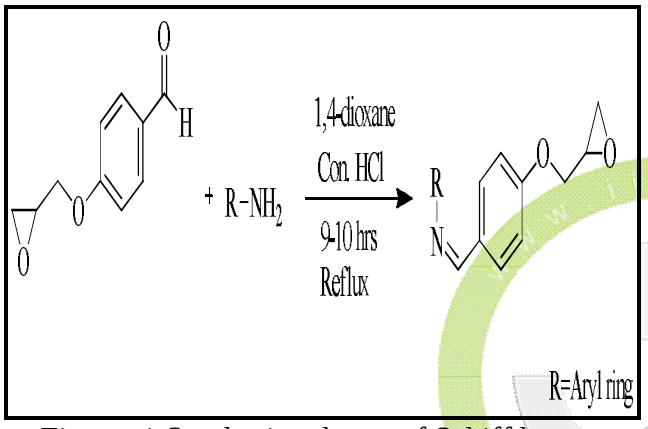

Figure: 1 Synthesis scheme of Schiff bases.

Characteristics of Schiff Bases

4-methyl-N-{(E)-[4-(oxiran-2-yl methoxy) phenyl] methylidene} aniline (BKC-1). IR (KBr) cm^{-1}**:** 3059 (Ar, C-H str.), 2951 (C-H str. (asym)), 2866 (C-H str.(sym)), 1625 (C=N str.), 1514 (aromatic C=C str.), 1474 (alkane C-H def.(asym.)), 1274 (Epoxy ring str. (sym)), 1053 (C-O-C str. (asym)), ms (m/z): 268 (M+1); ^{1}H NMR δppm:2.36 (3H, s), 4.19-4.25 (5H, m), 7.07-7.09(4H, m), 7.19-7.27(4H, m), 9.87 (1H, s, -N=CH).

4-methoxy-N-{(E)-[4-(oxiran-2-ylmethoxy) phenyl] methylidene} aniline (BKC-2). IR (KBr) cm^{-1}**:**3064 (Ar, C-H str.), 2958 (C-H str. (asym)), 2861 (C-H str.(sym)), 1629 (C=N str.), 1513 (aromatic C=C str.), 1463 (alkane C-H def.(asym.)), 1274 (Epoxy ring str. (sym)), 1160 (C-O-C str), 1059 (C-O-C str. (asym)), ms(m/z): 284 (M+1); ^{1}H NMRδppm: 3.8 (3H, s), 4.22-4.28 (5H, m), 7.15-7.19(4H, m), 7.21-7.25(4H, m), 9.88 (1H, s, -N=CH).

4-chloro-N-{(E)-[4-(oxiran-2-ylmethoxy) phenyl] methylidene}aniline(BKC-3).IR (KBr)cm^{-1}:3061 (Ar, C-H str.), 2968 (C-H str. (asym)), 2860 (C-H str.(sym)), 1621 (C=N str.), 1543(aromatic C=C str.), 1469 (alkane C-H def.(asym.)), 1264 (Epoxy ring str. (sym)), 1053 (C-O-C str. (asym)), 739 (C-Cl str.);ms (m/z): 289 (M+1); ^{1}H NMR δppm:4.25-4.29 (5H, m), 7.45-7.50(4H, m), 7.57-7.62(4H, m), 8.9 (1H, s, -N=CH).

4-nitro-N-{(E)-[4-(oxiran-2-ylmethoxy) phenyl] methylidene} aniline(BKC-4).IR (KBr), cm^{-1}:3070 (Ar, C-H str.), 2952(C-H str. (asym)), 2824 (C-H str.(sym)), 1626 (C=N str.), 1556 (N-O str. (asym)), 1543 (aromatic C=C str.), 1469 (alkane C-H def.(asym.)), N-O str.(sym.), 1267 (Epoxy ring str. (sym)), 1067 (C-O-C str. (asym)); ms (m/z): 299 (M+1); ^{1}H NMR δppm :4.27-4.32 (5H, m), 7.41-7.46(4H, m), 7.59-7.63(4H, m), 9.1 (1H, s, -N=CH).

ANTIMICROBIAL ACTIVITY

The synthesized compound was evaluated for antimicrobial activity against 3 gram positive bacteria viz. *S. aureus, B. cereus* and *B. Megaterium* and three Gram negative bacteria viz. *K. Pneumoniae, S. typhimurium* and *P. mirabilis*

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Preparation of the Test Compound

The solutions were prepared at a concentration of 2mg/ ml for all the Schiff bases in DMF and DMSO.

Preparation of the Plates and Microbiological Assay

The antimicrobial evaluation was done by agar well diffusion method using Mueller Hinton Agar No.2 as the nutrient medium. The agar well diffusion method was preferred to be used in this study since it was found to be better than the disc diffusion method as suggested by Parekh et al.[17] The bacterial strains were activated by inoculating a loop full of test strain in 25ml of N-broth and the same was incubated for 24h in an incubator at 37°C. 0.2 ml of the activated strain was inoculated in Mueller Hinton Agar. Mueller Hinton Agar kept at 45°C was then poured in the Petri dishes and allowed to solidify. After solidification of the media, 0.85 cm ditch was made in the plates using a sterile cork borer and these were completely filled with the test solution. The plates were incubated for 24 h at 37°C. The mean value obtained for the three wells was used to calculate the zone of growth inhibition of each sample. The controls were maintained for each bacterial strain and each solvent. The inhibition zone formed by these compounds against the particular test bacterial strain determined the antibacterial activities of the synthetic compounds.

RESULTS AND DISCUSSION

It is observed from Figure:2[A], that all the studied compounds exhibited significant inhibition against the selected Gram positive bacteria. The inhibition is maximum against *B. cereus* and inhibition is maximum for BKC-4. However, almost equal inhibition is exhibited by all Schiff bases against *S. aureus* and *B. Megaterium*. All compounds have same central moiety but different substitution groups at para position. Thus, against *S. aureus* and *B. Megaterium*, different substitution does not affect the activity where as against *B.cereus*, para nitro group is found be most effective. Fig.: 2[B] shows the zone of inhibition against three Gram negative bacteria in DMF. All compounds showed inhibition against *S. typhimurium* to the same extent. BKC-1 and BKC-4 exhibited inhibition against *K. pneumoniae* whereas BKC-2 and BKC-3 could not affect this bacterium. Only BKC-3 showed inhibition against *P.mirabilis*. Other compounds did not exhibit inhibition against this bacterium. Thus, only chloro group is effective against *P.mirabilis* whereas methyl and nitro groups present in BKC-1 and BKC-4 respectively are effective against *K. pneumoniae*. The methoxy group present in BKC-2 had no effect against both *P.mirabilis* and *K. pneumoniae* bacterial strains.Figure:3[A] and 3[B] show the zone of inhibition for the studied Schiff bases in DMSO against three Gram positive and Gram negative bacteria respectively. It is observed that all the studied compounds exhibited no inhibition against *S. aureus*. Thus, *S. aureus* is found to be most resistant bacteria in DMSO. Against other two Gram positive bacteria i.e., *B.cereus* and *B.Megaterium*, all the Schiff bases showed inhibition and maximum inhibition is exhibited by BKC-4.In BKC-4, substitution is nitro group at para position, which is found to be more effective against these bacteria in DMSO. Thus, solvent also play important role in inhibition. This is again proved against the Gram negative bacteria (Fig.:3 [B]). Against *K .Pneumoniae* and *S. typhimurium*, all the Schiff bases showed no inhibition. However, against *P. mirabilis*, BKC-3 and BKC-4 exhibited inhibition and inhibition is maximum for BKC-4.BKC-1 and BKC-2 again could not *P. mirabilis*. Thus, in DMSO, *K. Pneumoniae* and *S. typhimurium* is the most resistant strain.

Thus, it is concluded that structure of compound and solvent both plays important role in inhibition. Overall, nitro substitution is most effective. DMF is found to be better solvent for the studied bacteria and compounds. In DMF, *P. mirabilis* is the most resistant bacteria. In DMSO, *S. aureus*, *K. Pneumoniae* and *S. typhimurium* are the most resistant strains.

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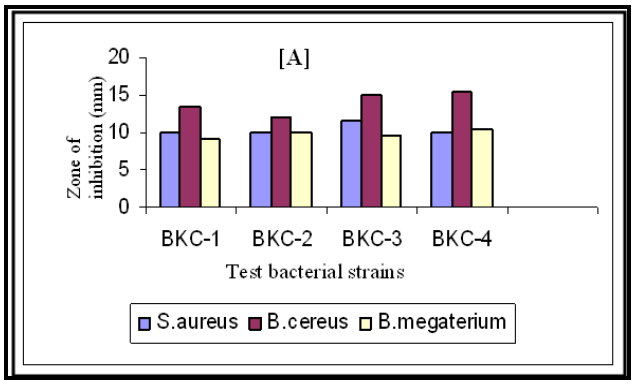


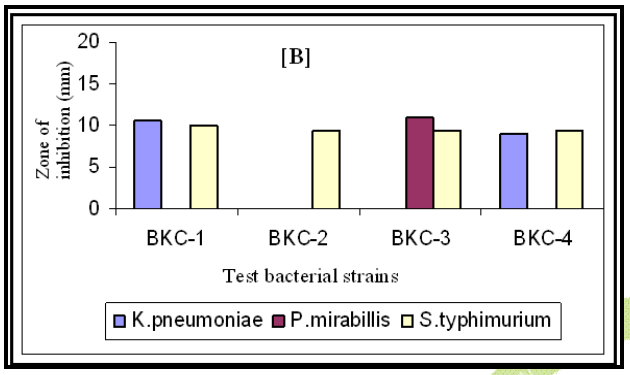
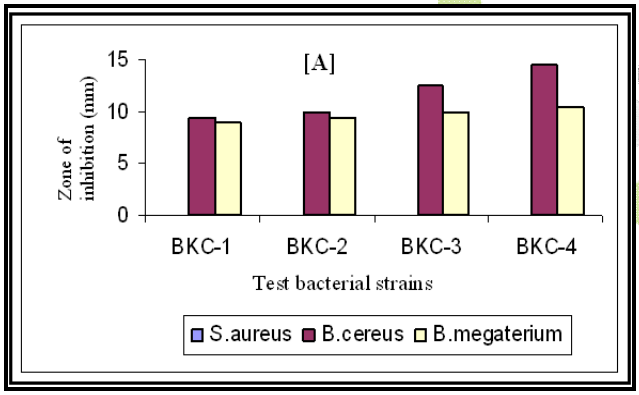


Figure: 2 Antimicrobial activity of Schiff bases against [A] Gram positive and [B] Gram negative bacteria in DMF.



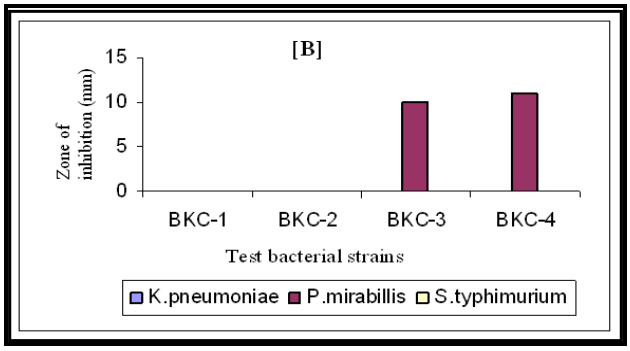


Figure: 3 Antimicrobial activity of Schiff bases against [A] Gram positive and [B] Gram negative bacteria in DMSO.

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