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Research Article

Synthesis and Antimicrobial Evaluation of 2-Chloromethyl-1H-Benzimidazole Derivative

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ABSTRACT

This study focuses on the synthesis and evaluation of 2-chloromethyl-1H-benzimidazole derivatives for potential pharmacological applications. Subsequent reactions with various nucleophiles, including amines, alcohols, and thiols, afforded a library of diverse benzimidazole derivatives. The synthesized compounds were characterized using spectroscopic techniques such as, infrared (IR) spectroscopy. The purity and structural integrity of the compounds were confirmed, ensuring reliable results for subsequent evaluations. Biological evaluation of the synthesized derivatives was conducted to assess their potential pharmacological activities. Antimicrobial assays against a panel of bacterial strains were performed to determine the compounds' efficacy in inhibiting microbial growth. Overall, the synthesis and evaluation of 2-chloromethyl-1H-benzimidazole derivatives represent a promising approach for the discovery of novel pharmacologically active compounds with potential applications in antimicrobial and anticancer drug development. Further studies are warranted to explore the therapeutic potential of these derivatives and their mechanism of action in relevant biological systems.

INTRODUCTION

For the healthcare professional, invasive bacterial infections pose significant diagnostic and treatment hurdles. Even with the widespread use of topical antibacterial medications, systemic and superficial bacterial infections continue to be major sources of morbidity and mortality among transplant recipients, despite the fact that many viral infections are now preventable. Furthermore, as a result of bacterial resistance, antibacterial medications used to treat bacterial infections are now less effective. The objective of present study was to synthesize novel 2-chloromethyl-1H-benzimidazole derivatives by using different aromatic amines and heterocycle and to evaluate them for antimicrobial activity. In recent years,

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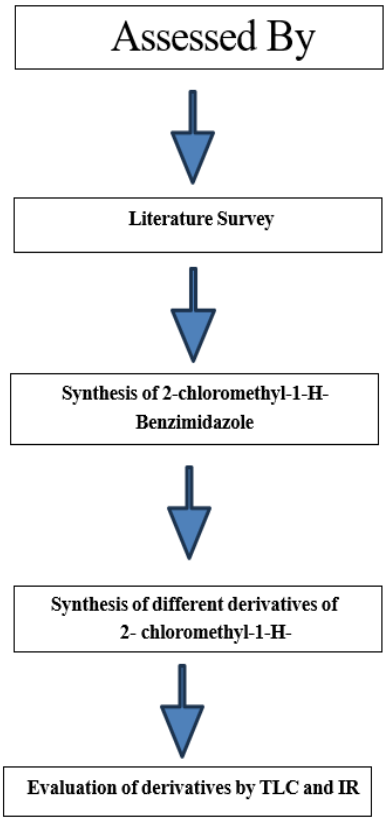
considerable attention has been given to the synthesis of benzimidazole derivatives because of their various pharmacological activities such as antitumour, anti-ulcer, anti-inflammatory, antiviral, anthelmintic, antibacterial and antifungal properties.

- **Need of investigation**

Investigating the antifungal activity of 2-chloromethyl-1H-benzimidazole derivatives is important for several reasons:

1. Drug Development: Microbial infections pose a significant threat to human health, especially in immunocompromised individuals. There is a growing need for novel antimicrobial agents due to the emergence of drug-resistant microbial strains and limitations of current therapies. Investigating the antimicrobial activity of these derivatives could lead to the development of new drugs for the treatment of microbial infections.
2. Expanding Therapeutic Options: Current antimicrobial drugs often have limitations such as toxicity, narrow spectrum of activity, and drug interactions. Investigating new classes of antimicrobial agents, such as 2-chloromethyl-1H-benzimidazole derivatives, can expand the therapeutic options available for the treatment of microbial infections and improve patient outcomes.
3. Preclinical and Clinical Development: Investigating the antimicrobial activity of 2-chloromethyl-1H-benzimidazole derivatives is an essential step in their preclinical and clinical development. Positive results from in vitro and in vivo studies provide the basis for advancing these compounds through preclinical testing in animal models and subsequent clinical trials in humans.

Plan of Work:



➢ **Objective:**

1) To synthesize 2-chloromethyl-1H-benzimidazole derivatives
2) To compare antimicrobial activity for different derivatives of 2-chloromethyl-1H-benzimidazole
3) To evaluate of all derivatives by TLC, IR and antimicrobial screening.
4) To compare and evaluation of all derivatives of 2-chloromethyl-1H-benzimidazole.

➢ **Experimental Work**

1. Materials

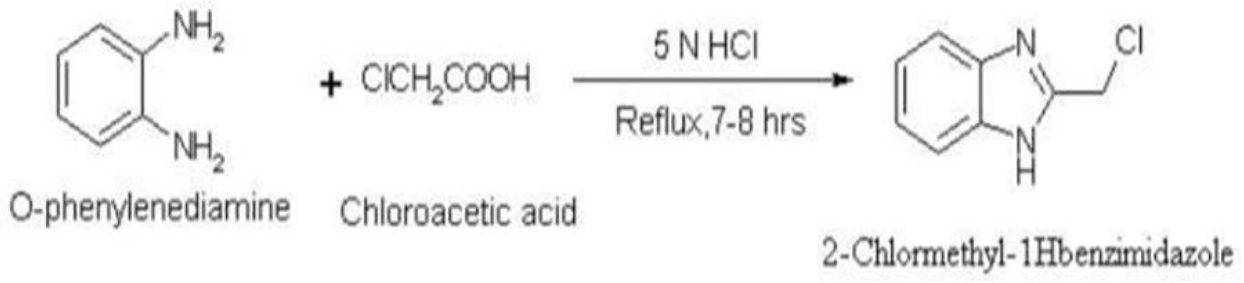
Chemicals used are-

Chloroacetic acid and O-Phenylenediamine, Aniline, p-nitro aniline, p-amino phenol, p-amino benzoic acid, sulphanilamide, Potassium Carbonate (K2CO3), Dimethylformamide (DMF), Potassium Iodide(KI), Ethyl Acetate, Sodium Sulphate was purchased from S.D. Chemical Lab, Mumbai.

2. Methodology

2-chloromethyl-1H-benzimidazole derivatives were prepared by condensing 2-chloromethyl-1H-benzimidazole with different aromatic amines and heterocycle. The synthesized were screened for their antimicrobial activity against Staphylococcus aureus (Gram-positive Bacteria) by well plate method.

Synthesis of 2-Chloromethyl-1H-benzimidazole (As starting material)



Procedure:

1) 3.75 gm of chloroacetic acid and 3.75 gm of O-Phenylenediamine,10ML of 5 N HCL was taken in 250 ML beaker and mixed well.
2) Cover the beaker with a petri-plate and place in a microwave at medium low level for 2-3 Min.
3) Take beaker out of the microwave oven, allow it to cool to room temperature and then place in an ice bath.
4) The reaction mixture is cooled to about 5°C.
5) It was neutralized with aq. ammonium hydroxide or dilute NaOH.
6) The Product was filtered to remove the traces of Hydrochloric acid, then dried and then recrystallized from benzene: hexane [14:15].

- **Molecular formula** -C8H8ClN2
- **Molecular weight** -166.61g/mol
- **Melting point**- 153- 155°**C**
- **Percent Yield**- 60%

Applications: 2-Chloromethyl-1H-benzimidazole and its derivatives have several applications and uses across various fields, primarily due to their diverse chemical properties and pharmacological activities. Some common applications include:

1. Pharmaceuticals: 2-Chloromethyl-1H-benzimidazole derivatives serve as valuable intermediates in the synthesis of pharmaceutical compounds. They can be further functionalized to introduce specific pharmacophores or

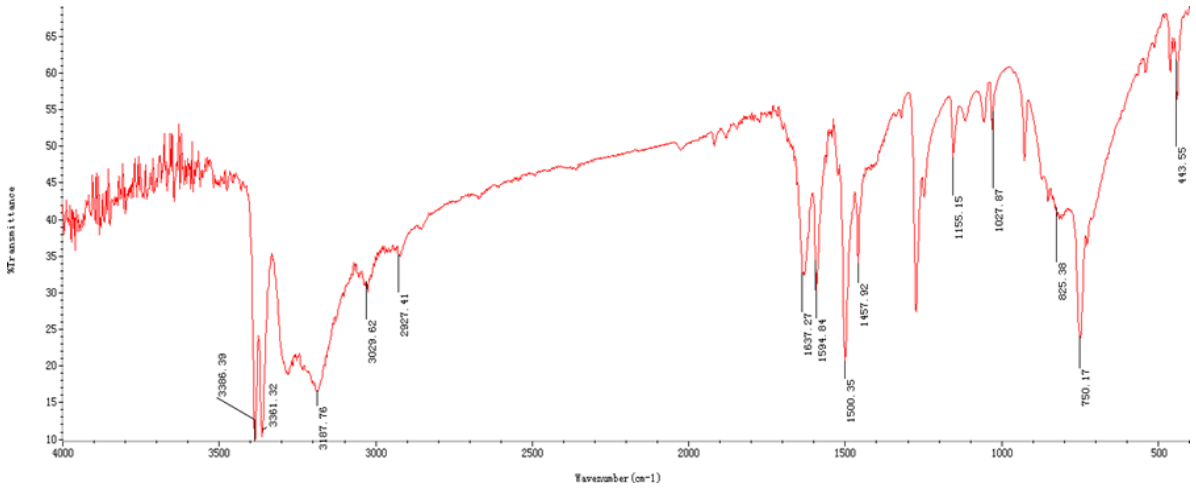
structural motifs, leading to the development of novel drugs with diverse therapeutic activities. Benzimidazole derivatives have been explored as potential antimicrobial, antifungal, anticancer, anti-inflammatory, and antiviral agents, among others.

2. Agrochemicals: Benzimidazole derivatives, including 2-chloromethyl-1H-benzimidazole, are used in the synthesis of agrochemicals such as fungicides and herbicides. These compounds exhibit fungicidal activity against a wide range of plant pathogens, protecting crops from fungal diseases and improving agricultural productivity.
3. Materials Science: 2-Chloromethyl-1H-benzimidazole derivatives are employed in materials science for their ability to undergo various chemical transformations and participate in polymerization reactions. They can be incorporated into polymers and resins to impart specific properties such as thermal stability, flame retardancy, and chemical resistance. Additionally, benzimidazole-based materials have applications in coatings, adhesives, and electronic devices.
4. Biological Research: Benzimidazole derivatives are valuable tools in biological research and drug discovery. They are used as molecular probes to study biological processes, including enzyme inhibition, protein-ligand interactions, and signal transduction pathways. Benzimidazole-based compounds also serve as lead compounds for the development of new therapeutic agents targeting various diseases, including cancer, infectious diseases, and neurological disorders. Overall, 2-chloromethyl-1H-benzimidazole and its derivatives have a wide range of applications and uses, spanning pharmaceuticals, agrochemicals, materials science, biological research, and chemical synthesis. Their versatility and potential for modification make them valuable compounds in many industries.

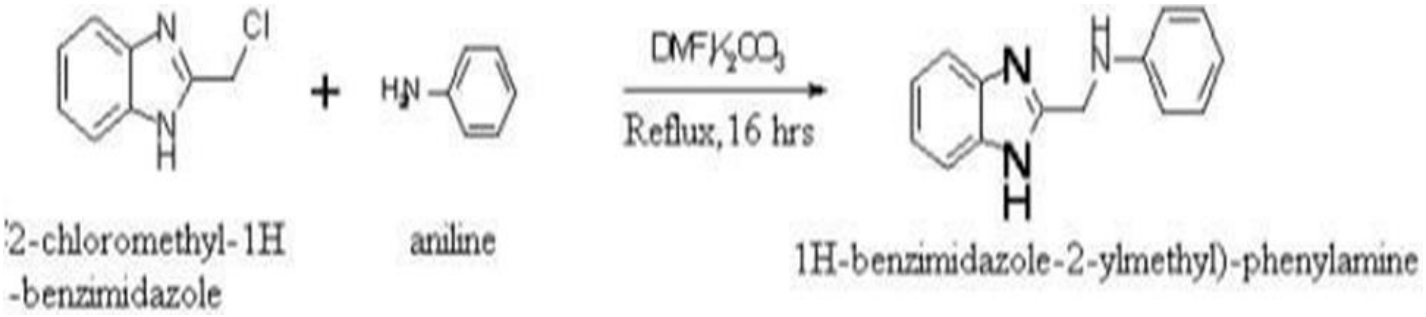
Spectral Data:

Yield:60%; melting point:153- 155°C; TLC: **Chloroform:** Methanol (9:1); Rf: 0.68 IR **(Infrared) Interpretation:**

Sr. No.	Functional Group	Standard Range	Observed Values
1	N-H	3500-1000	3386.39
2	C-H Aromatic	3150-3050	3029.62
3	C=N	1690-1640	1637.27
4	C=C	1600-1475	1594.35
5	C-Cl	785-540	750.17



Synthesis of 2-Chloromethyl 1H-benzimidazole derivatives



Procedure:

1) 1.66 gm of 2-chloromethyl-1H- benzimidazole and 2.76 gm of K2CO3, 20 ML of Dimethylformamide [DMF] was taken in a 250 ML beaker and stirred at room temperature. After stirring half an hour add pinch of KI. Then Aniline 0.095 gm was added in a reaction mixture.
2) Cover the beaker with a petri-plate and place in microwave at medium low level for 3-4 Min.
3) Take beaker out of the microwave oven allow it to cool to room temperature.
4) The Reaction Mixture was poured into water (20ML) and the mixture was extracted with ethyl acetate (60ML). The organic extracts were washed with water dried over anhydrous sodium sulphate and concentrated to obtain crude product. The residue was recrystalized from diethyl ether to give pure compound.

1. Synthesis of (1H-Benzimidazole-2-ylmethyl)-phenyl amine

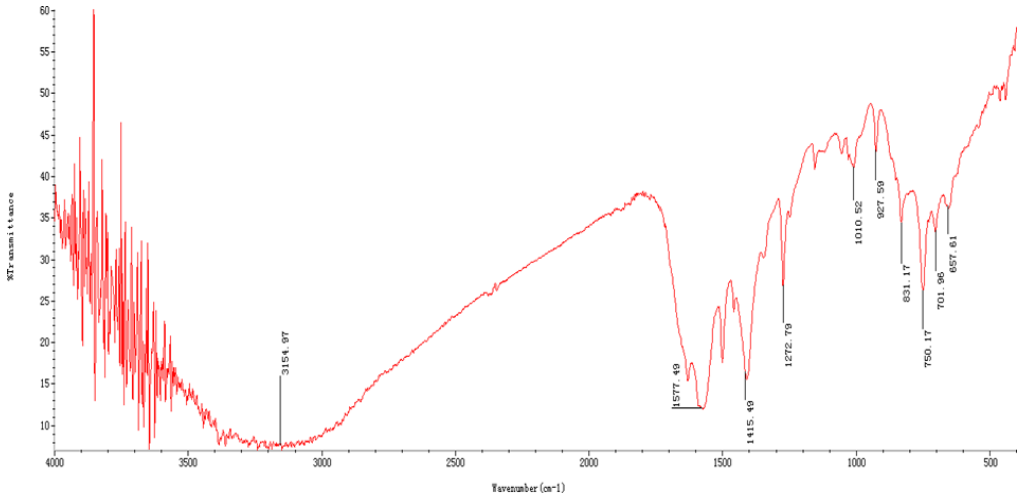
- **Molecular Formula:** C14H13N3
- **Molecular Weight:** 223.230 g.mol−1
- **Melting Point:** 146-148°C
- **Solubility:** soluble in water, ethanol, methanol, acetone, DMSO
- **Uses:** Anti parasitic, Antimicrobial, Anticancer, Anti-inflammatory agents

Spectral Data:

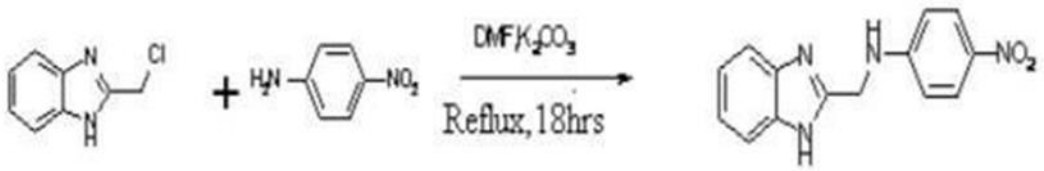
Yield: 70%, melting point: 146-148°C TLC: Benzene: Ethyl acetate (4:1), Rf: 0.43

IR (Infrared) Interpretation

Sr. No.	Functional group	Standard range	Observed values
1	N-H	3500-3100	3154.97
2	C=C	1680-1550	1577.49
3	C-N	1350-1000	1272.79
4	Aromatic C-H	900-690	750.17



Synthesis of (1H-Benzimidazole-2-ylmethyl) -(4-nitro-phenyl)-amine



2-chloromethyl-1H-benzimidazole

p-nitroaniline

(1H-benzimidazole-2ylmethyl)-(4-nitro-phenyl) -amine

Procedure:

1. 1.66 gm of 2-chloromethyl-1H- benzimidazole and 2.76 gm of K2CO3, 20 ML of Dimethylformamide [DMF] was taken in a 250 ML beaker and stirred at room temperature. After stirring half an hour add pinch of KI. Then add p-nitroaniline 2.76gm in a reaction mixture.
2. The beaker was covered with a petri-plate and place in microwave at medium low level for 3-4 Min.
3. Take beaker out of the microwave oven allow it to cool to room temperature.
4. The Reaction Mixture was poured into water (20ML) and the mixture was extracted with ethyl acetate (60ML). The organic extracts were washed with water dried over anhydrous sodium sulphate and concentrated to obtain crude product. The residue was recrystalized from diethyl ether to give pure compound.

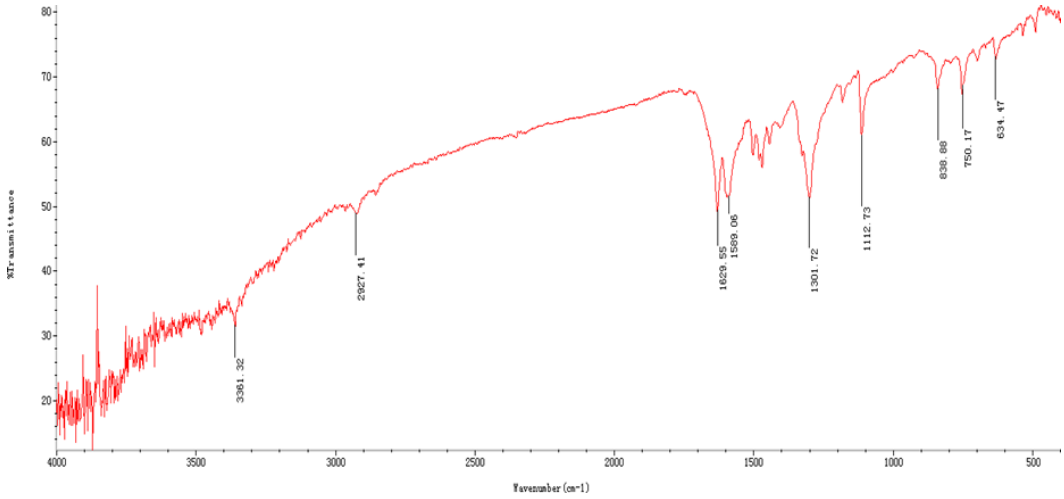
- **Molecular Formula:** C13H10N4O2
- **Molecular Weight:** 254.25 g.mol−1
- **Melting Point:** 118-120°C
- **Solubility:** soluble in ethanol, methanol, acetone, dichloromethane, DMSO
- **Uses:** Anti parasitic, Antimicrobial, Anticancer, Anti-inflammatory agents, Antifungal

Spectral Data:

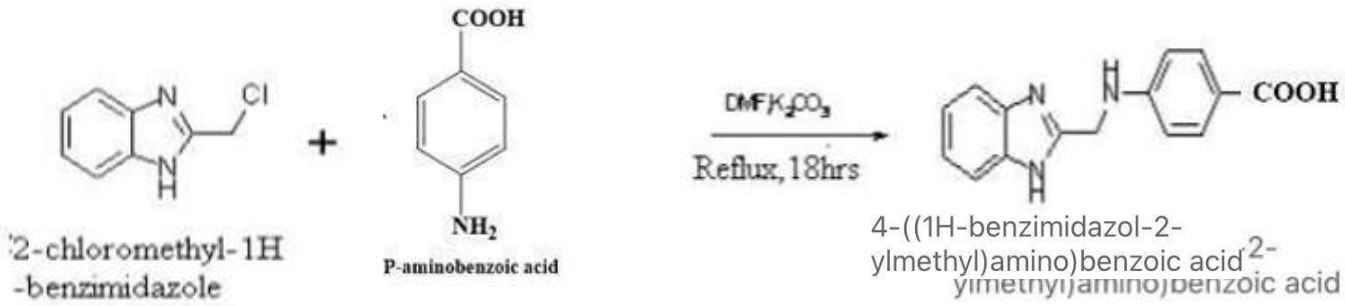
- Yield: 46%, M.p.: 118- 120°C
- TLC: Benzene: Ethyl acetate (3:1.5), Rf:0.66,

IR (Infrared) Interpretation

Sr. No.	Functional group	Standard range	Observed values
1	N-H	3500-3100	3361.32
2	C-H	3000-2850	2927.41
3	N=O	1600-1350	1589.06
4	C-N	1350-1000	1301.72
5	C-O	1300-1000	1112.73



Synthesis of 4-((1H-benzimidazol-2-ylmethyl)amino)benzoic acid



Procedure:

- 1.66 gm of 2-chloromethyl-1H- benzimidazole and 2.76 gm of K2CO3, 20 ML of Dimethylformamide [DMF] was taken in a 250 ML beaker and stirred at room temperature. After stirring half an hour add pinch of KI. Then p-aminobenzoic acid 2.70 gm was added in a reaction mixture.
- The beaker was covered with a petri-plate and place in microwave at medium low level for 3-4 Min.
- Take beaker out of the microwave oven allow it to cool to room temperature.
- The Reaction Mixture was poured into water (20ML) and the mixture was extracted with ethyl acetate (60ML). The organic extracts were washed with water dried over anhydrous sodium sulphate and concentrated to obtain

crude product. The residue was recrystalized from diethyl ether to give pure compound.

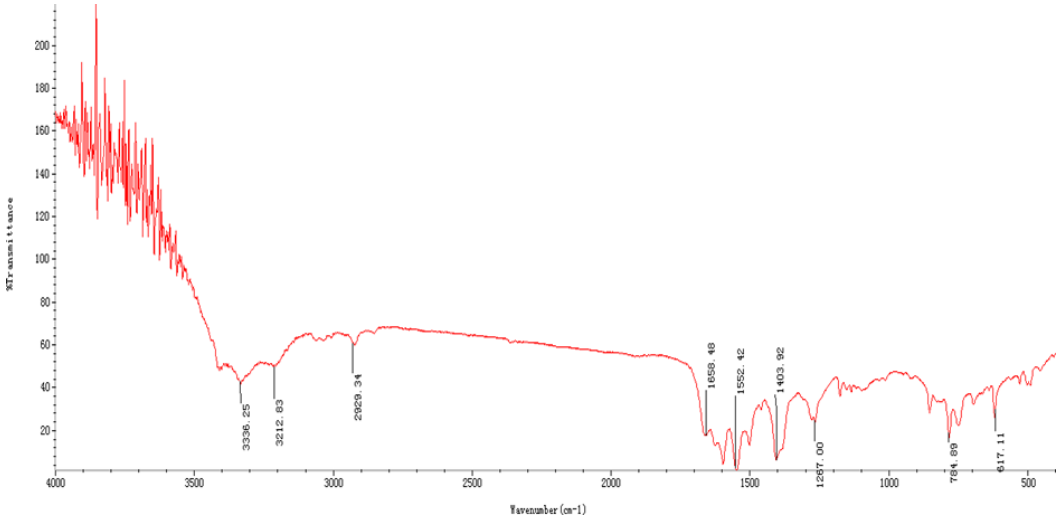
- **Molecular Formula:** C15H13N3O2
- **Molecular Weight:** 267.29 g.mol−1
- **Melting Point:** 120-152°C
- **Solubility:** soluble in ethanol, methanol, acetone, dichloromethane, DMSO
- **Uses:** Anti parasitic, Antimicrobial, Anticancer, Anti-inflammatory agents, Antifungal

Spectral Data:

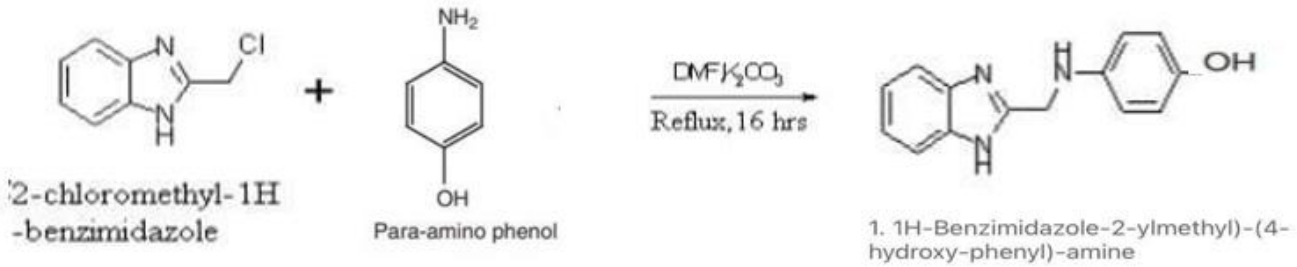
- Yield: 48%, M.p.: 120-152°C
- TLC: Benzene: Ethyl acetate (3:1.5), Rf:0.63

IR (Infrared) Interpretation

Sr. No.	Functional group	Standard range	Observed values
1	N-H	3500-3100	3336.25
2	O-H	3400-2400	3212.83
3	C-H	2950-2800	2929.34
4	C=C	1680-1600	1658.48
5	C-N	1350-1000	1267.00



Synthesis of (1H-Benzimidazole-2-ylmethyl) -(4-hydroxy-phenyl)-amine



Procedure:

1. 1.66 gm of 2-chloromethyl-1H- benzimidazole and 2.76 gm of K2CO3, 20 ML of Dimethylformamide [DMF] in a 250 ML was taken in beaker and Stirred at room temperature. After stirring half an hour a pinch of KI was added. Then p-aminophenol 2.76 gm was added in a reaction mixture.
2. The beaker was covered with a Petri-plate and place in microwave at medium low level for 3-4 Min.
3. Take beaker out of the microwave oven allow it to cool to room temperature.
4. The Reaction Mixture was poured into water (20ML) and the mixture was extracted with ethyl acetate (60ML). The organic extracts were washed with water dried over anhydrous sodium sulphate and concentrated to obtain crude product. The residue was recrystalized from diethyl ether to give pure compound

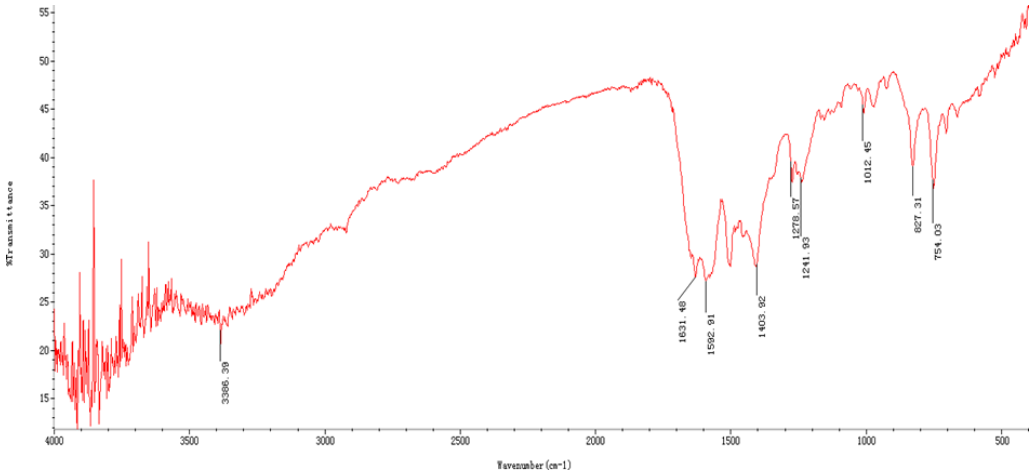
- **Molecular Formula:** C14H12N2O
- **Molecular Weight:** 224.27 g.mol−1
- **Melting Point:** 170-172°C
- **Solubility:** soluble in ethanol, methanol, acetone, dichloromethane, DMSO
- **Uses:** Anti parasitic, Antimicrobial, Anticancer, Anti-inflammatory agents, Antifungal

Spectral Data:

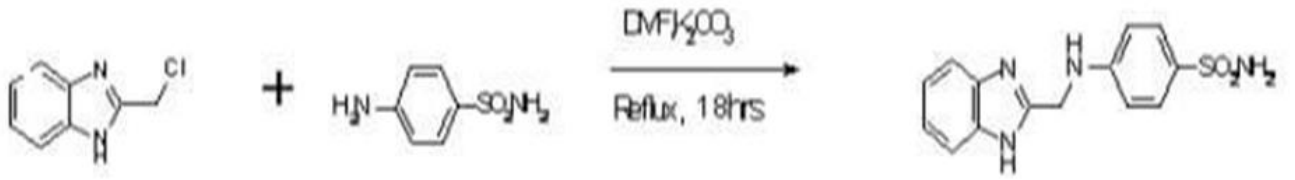
- Yield: 62%, M.p.: 170-172°C
- TLC: Benzene: Ethyl acetate (3:1.5), Rf:0.54

IR (Infrared) Interpretation:

Sr. No.	Functional group	Standard range	Observed values
1	N-H	3500-3100	3386.39
2	C=O	1680-1600	1631.48
3	C-N	1350-1000	1278.57
4	C-O	1300-1000	1012.45
5	Aromatic C-H	900-690	827.31



Synthesis of 4[(1H-Benzimidazole-2-ylmethyl)-amino]-benzene sulfonamide



2-chloromethyl-1H-benzimidazole | sulphanilamide | [4-(1H-benzimidazole-2-ylmethyl)-amino]-benzenesulfonamide

Procedure:

1. 1.66 gm of 2-chloromethyl-1H- benzimidazole and 2.76 gm of K2CO3, 20 ML of Dimethylformamide [DMF] was taken in a 250 ML beaker and Stirred at room temperature. After stirring half an hour a pinch of KI was added. Then add Sulphanilamide 1.72 gm in a reaction mixture.
2. The beaker was covered with a Petri-plate and place in microwave at medium low level for 3-4 Min.
3. Take beaker out of the microwave oven allow it to cool to room temperature.
4. The Reaction Mixture was poured into water (20ML) and the mixture was extracted with ethyl acetate (60ML). The organic extracts were washed with water dried over anhydrous sodium sulphate and concentrated to obtain crude product. The residue was recrystalized from diethyl ether to give pure compound

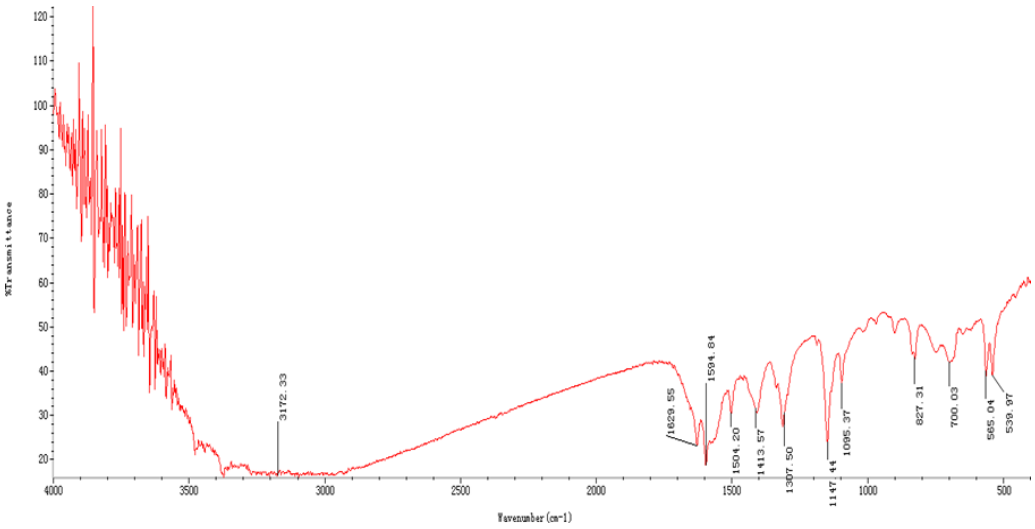
- **Molecular Formula:** C13H14N4O2S
- **Molecular Weight**: 290.27 g.mol−1
- **Melting Point:** 196-198°C
- **Solubility:** soluble in ethanol, methanol, acetone, dichloromethane, DMSO
- **Uses:** Anti parasitic, Antimicrobial, Anticancer, Anti-inflammatory agents, Antifungal

Spectral Data:

- Yield: 48%, M.P.:196-198°C
- TLC: Benzene: Ethyl acetate (3:1.5), Rf: 0.63

IR (Infrared) Interpretation:

Sr. No.	Functional group	Standard range	Observed values
1	N-H	3600-3100	3172.33
2	C=O	1680-1600	1629.33
3	C=C	1680-1550	1594.84
4	S=O	1375-1300	1307.50
5	Aromatic C-H	900-690	827.31



Antimicrobial Study

Microbiology is one of the basic sciences it attempts to cover most of its offshoots such as bacteriology, and immunology, virology and mycology have already established themselves as separate and independent sciences. microorganism are closely associated with the health and welfare of human beings; some microorganisms are beneficial and other are detrimental. Bacteria and yeast were actually first observed under the microscope in the 18" century, and in 1877 Pasteur and Joubert reported how a culture could be inhibited by products of a contaminating organism. The most celebrated of these observations is Fleming's who in 1929 observed the lysis of staphylococci colonies adjacent to colonies of the mold Penicillium notatum.53 Waksman, a soil microbiologist in 1944, discovered streptomycin. The first synthetic compounds were sulfonamide, and amino benzene sulfonamide, were characterized in mid 1930s by Trefoil in France. Antibiotics are microbial metabolites or synthetic analogues inspired by them that, in small doses, inhibit the growth and survival of microorganisms without serious toxicity to the host. Selective toxicity is the key concept. Antibiotics are among the most frequently prescribed medications today, although microbial resistance result in from evolutionary pressures and misuse threatens their continued efficacy. In many cases, the clinical utility of natural antibiotics has been enhanced through medicinal chemical manipulation of the original structure, leading to broader antimicrobial spectrum, greater potency, lesser toxicity, more convenient administration and additional pharmacokinetic advantages. Through customary usage, the many synthetic substances that are unrelated to natural products but still inhibit or kill microorganisms are referred to as antimicrobial agents instead. Because of a significant decrease in the pace of novel ant infective discovery, increased regulatory constraints, and greater profits to be made by the use of medications for chronic conditions, there is presently a decreased research emphasis on microbial agents. This coincides with a dramatic increase in microbial resistance to chemotherapy that portends a bleak future in which humankind may once again face infectious diseases with few available countermeasures. Our environment, body surfaces, and cavities support a rich and character stick microbial flora. These cause us no significant illness or inconvenience as long as our neighbours or we do not indulge in behaviour that exposes us to exceptional quantities or unusual strains of microbes or introduces bacterial into parts of the body where they are not

normally resident. Protect ion against this happening is obtained primarily through public health measures, heal the full habits, intact skin and mucosal barriers. and a properly functioning immune system. All parts of our bodies that are in contact with the environment support microbial life. It is estimated that I g of feces contains approximately 1013 microorganisms! All our internal fluids, organs, and body structures, however, are sterile under normal circumstances, and the presence of bacteria, fungi, viruses, or other organisms in these places is diagnostic evidence of infection. When mild microbial disease occurs, the otherwise healthy patient often will recover without requiring treatment. Here, an intact, functioning immune system is called on to kill invasive microorganisms. When this is insufficient to protect us, appropriate therapeutic intervention is indicated.

Clinical Significance:

The treatment of bacterial infections is one of the few disease states that all clinicians are guaranteed to be challenged with at some time in their career. Because bacteria are constantly changing, the selection of appropriate antimicrobial therapy is crucial in providing efficacious treatment of infect ions. It is of the utmost importance that clinicians understand the medicinal chemistry of antimicrobial agents to choose the most effective therapy for their patients.

Antibacterial Activity

- Standard drug – Ciprofloxacin
- Bacteria - Staphylococcus aureus (Gram-positive Bacteria) Method - Agar Well Diffusion (in-vitro)
- Agar- Nutrient Agar

Method For Antibacterial Activity Determination:

Dilution of the compounds:

All the synthesized compounds were dissolved in DMSO (Dimethyl Sulfoxide) so as to get concentration of 50µg/ml and 100µg/ml and standard drugs Ciprofloxacin as a concentration of 10mg/ml.

Sterilization of equipment's

Sterilisation is the complete destruction of all microorganisms by suitable chemical agent or by heat in Hot air oven under pressure at 100-120°C for at least 15 minutes

Selection of microorganisms:

Choose a panel of microorganisms against which you want to test the antimicrobial activity. This may include bacteria (both Gram-positive and Gram-negative), and other pathogens. The staphylococcus aureus bacteria Was selected. Staphylococcus aureus is gram-positive type bacteria which is found in upper respiratory tract and on skin.

Chemicals

Nutrient agar medium [NO11], and normal saline solution were sterilized in autoclave at 15 lbs pressure [121C] for 15 minutes. Petri plates, Whatman filter paper and cotton swabs were sterilized in oven at 100-120°C for at least 15 minutes

Preparation of Nutrient agar:

Nutrient Agar (Peptone, Beef extract, Sodium chloride, Agar and distilled water were used) boiled and poured in test tube then plugged with cotton and sterilized in autoclave at 15lbs pressure (1210C) for 15 min. After sterilization the tubes containing the Nutrient agar were poured in petri plate and kept for 30 min. Then on the surface of

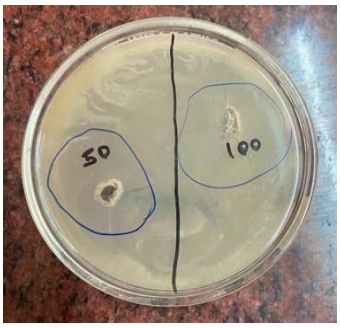
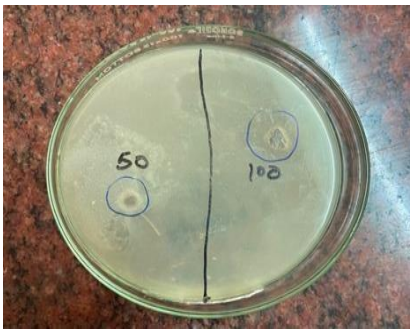
plates pure culture staphylococcus aureus were streaked in aseptic condition and cooled. After cooling the solution whose antibacterial activity is to be check is inserted in plate and the plates are incubated at 37°C for 24 hrs.

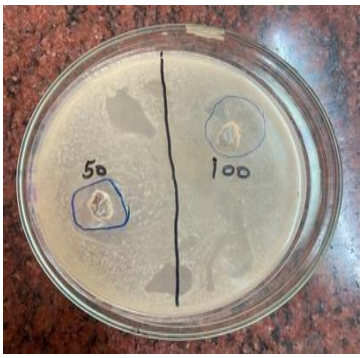
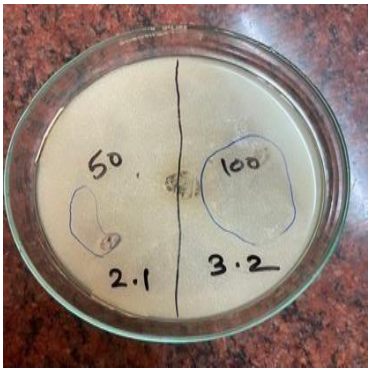
Measurement of Inhibition zones:

Measure the diameter of the zones of inhibition around the disks after a specified incubation period. Larger zones indicate greater antimicrobial activity

Comparison with Standard Drugs:

Compare the antimicrobial activity of the compound with that of standard antimicrobial drugs to assess its efficacy and potential for further development.

Sample	Front view	Back view
Standard sample (Ciprofloxacin)		
(1H-Benzimidazole-2- ylmethyl)-phenyl amine		
(1H-Benzimidazole-2-ylmethyl) (4-nitro-phenyl)-amine		

4-((1H-benzimidazol-2-ylmethyl)amino)benzoic acid		
1H-Benzimidazole-2-ylmethyl)- (4-hydroxy-phenyl)-amine		
4[(1H-Benzimidazole-2- ylmethyl)-amino]- benzenesulfonamide		

Observation:

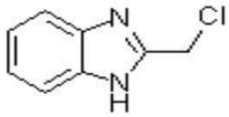
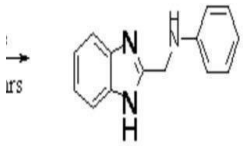
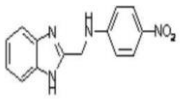
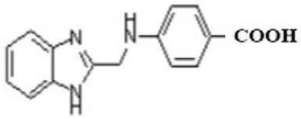
Five derivatives of 2-Chloromethyl-1H-benzimidazole were synthesized using different aromatic amines and heterocycles as substituents. Synthesized compounds were characterized by chromatographic methods, Infrared spectroscopy for their structural confirmation. These five compounds were tested for antifungal activity by in vitro well plate method. Activity was presented in the form of zone of inhibition (mm) in agar culture plates are seen as below.

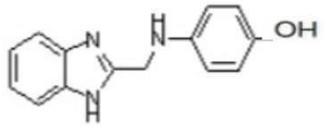
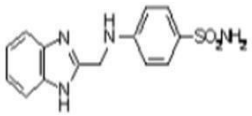
Compound	Zone of inhibition	
	50µg/ml	100µg/ml
Standard sample	2.7	3.3
(1H-Benzimidazole-2- ylmethyl)-phenyl amine	1.3	1.6

(1H-Benzimidazole-2-ylmethyl)-(4-nitro-phenyl)- amine	2.0	2.4
4-((1H-benzimidazol-2-ylmethyl)amino)benzoic acid	1.6	1.9
1H-Benzimidazole-2- ylmethyl)-(4-hydroxy-phenyl)-amine	1.4	1.6
4[(1H-Benzimidazole-2-ylmethyl)-amino]- benzenesulfonamide	2.1	3.2

4[(1H-Benzimidazole-2-ylmethyl)-amino]-benzenesulfonamide exhibited maximum activity among the Five Derivatives of 2-Chloromethyl-1H-benzimidazole with MIC (Minimum Inhibitory Concentration) equal to that of the Standard Ciprofloxacin.

RESULTS & DISCUSSION

Compounds & Structure	Molecular Formula	Practical Yield	Melting point	Rf value	Zone of inhibition	
					50µg/ml	100 µg/ml
 2-chloromethyl-1H-benzimidazole	C8H8CIN2	60%	153-155°C	0.43	2.7	3.3
 1H-benzimidazole-2-ylmethyl)-phenylamine	C14H13N3	70%	146-148°C	0.47	1.3	1.6
 (1H-benzimidazole-2ylmethyl)-(4-nitro-phenyl)-amine	C13H10N4 02	46%	118-120°C	0.66	2.0	2.4
 4-((1H-benzimidazol-2-ylmethyl)amino)benzoic acid	C15H13N3 O2	48%	120-152°C	0.60	1.6	1.9

 1. 1H-Benzimidazole-2-ylmethyl)-(4-hydroxy-phenyl)-amine	C14H12N2 0	62%	170-172°C	0.54	1.4	1.6
 [4-(1H-benzimidazole-2-ylmethyl)-amino]-benzenesulfonamide	C13H14N4 02S	48%	196-198°C	0.63	2.1	3.2

Five derivatives of 2-Chloromethyl-1H-benzimidazole were synthesized using different aromatic amines and heterocycles as substituents. Synthesized compounds were characterized by chromatographic methods and Infrared spectroscopy for their structural confirmation. These five compounds were tested for antimicrobial activity by in vitro well plate method. Activity was presented in the form of zone of inhibition (mm) in agar culture plates and MIC.

CONCLUSION

- All the five synthesized compounds screened for in vitro antimicrobial activity showed antimicrobial activity. 4[(1H-Benzimidazole-2-ylmethyl)-amino]-benzene sulfonamide exhibited potent activity. In conclusion, these compounds provide preliminary insights into newer antimicrobial agents, which can help further modification to improve upon the activity profile.
- In the synthesis and evaluation of 2-chloromethy/1-1H-benzimidazole derivatives, several key findings and conclusions can be drawn based on the experimental results:

1. **Synthesis Method:** The synthesis method used for preparing 2-chloromethyl-1H-benzimidazole derivatives proved to be efficient and reproducible. The reaction conditions provided good yields and purity of the desired products.

2. **Characterization:** The synthesized compounds were characterized using various spectroscopic techniques, including IR. The spectral data confirmed the identity and structural integrity of the synthesized derivatives.

3. **Antimicrobial Activity:** Evaluation of the synthesized 2-chloromethyl-1H-benzimidazole derivatives revealed promising antimicrobial activity against a panel of microorganisms.

In conclusion, the synthesis and evaluation of 2-chloromethyI-1H-benzimidazole derivatives have provided valuable insights into their potential as novel antimicrobial agents. Further research and development efforts are necessary to optimise their therapeutic utility and advance them towards clinical application.

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