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Schiff bases derivatives: synthesis, identification, and antibacterial activity against pathogenic bacteria isolated from patients infected with wound infection

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ABSTRACT

Schiff bases derivatives are one of the most important compounds that have been used in many biological applications such as antimicrobial activity. Pseudomonas aeruginosa and Staphylococcus aureus are two of the most important pathogenic bacteria that cause wound infection in Iraq and many developing countries. This research involves a synthesis of some Schiff bases compounds [A_1 – A_3] that were prepared from the condensation of [4-chlorobenzaldehyde, 4-bromobenzaldehyde, and 4-hydroxybenzaldehyde] in absolute ethanol. All of these compounds are characterized by [FTIR] spectroscopy. The antibacterial activity test was done according to agar well diffusion method for all derivative compounds with a concentration of 100 mg/ml and 200 mg/ml for each compound. The derivative compound A3 with a concentration of 200 mg/ml had an excellent antibacterial effect against Pseudomonas aeruginosa and Staphylococcus aureus with a diameter of inhibition zone of 18.417 ± 0.54645 and 16.000 ± 0.57735, respectively. Schiff bases derivatives synthesis compounds in this study (A1 and A2) can be considered as suitable antibacterial materials and can be used as raw materials to the synthesis of new ointment.

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INTRODUCTION

The formation of N-substituted imines (Schiff base) was described by Hugo Schiff in 1864 (Adam *et al.*, 2019). Schiff bases have interesting applications such as promising biological activity and industrial fields (Bukhari *et al.*, 2005). Complexion Schiff bases with metals formed mono-, di- and polynuclear metal completes. They behaved as monodentate, bidentate, or tridentate ligands depending on the number of electrons donating group (Anacona *et al.*, 2013). Schiff bases have interesting biological and pharmacological activities such as antimicrobial, antidepressant, anti-HIV, cytotoxicity, analgesic, antileishmanial, anticonvulsant, insecticides, fungicides, anticancer, tuberculostatic, and anti-inflammatory (Witwit *et al.*, 2019). In addition, Schiff bases showed antibacterial and antiviral activities (Al-Labban *et al.*, 2019).

MATERIALS AND METHODS

Chemicals

In this study, all chemicals were provided by the Merck, BDH, and Fluke Chemicals Company.

Table 1: Three Schiff base compounds and physicalproperties.

Compound No.	Molecular formula	Yield (%)	Color	M.P. (^{0}C)
A1	C14H12NOCl	82	Pale	126
A2	C14H12NOBr	75	Grey	148
A3	C14H13NO2	87	Dark green	205

M.P.: Melting point

Table 2: Three Schiff bases compounds; FT.IR data

	υ (C-H)Str. Aromatic Aliphatic cm^{-1}	υ (C=N) Str. Imin cm^{-1}	υ(C-H) Ben. Aromatic cm^{-1}	Other cm^{-1}
A1	2962 2881	1620	839	υ(Ar-Cl)Str. Ben:1255
A2	2958 2879	1622	839	υ(Ar-Br)Str. 1249
A3	2916 2839	1606	842	υ(Ar-Br)Str. 3431

Table 3: Diameters of inhibitions zones of all derivative compounds against gram negative and positive bacteria.

Derivative compound	Pathogenic bacteria				
	Pseudomonas aeruginosa			Staphylococcus aureus	
	Con.	M±S		Con.	M±S
A1	100	7.8333 0.44096	±	100	7.8000 ± 0.47258
	200	8.1167 0.49694	±	200	8.0000 ± 0.57735
A2	100	8.3667 0.59255	±	100	8.6667 ± 0.72648
	200	10.000 0.28868	±	200	9.5000 ± 0.76376
A3	100	13.333 0.72648	±	100	13.167 ± 0.44096
	200	18.417 0.54645	±	200	16.000 ± 0.57735

Con.; Concentration mg/ml. M±S; Mean±standard error

Instruments

- Electrothermal melting point apparatus (UK) was used to record the melting point.

- FTIR instrument SHIMADZU FTIR-8400S spectrophotometer was used to detect FTIR spectra by using KBr disc.

Schiff bases derivatives [A_1 – A_3] synthesis

The general method

(Al-Labban, 2017) method was used in this study as follows: Glacial acetic acid (2 drops) was added to the mixture of 4-methoxyaniline (0.01 mole) and a variety of substituted benzaldehyde in 40 ml absolute ethanol. The mixture was refluxed for 2 to 4 hours, then the volatiles were evaporated, and the residue was poured into water. By filtration, all precipitate was collected and washed with water. The three compounds were named A1, A2, and A3. All steps are shown in Table 1 and the structural formula of the three compounds are shown in Figure 1.

Gram-negative and gram-positive bacterial isolates

Two bacterial isolates were selected in this study:

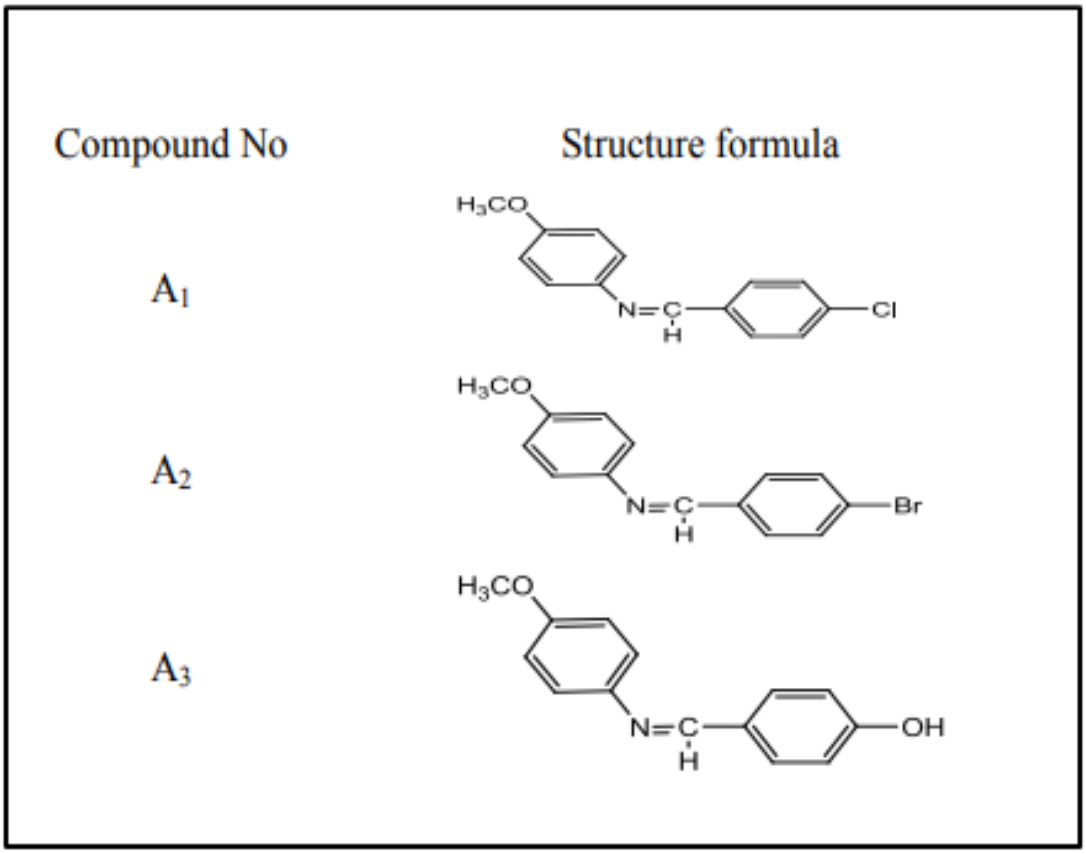

Figure 1: Structure formula of three synthesized compounds

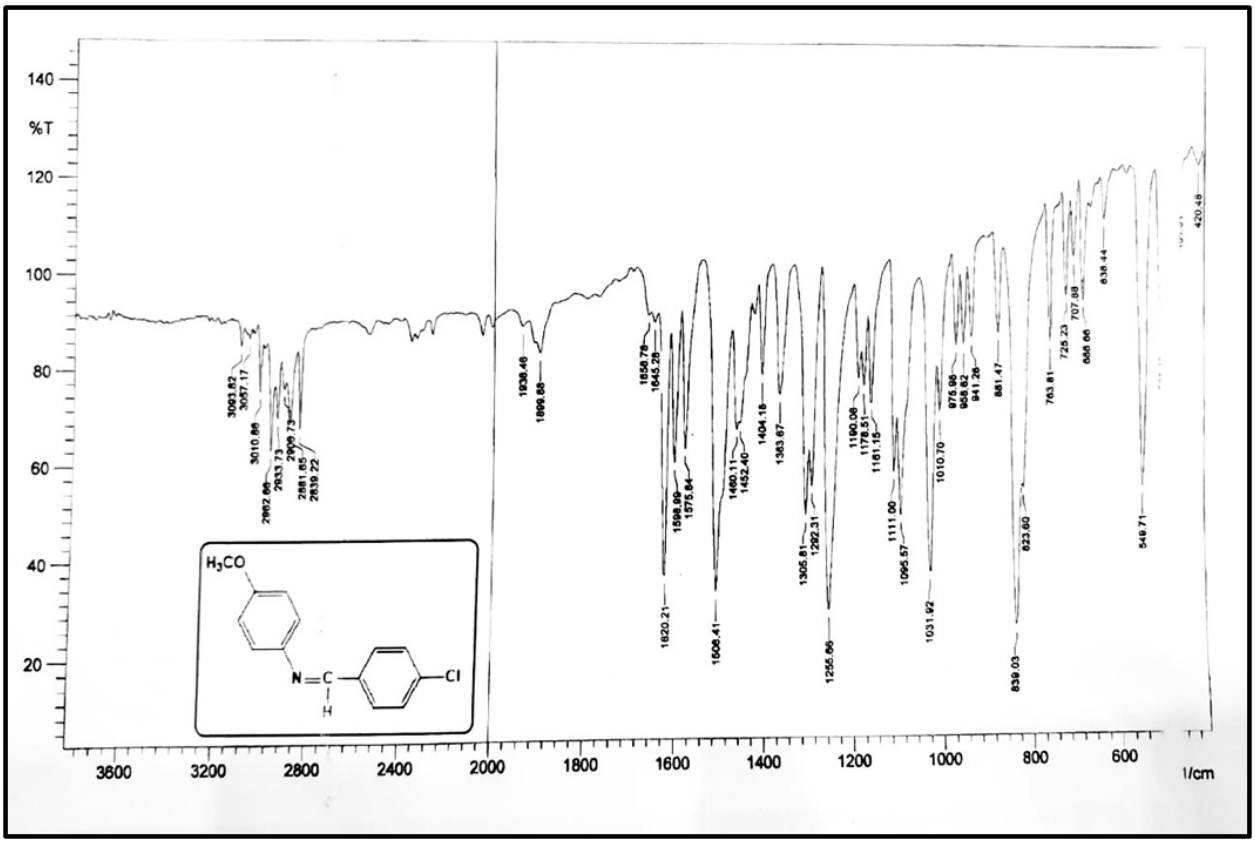

Figure 2: A1 compound; the FT.IR spectrum

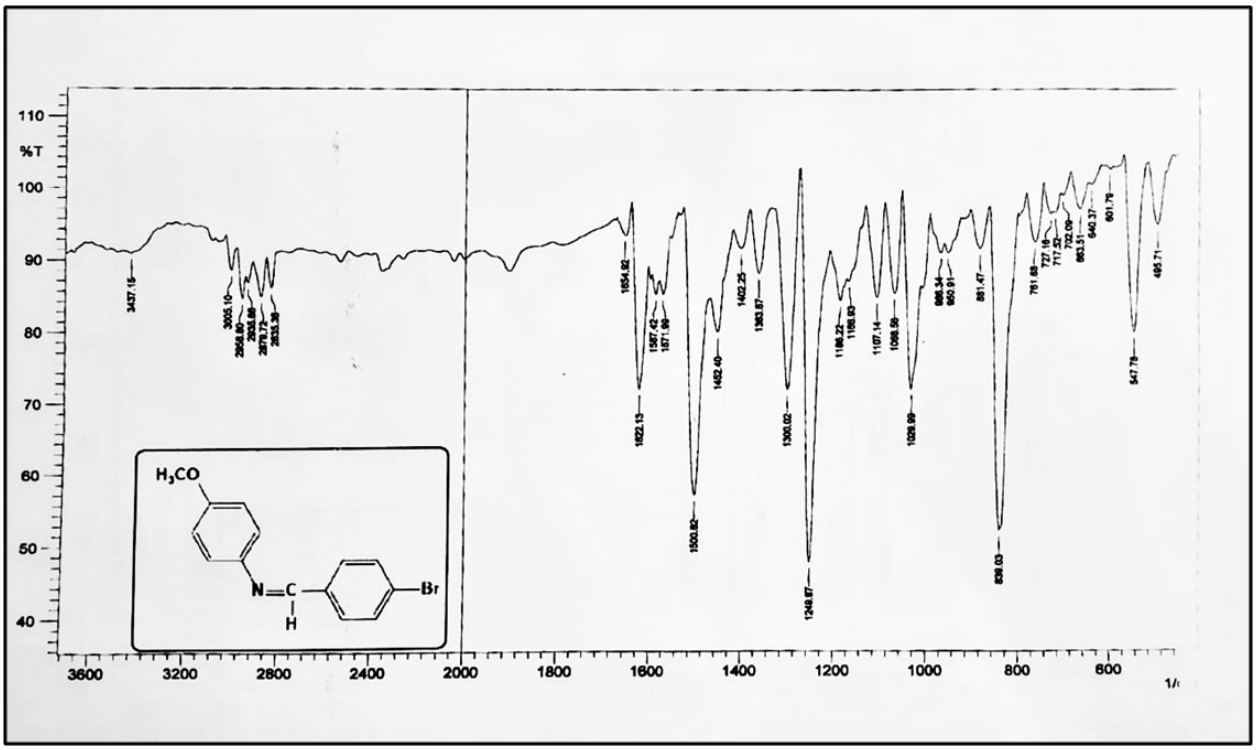

Figure 3: A2 compound; the FT.IR spectrum

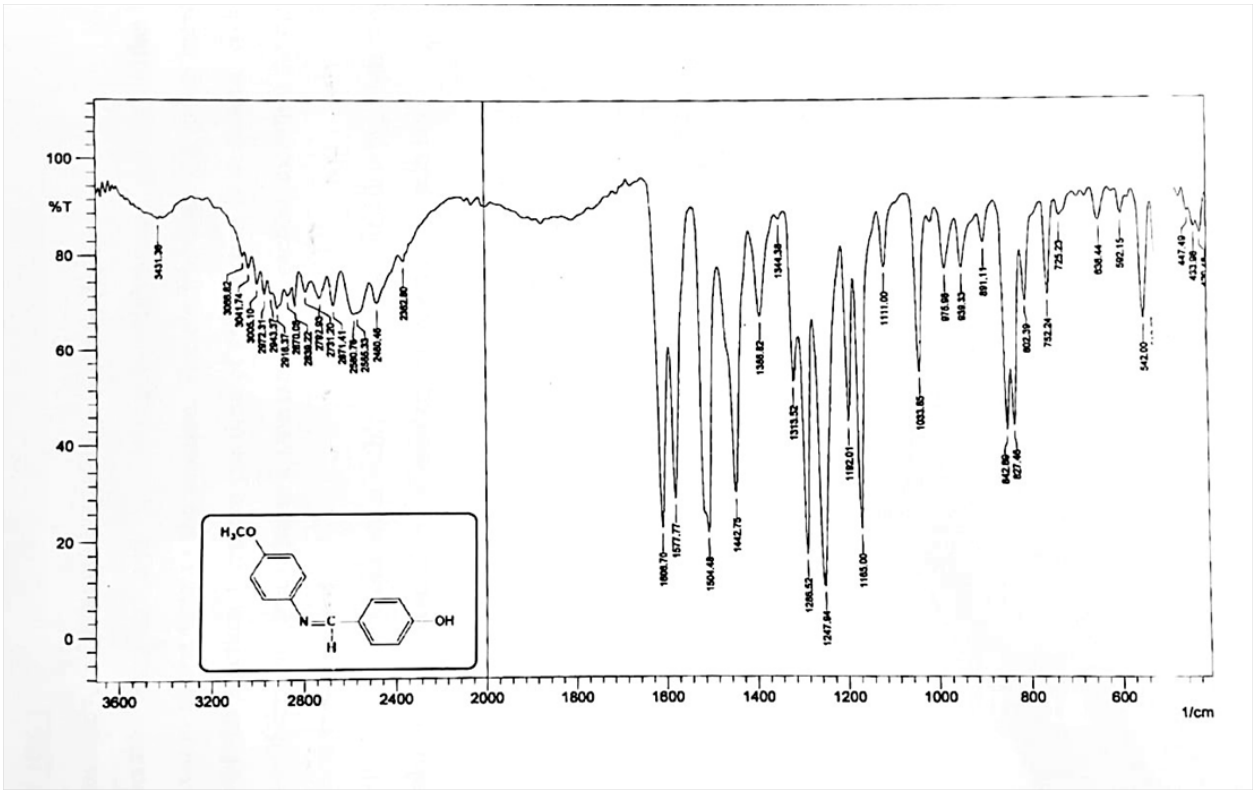

Figure 4: A3 compound; the FT.IR spectrum

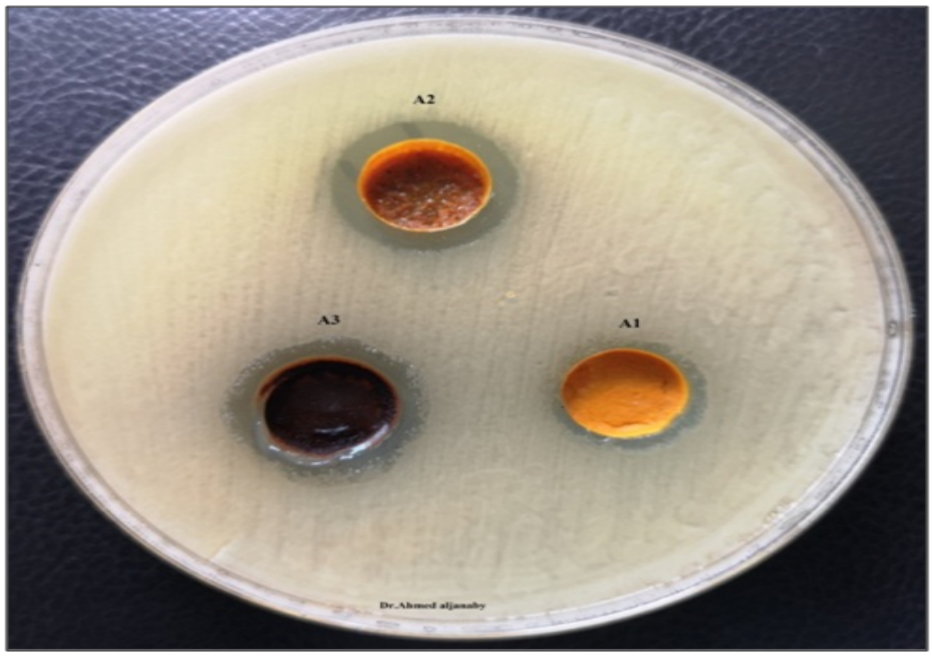

Figure 5: Effect of three derivative compounds with concentration 200 mg/ml against gram negative bacteria.

P.aeruginosa (gram-negative bacteria) and S.aureus (gram-positive bacteria) were obtained from the University of Kufa, Faculty of Science, Department of Microbiology, and were isolated from the patients with wound infection. All bacteria isolates were identified according to the slandered bacteriological methods (Aljanaby and Gafil, 2013a).

Antibacterial activity test

Agar well diffusion method (Hayder and Aljanaby, 2019b) was used in this study as follows: the three derivative compounds (A1, A2, and A3) with concentrations (100 mg/ml, 200 mg/ml) for each compound were prepared and dissolved with DMSO (Majeed and Aljanaby, 2019). By sterile swab, all Mueller-Hinton agar plated were streaked with 1.5 x 10^5P.aeruginosa and S.aureus alone (Hayder and Aljanaby, 2019a). Three wells were made in all streaked Mueller-Hinton agar plates with diameters of 5 mm by using cork-borer. Fifty microliters of each derivative compounds were transferred to each well and incubated at 37 °C for 24 hours. All inhibition zones were measured in millimeters (Aljanaby and Gafil, 2013b).

Statistical Analysis

The tenth version of GraphPad Prism Windows software was used to compare the diameters of inhibition zones using mean ± standard error (Aljanaby, 2018).

RESULTS AND DISCUSSION

Schiff base compounds [A_1 – A_3] were synthesized by the reaction of 4-methoxyaniline with different aromatic benzaldehyde. All absorption bands (3471 cm^{-1}) and (3379 cm^{-1}) corresponding to the asymmetric and symmetric stretching vibration of –NH_2 group in 4-methoxyaniline disappeared. Also, the absorption band (1680 – 1720 cm^{-1}) corresponding to the (C=O) disappeared (Stuart, 2004). The FTIR showed that the absorption band (1606 – 1622 cm-1) corresponding to the imine group (C=N) appeared (Al-Rufaie *et al.*, 2017). Table 2 and Figures 2, 3 and 4 show the other functional groups.

Results of antibacterial activity

Figure 5 and Table 3 showed that all three derivative compounds had good antibacterial activity against the two types of pathogenic bacteria. But the derivative compound A3 with a concentration of 200 mg/ml had a good antibacterial effect against the gram-negative and gram-positive bacteria with a diameter of inhibition zone of 18.417 ± 0.54645 and 16.000 ± 0.57735, respectively.

CONCLUSIONS

The three compounds in this study have good antibacterial activity against Pseudomonas aeruginosa and Staphylococcus aureus. Therefore, they can be considered as good raw materials to synthesize a new ointment for the treatment of bacterial infection.

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Conflict Of Interest

There was no conflict of interest in this work.

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