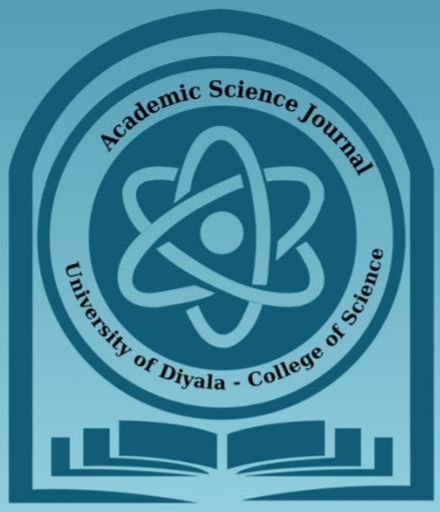

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Evaluation of the Antibacterial Potential of Cephalexin Schiff Bases against Bacillus Pumilus and Candida albicans

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Abstract

In the current study, cephalexin and two beta-lactam antibiotics were combined with four distinct aldehydes: 3-hydroxybenzaldehyde, 4-dimethylaminobenzaldehyde, 4-methoxybenzaldehyde, and 4-bromobenzaldehyde, to synthesize Schiff bases. The reaction between the free amino group of the acylamino side chain and the aldehydes resulted in the formation of four Schiff bases within the medication. Comprehensive characterization and surface examination were performed on each Schiff base. The biological activity of the synthesized compounds against Bacillus Pumilus (Gram-positive bacteria) and Candida

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albicans (fungus) was evaluated using the agar diffusion disc method. The antibacterial screening tests revealed that the Schiff bases exhibited enhanced antibacterial activity against these microorganisms, indicating superior efficacy compared to the parent drugs. However, no significant inhibitory effect on the tested fungus was observed.

Keywords: Schiff base; Cephalexin; Aldehydes; Bacillus Pumilus; Candida albicans.

النشاط المضاد للبكتريا باستخدام معقدات القصدير المشتقة من قاعدة شيف ضد Bacillus Pumilus وCandida albicans

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الخلاصة

في الدراسة الحالية ، تم الجمع بين سيفالكسين واثنين من المضادات الحيوية بيتا لاكتام مع أربعة ألدهيدات مميزة: 3-هيدروكسي بنزالديهيد ، 4-ثنائي ميثيل أمينوبنزالديهيد ، 4-ميثوكسي بنزالديهيد ، و 4-بروموبنزالديهايد ، لتكوين قواعد شيف. نتج عن التفاعل بين المجموعة الأمينية الحرة من السلسلة الجانبية والألدهيدات تكوين أربع قواعد Schiff داخل الدواء. تم إجراء توصيف شامل وفحص السطح على كل قاعدة شيف. تم تقييم النشاط البيولوجي للمركبات المحضرة ضد (البكتيريا موجبة الجرام) والمبيضات البيضاء (الفطريات) باستخدام طريقة قرص انتشار الآجار. أظهرت اختبارات الفحص المضاد للبكتيريا أن قواعد شيف أظهرت نشاطًا مضادًا للبكتيريا معززًا ضد هذه الكائنات الدقيقة ، مما يشير إلى فعالية فائقة مقارنة بالأدوية الأم. ومع ذلك ، لم يلاحظ أي تأثير مثبط معنوي على الفطريات المختبرة.

الكلمات المفتاحية: قاعدة شيف. سيفالكسين. الألدهيدات. Candida albicans. Bacillus Pumilus.

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Introduction

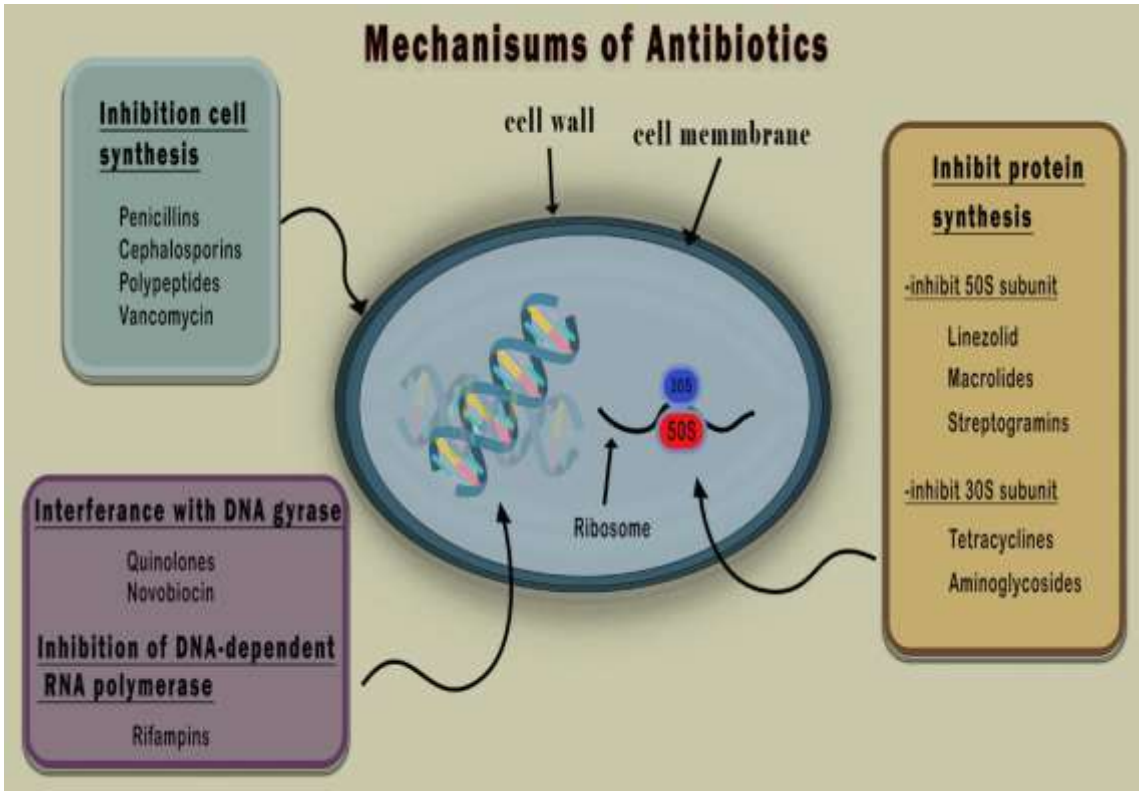
Antibiotics are substances that are released by microorganisms as natural metabolites that have a bactericidal or bacteriostatic effect on the growth of other microorganisms. The effect of the antibiotic on one of the main parts of the bacterial cell as shown in Scheme 1 [1]:

Cephalexin and all forms of penicillin inhibit the growth of the gram-positive germ wall on the cell wall.

Tetracyclines target the 30S ribosomal subunit, preventing t-RNA from binding to the A site.

The formation of the RNA, such as rifampsin, streptomycin, tetracycline, and erythromycin.

On DNA, Quinilones, The fluoroquinolones (FQ) inhibit the enzyme bacterial DNA gyrase, which nicks the double-stranded DNA.



Scheme 1: Mechanisms of antibiotics [1]

Chemical therapies use inorganic substances to inhibit growth. The effects of several chemical agents on bacterial cells are unclear, but some, such as sulfonamides, disrupt the production of tetrahydrofolic acid, an important catalyst in bacteria metabolism. The uses of chemical therapeutic materials are limited due to their relatively high toxicity and many side effects [2, 3]. Derivatives of -lactam antibiotics have been made to boost their potency and widen their antibacterial abilities. Schiff base ligands and their metal complexes generated from various aldehydes with cefadroxil [4], cephradine [5, 6], ceftriaxone [7], and cephalothin [8], as well as amoxicillin [9-13]. Metal complexes and Schiff bases were created by combining the drug molecule with various aldehydes. Metal complexes for the prepared Schiff bases have also been produced. The synthesized compounds' potential antibacterial qualities were examined [14–31]. Research has shifted towards metal-drug complexes to increase activity and reduce side effects. The work's goal is to investigate cephalexin Schiff bases' biological activities.

Experimental

1. **Material**.

All the chemicals and solvents such as CH3Cl, AcOH, DMSO, cephalexin, nutrient agar were analytical grade (Fluka and Sigma-Aldrich) and weren't further purified before usage.

2. **Synthesis of Cephalexin Schiff Bases.**

The Schiff bases were made as previously described [32] by boiling CHCl3 (25 mL) with AcOH (0.5 mL) and stirring in cephalexin (1.83 g, 5.0 mmol) and an aryl aldehyde (5.0 mmol). This mixture was refluxed for 6 hours (Scheme 2). The mixture was cooled to room temperature and the solid was collected, washed with CHCl3, and dried to obtain 1-4 ml in high yields.

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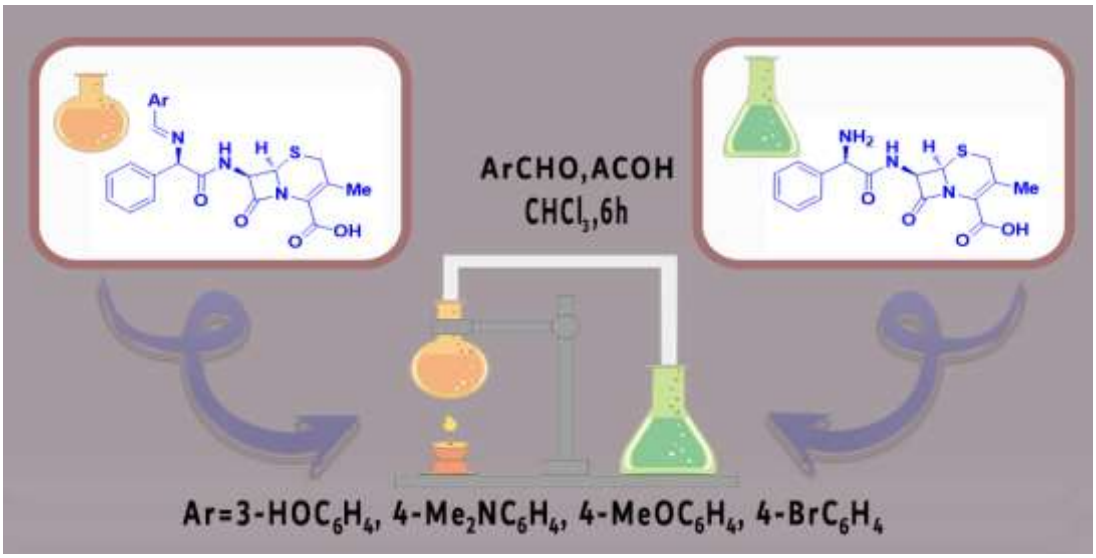

Scheme 2: Synthesis of cephalexin Schiff bases 1–4.

3. Culture media preparation.

A - The clusters (28gm) were dissolved in a liter of distilled water to make the nutrient agar. The temperature of (45Co) was placed on a culture plate and left to solidify at room temperature for (15min). The culture media were then perforated and injected with both bacterial and fungal inoculums. Before pouring it onto dishes, it was heated to (37Co) for one hour in the incubator [33].

B- The weights of the aforementioned ingredients were dissolved in one liter of distilled water to create Media 1 [34]:

4. Preparing chemical solutions

The dimethyl sulfoxide solution was utilized to prepare the chemical solutions for the biological study (DMSO). The two concentrations of 10-2 M and 10-4 M were created from each sample. Glass tubes utilized for the preparation were sterilized in an autoclave for 15 minutes at 120 Co and 15 atm of pressure. The antibiotic cephalexin served as a point of reference.

Under the same conditions, a control model using only (DMSO) was carried out, and its impact on bacteria and fungus was investigated [35].

5. Sensitivity examination technique for compound preparation.

The concentrations of the prepared compounds, the antibiotic, were prepared with two concentrations of each, 10-2 M and 10-4 M, and then 50µl into the holes that were made in the culture medium and allowed to absorb the material. The media was then preserved in the incubator at a degree (37 Co), which is the proper degree for bacterial growth, for a period of (24) hours.

6. Damping area measurements via (diameter determination)

The transparent region that included the hole and did not support bacterial growth (the zone of inhibition) was measured by millimeters. The synthesized compounds have a higher biological activity when the diameter of inhibition is larger.

Results and Discussion

1. The FESEM of cephalexin Schiff bases 1–4

The FESEM was used to examine the surface morphology of the sample (Fig. 1). Images revealed that layers 1-4 have porous and diverse structures. The particles' diameters ranged from 40.58 to 56.65 nm for Schiff base 1, 39.96 to 49.75 nm for Schiff base 2, 29.46 to 39.01 nm for Schiff base 3, and 42.29 to 47.16 nm for Schiff base 4. Additionally, the particles' morphologies were varied.

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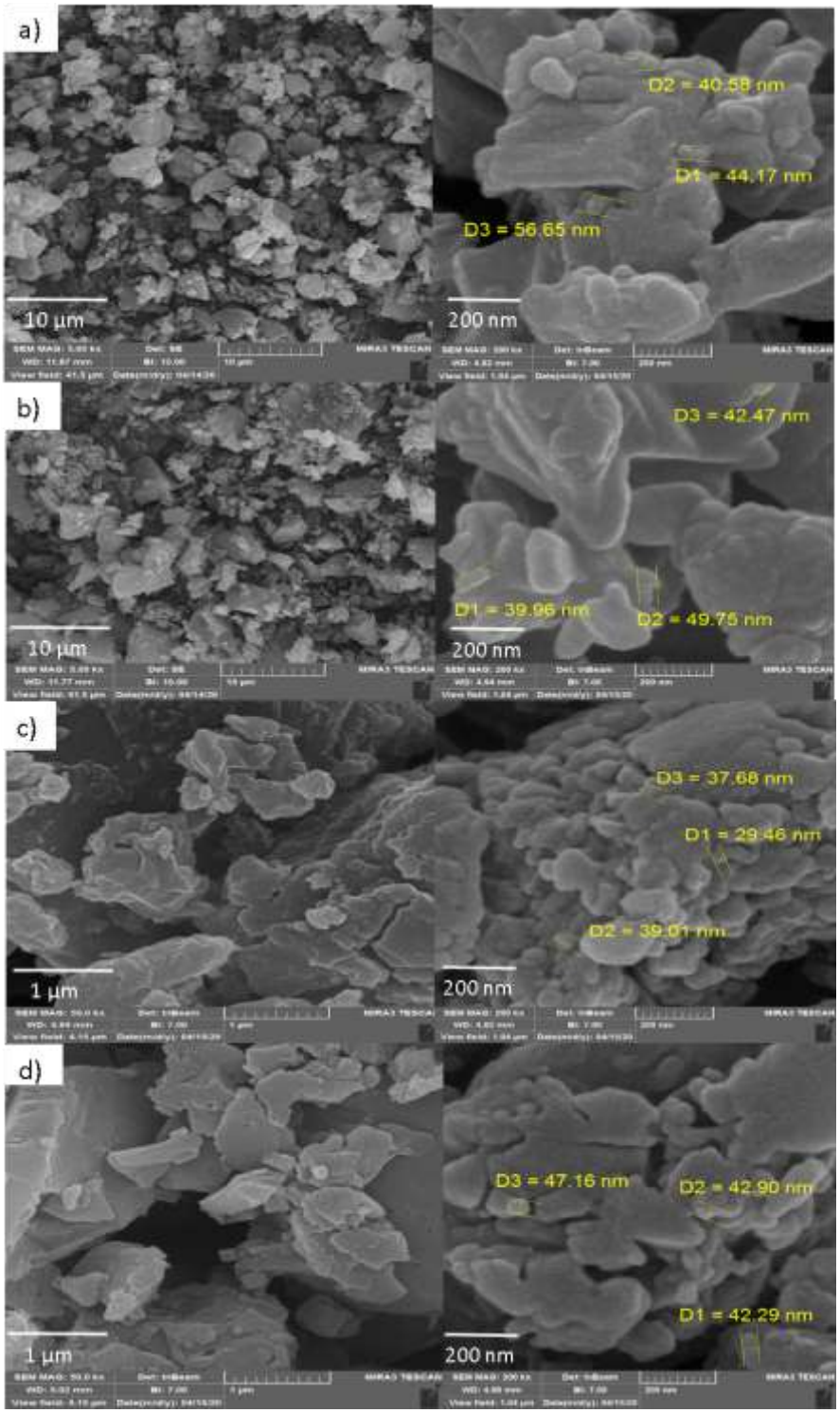

Figure 1: (a-d) SEM images of cephalexin Schiff bases 1-4, respectively.

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This study used one type of bacteria, Bacillus Pumilus, and one type of fungi, Candida albicans, to upgrade the action of cephalexin and cephalexin Schiff bases. The compounds gave high inhibition for the bacteria, but no inhibition for the mushrooms, as shown in Table (1).

Table 1: Biological activity for cephalexin and cephalexin Schiff bases.

COMPOUND	CONC. (MG/ML)	INHIB. ZONE (MM) BACILLUS-PUMILUS	INHIB. ZONE (MM) CANDIDA-ALBICANS
Cephalexin(Ceph)	1×10-2	13.2	25.6
	1×10-4	12.2	25.5
Ceph+3-HOC6H4	1×10-2	28.5	0.0
	1×10-4	22.6	0.0
Ceph+4-Me2NC6H4	1×10-2	31.9	0.0
	1×10-4	28.1	0.0
Ceph+ 4-MeOC6H4	1×10-2	29.1	15.9
	1×10-4	28.7	11.7
Ceph+ 4-BrC6H4	1×10-2	27.6	12.9
	1×10-4	26.5	11.6

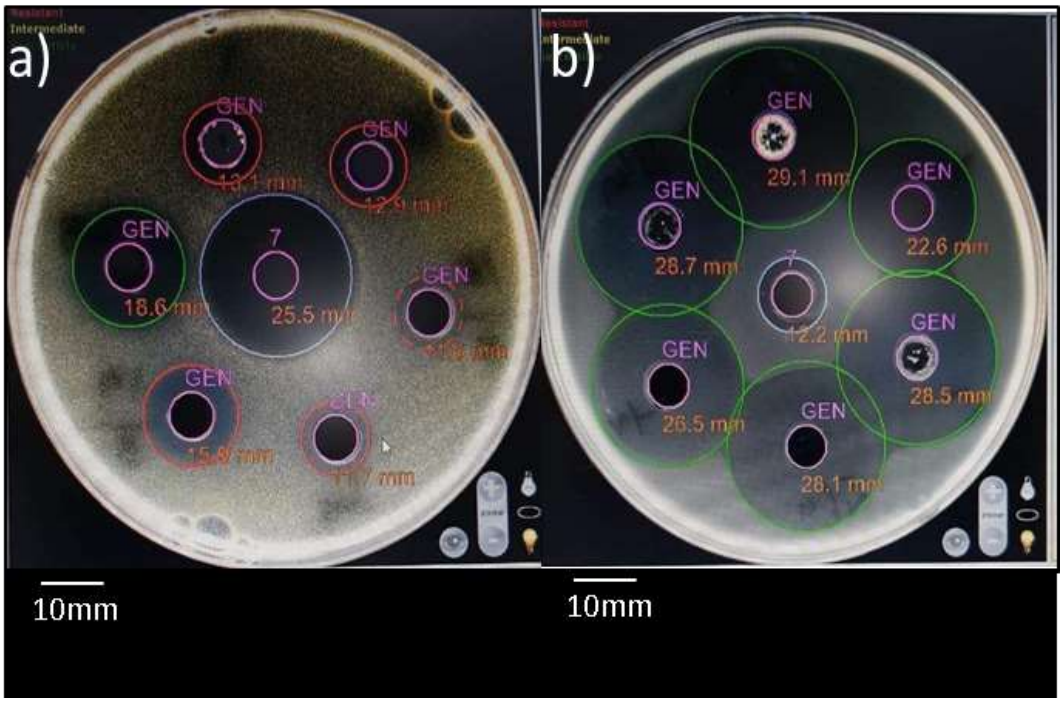

Figure 2: Biological activity for cephalexin Schiff bases against a) Bacillus Pumilus and b) Candida albicans.

Conclusions

In conclusion, benzaldehyde derivatives have been shown to be effective against microbes. These include three-hydroxybenzaldehyde, 4-dimethylaminobenzaldehyde, 4-methoxybenzaldehyde, and 4-bromobenzaldehyde. These substances have antibacterial qualities that make them effective at preventing bacterial and fungal diseases. Prospects for using benzaldehyde derivatives as powerful antibacterial agents in medical and pharmaceutical applications are bright with more study and development in this field.

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14. Hasil Turnitin_Evaluation of the Antibacterial activity for Tin-cephalexin Schiff bases against Bacillus Pumilus and Candida albicans

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Evaluation of the Antibacterial Potential of Cephalexin Schiff Bases against Bacillus Pumilus and Candida albicans

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Abstract

In the current study, cephalexin and two beta-lactam antibiotics were combined with four distinct aldehydes: 3-hydroxybenzaldehyde, 4-dimethylaminobenzaldehyde, 4-methoxybenzaldehyde, and 4-bromobenzaldehyde, to synthesize Schiff bases. The reaction between the free amino group of the acylamino side chain and the aldehydes resulted in the formation of four Schiff bases within the medication. Comprehensive characterization and surface examination were performed on each Schiff base. The biological activity of the synthesized compounds against Bacillus Pumilus (Gram-positive bacteria) and Candida

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albicans (fungus) was evaluated using the agar diffusion disc method. The antibacterial screening tests revealed that the Schiff bases exhibited enhanced antibacterial activity against these microorganisms, indicating superior efficacy compared to the parent drugs. However, no significant inhibitory effect on the tested fungus was observed.

Keywords: Schiff base; Cephalexin; Aldehydes; Bacillus Pumilus; Candida albicans.

النشاط المضاد للبكتريا باستخدام معقدات القصدير المشتقة من قاعدة شيف ضد Candida albicans وBacillus Pumilus

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الخلاصة

في الدراسة الحالية ، تم الجمع بين سيفالكسين واثنين من المضادات الحيوية بيتا لاكتام مع أربعة ألدهيدات مميزة: 3-هيدروكسي بنزالديهيد ، 4-ثنائي ميثيل أمينوبنزالديهيد ، 4-ميثوكسي بنزالديهيد ، و 4-بروموبنزالديهايد ، لتكوين قواعد شيف. نتج عن التفاعل بين المجموعة الأمينية الحرة من السلسلة الجانبية والألدهيدات تكوين أربع قواعد Schiff داخل الدواء. تم إجراء توصيف شامل وفحص السطح على كل قاعدة شيف. تم تقييم النشاط البيولوجي للمركبات المحضرة ضد (البكتيريا موجبة الجرام) والمبيضات البيضاء (الفطريات) باستخدام طريقة قرص انتشار الأجار. أظهرت اختبارات الفحص المضاد للبكتيريا أن قواعد شيف أظهرت نشاطًا مضادًا للبكتيريا معززًا ضد هذه الكائنات الدقيقة ، مما يشير إلى فعالية فائقة مقارنة بالأدوية الأم. ومع ذلك ، لم يلاحظ أي تأثير مثبط معنوي على الفطريات المختبرة.

الكلمات المفتاحية: قاعدة شيف. سيفالكسين. الألدهيدات. Candida albicans. Bacillus Pumilus.

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Introduction

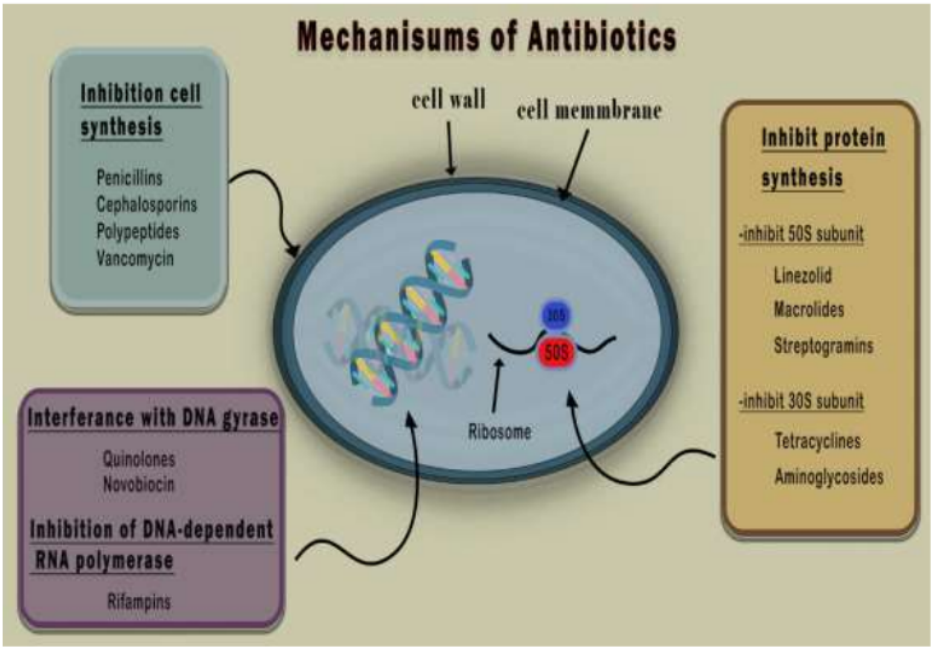
Antibiotics are substances that are released by microorganisms as natural metabolites that have a bactericidal or bacteriostatic effect on the growth of other microorganisms. The effect of the antibiotic on one of the main parts of the bacterial cell as shown in Scheme 1 [1]:

Cephalexin and all forms of penicillin inhibit the growth of the gram-positive germ wall on the cell wall.

Tetracyclines target the 30S ribosomal subunit, preventing t-RNA from binding to the A site.

The formation of the RNA, such as rifampsin, streptomycin, tetracycline, and erythromycin.

On DNA, Quinilones, The fluoroquinolones (FQ) inhibit the enzyme bacterial DNA gyrase, which nicks the double-stranded DNA.



Scheme 1: Mechanisms of antibiotics [1]

Chemical therapies use inorganic substances to inhibit growth. The effects of several chemical agents on bacterial cells are unclear, but some, such as sulfonamides, disrupt the production of tetrahydrofolic acid, an important catalyst in bacteria metabolism. The uses of chemical therapeutic materials are limited due to their relatively high toxicity and many side effects [2, 3]. Derivatives of -lactam antibiotics have been made to boost their potency and widen their antibacterial abilities. Schiff base ligands and their metal complexes generated from various aldehydes with cefadroxil [4], cephradine [5, 6], ceftriaxone [7], and cephalothin [8], as well as amoxicillin [9-13]. Metal complexes and Schiff bases were created by combining the drug molecule with various aldehydes. Metal complexes for the prepared Schiff bases have also been produced. The synthesized compounds' potential antibacterial qualities were examined [14–31]. Research has shifted towards metal-drug complexes to increase activity and reduce side effects. The work's goal is to investigate cephalexin Schiff bases' biological activities.

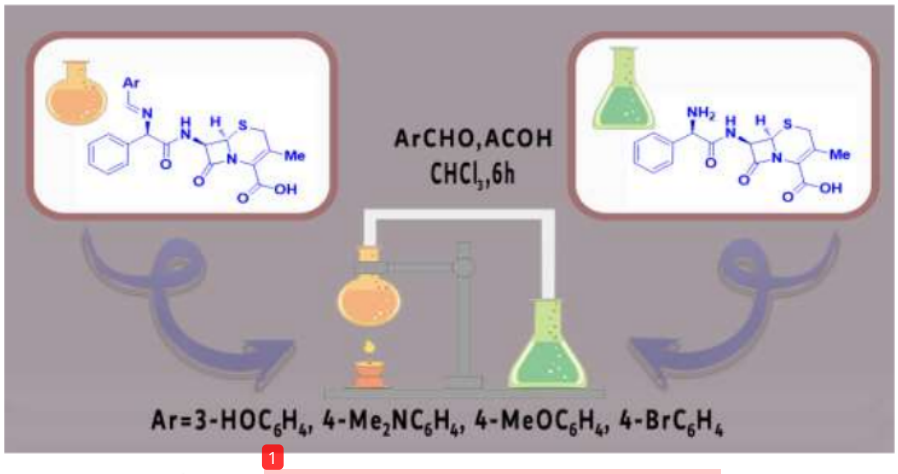
Experimental

1. **Material**.

All the chemicals and solvents such as CH3Cl, AcOH, DMSO, cephalexin, nutrient agar were analytical grade (Fluka and Sigma-Aldrich) and weren't further purified before usage.

2. Synthesis of Cephalexin Schiff Bases.

The Schiff bases were made as previously described [32] by boiling CHCl3 (25 mL) with AcOH (0.5 mL) and stirring in cephalexin (1.83 g, 5.0 mmol) and an aryl aldehyde (5.0 mmol). This mixture was refluxed for 6 hours (Scheme 2). The mixture was cooled to room temperature and the solid was collected, washed with CHCl3, and dried to obtain 1-4 ml in high yields.



Scheme 2: Synthesis of cephalexin Schiff bases 1–4.

3. Culture media preparation.

A - The clusters (28gm) were dissolved in a liter of distilled water to make the nutrient agar. The temperature of (45Co) was placed on a culture plate and left to solidify at room temperature for (15min). The culture media were then perforated and injected with both bacterial and fungal inoculums. Before pouring it onto dishes, it was heated to (37Co) for one hour in the incubator [33].

B- The weights of the aforementioned ingredients were dissolved in one liter of distilled water to create Media 1 [34]:

4. Preparing chemical solutions

The dimethyl sulfoxide solution was utilized to prepare the chemical solutions for the biological study (DMSO). The two concentrations of 10-2 M and 10-4 M were created from each sample. Glass tubes utilized for the preparation were sterilized in an autoclave for 15 minutes at 120 Co and 15 atm of pressure. The antibiotic cephalexin served as a point of reference.

Under the same conditions, a control model using only (DMSO) was carried out, and its impact on bacteria and fungus was investigated [35].

5. Sensitivity examination technique for compound preparation.

The concentrations of the prepared compounds, the antibiotic, were prepared with two concentrations of each, 10-2 M and 10-4 M, and then 50μl into the holes that were made in the culture medium and allowed to absorb the material. The media was then preserved in the incubator at a degree (37 Co), which is the proper degree for bacterial growth, for a period of (24) hours.

6. Damping area measurements via (diameter determination)

The transparent region that included the hole and did not support bacterial growth (the zone of inhibition) was measured by millimeters. The synthesized compounds have a higher biological activity when the diameter of inhibition is larger.

Results and Discussion

1. The FESEM of cephalexin Schiff bases 1–4

The FESEM was used to examine the surface morphology of the sample (Fig. 1). Images revealed that layers 1-4 have porous and diverse structures. The particles' diameters ranged from 40.58 to 56.65 nm for Schiff base 1, 39.96 to 49.75 nm for Schiff base 2, 29.46 to 39.01 nm for Schiff base 3, and 42.29 to 47.16 nm for Schiff base 4. Additionally, the particles' morphologies were varied.

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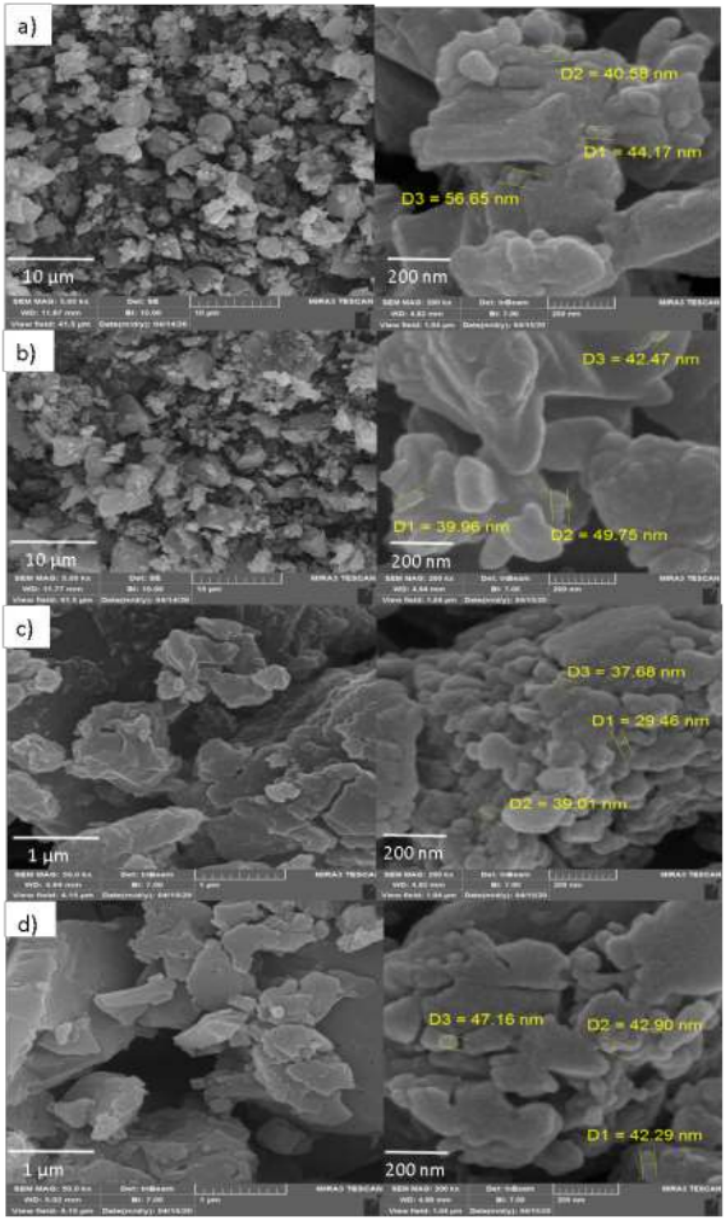

Figure 1: (a-d) SEM images of cephalexin Schiff bases 1-4, respectively.

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This study used one type of bacteria, Bacillus Pumilus, and one type of fungi, Candida albicans, to upgrade the action of cephalexin and cephalexin Schiff bases. The compounds gave high inhibition for the bacteria, but no inhibition for the mushrooms, as shown in Table (1).

Table 1: Biological activity for cephalexin and cephalexin Schiff bases.

COMPOUND	CONC. (MG/ML)	INHIB. ZONE (MM) BACILLUS-PUMILUS	INHIB. ZONE (MM) CANDIDA-ALBICANS
Cephalexin(Ceph)	1×10-2	13.2	25.6
	1×10-4	12.2	25.5
Ceph+3-HOC6H4	1×10-2	28.5	0.0
	1×10-4	22.6	0.0
Ceph+4-Me2NC6H4	1×10-2	31.9	0.0
	1×10-4	28.1	0.0
Ceph+ 4-MeOC6H4	1×10-2	29.1	15.9
	1×10-4	28.7	11.7
Ceph+ 4-BrC6H4	1×10-2	27.6	12.9
	1×10-4	26.5	11.6

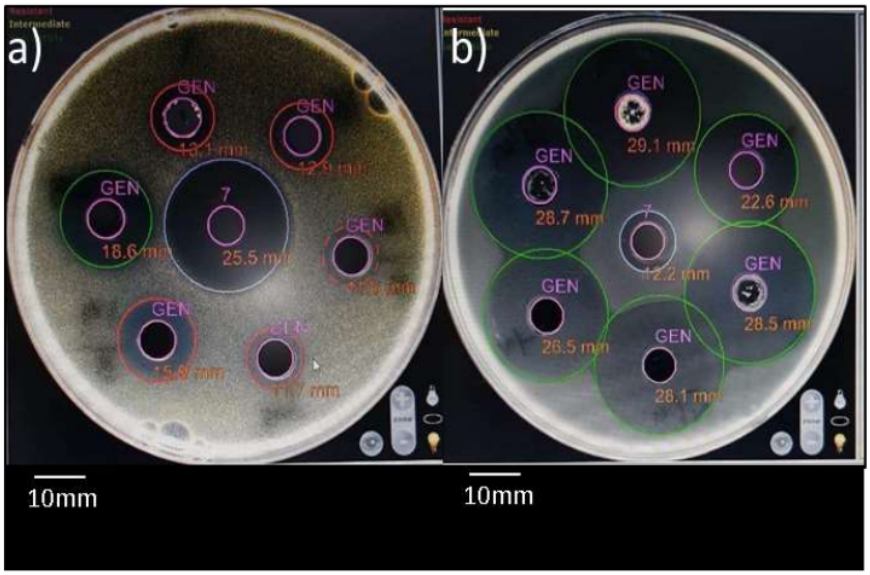

Figure 2: Biological activity for cephalexin Schiff bases against a) Bacillus Pumilus and b) Candida albicans.

Conclusions

In conclusion, benzaldehyde derivatives have been shown to be effective against microbes. These include three-hydroxybenzaldehyde, 4-dimethylaminobenzaldehyde, 4-methoxybenzaldehyde, and 4-bromobenzaldehyde. These substances have antibacterial qualities that make them effective at preventing bacterial and fungal diseases. Prospects for using benzaldehyde derivatives as powerful antibacterial agents in medical and pharmaceutical applications are bright with more study and development in this field.

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