4.1 Introduction:

The synthesis of heterocyclic compounds has always drawn the attention of researchers over the years mainly because of their important biological properties. Among these the N-heterocyclic compounds play an important role as most of the drugs used for the treatment of different diseases are mainly N-heterocycles.

It is carbonyl derivatives of azetidines containing carbonyl group at the position-2. These are also known as 2-azetidinones or more commonly β-lactam.

Azetidin-2-one is of special interest as it is an important moiety associated with the structure of penicillin molecule. The chemistry of β-lactams has taken an important place in organic chemistry, since the discovery of penicillin by Sir Alexander Fleming in 1928 and shortly thereafter cephalosporin compounds which were used as successful antibiotics. The four membered β-lactam (2-azetidinone) ring systems has many years of great practical significance as the centre of reactivity of penicillins (1) and Cephalosporin (2).

Biological activity of the β-lactam antibiotic is generally believed to be associated with the chemical reactivity of their β-lactam ring. β-lactam also possesses antibacterial, antifungal, anticancer, antiviral and cholesterol absorption inhibitory activities. Azetidin- 2-ones substituted at the 3rd position with aryloxy group were synthesized as this group increases antimicrobial activity. They also function as enzyme inhibitors & are effective on the central nervous system. In recent past years these derivatives are also found to be moderately active against different types of cancer and HIV.
Much efforts have been put for the synthesis of simple β-lactams for testing as antibiotics, anti-depressants, sedatives [1] etc. Synthesis of 2-azetidinones has been extensively studied by Sheeham and Corey [2]. More recently other aspects of synthesis have been reviewed [3, 4]. Different methods of preparation have been cited in the literature [5-12].

Azetidin-2-ones are the most extensively studied derivatives of azetidin-2-one, largely as a result of the discovery of antibacterial properties of penicillin, cephalosporin and cephymycin. Recently, there has been considerable interest in other fused β-lactams, such as clavulanic acid, thienamycin and the related clavulanic acid derivative and the penems. Nonfused β-lactam containing natural products include the nocardicins (3) and the monobactams (4) etc.

\[
\begin{align*}
(3) & \quad (4)
\end{align*}
\]

β-Lactams still serve as one of the largest segments in pharmaceutical market, and the discovery of nonclassical β-lactam antibiotics has attracted considerable attention for the synthesis organic chemists explore and developed new mild and better yielding routes. It is proposed in the light of these findings to carry out the synthesis of some novel azetidinone derivatives.

4.2 Biological Significance:

2-Azetidinones or β-Lactam drugs are still most widely prescribed antibiotics used in medicines. 2-Azetidinone derivatives possess wide therapeutic activity viz. sedative, hypnotics, anticonvulsant, herbicidal and antibacterial etc. 2-azetidinones having an amide linkage into a four membered ring results in angle strain and some degree of inhibition of amide resonance, rendering β-lactams more susceptible than normal amides to nucleophilic attack at the carbonyl group. β-lactams undergo N(1)-C(2) cleavage on treatment with variety of nucleophiles and this ability of a β-lactam to act as an acylating agent is generally considered to be a responsible for the antibacterial properties of penicillins and cephalosporins.
A) Antibacterial & antifungal activity:

A large number of 3-chloro monocyclic β-lactams have been prepared by the
cycloaddition of disubstituted enamines with aryl isothiocyanates which possess a
powerful antibacterial activity [13]. A series of (2-amino pyrimidinyl)-2-oxyimino
acetamido-cephalosporins have been prepared by Goto et al. as useful antibiotics [14].
Penicillins of type and their corresponding penicillins gave antibacterial activity. Akiba
et al. [15] reported 4-(trifluoromethyl)-2-azetidinone derivatives as an antibacterial
agent. Sendai and co-workers [16] have prepared 2-azetidinones of type (5) and
evaluated its antibacterial activity against Gram positive and Gram negative bacteria.

\[
\text{(5)}
\]

Priyadarsini et al. [17] have synthesized azetidinones (6) and reported as
antibacterial agent. Similarly Freedy et al. [18] described antibacterial activity of3-
chloro-4-(substituted phenyl)-1-(3-bromo-4-methoxybenzamido) azetidinones (7).

\[
\text{(6)} \quad \text{R1}= 2-\text{Cl, 3-OCH}_3
\]

\[
\text{(7)}
\]

V. Jayamma and co-workers have prepared some new derivatives of 2-
azetidinones and tested their antimicrobial activity. 2-Azetidinone derivatives have
been reported as antiparkinson, antibacterial and antifungal, anti-inflammatory,
hypcholesterolimic, and antimicrobial agents. Moreover, Saito et al. [19] synthesized
some new azetidinones as carbapenem antibiotics. Mulwad et al. [20] described
antibacterial activity of some azetidinones and hydroxycoumarin derivatives (8).

\[
\text{(8)}
\]

Shah et al. [21] have reported azetidinone derivatives as antimicrobial and
antitubercular agents. Khalafallah et al. have synthesized some new azetidinone
derivatives and screening their antimicrobial activity. Parekh et al. have synthesized 2-azetidinones as antimicrobial agents (9).

Non-penicillin/non-cephalosporin-lactam compounds have undergone extensive clinical evaluation. The compound (10) has potent broad-spectrum antibiotic named as moxalactam and latamoxef. Potency of moxalactam toward Gram-negative bacteria has been attributed to its improved stability towards the β-lactamases, the bacterial enzymes which can degrade the β-lactam antibiotics. The β-oxacephem nucleus of moxalactam is responsible for the greater *in-vitro* potency in comparison to its classical cephalosporin counterpart.

Carbapenem, N-formimidoyl thienamycin semisynthetic derivative of the parent antibiotic thienamycin has been shown to possess potent antibacterial activity against a wide range of *Pseudomonas aureginosa*. Spasov et al. [22] have synthesized and tested various azetidin-2-ones for bactericidal activity. Kolaus et al. [23] synthesized many azetidin-2-ones of the following type (11, 12, 13) and found them useful as bactericide.

The following azetidin-2-ones (14) were found useful against *B. substilis* and *Serratia mercense* by Stejepan et al. [24].
Osman et al. [25] synthesized many azetidin-2-ones and found them to be active against *B. cereus*, *B. megaterium* and *B. subtilis*. These compounds have variable antifungal activity against *A. niger*, *Mucor circinelloides*, *Curvularia lanata*, *A. flavus* and *Fusarium semitectum*. Desai et al. [26] synthesized azetidinone derivatives of thiadiazole and evaluated for antimicrobial activity. Diumo et al. [27] synthesized new substituted 1,3,4-triaryl-2-azetidinones and reported their *in-vitro* antimicrobial activity. Some of the compounds exhibited significant activity against Gram (-) bacteria and fungi. Bhat et al. [28] synthesized a series of azetidin-2-ones and 4-thiazolidinones and reported their antibacterial, antifungal and antitubercular activities.

S. Giri et al. [29] have synthesised some 1-[5'-aryl-1',3',4'-thiadiazol-2'-yl]-3-chloro-4-substituted 2-azetidinones as potential fungicides. R. H. Udupi et al. [30] synthesised some new azetidinone molecules which shows good antiinflammatory, antitubercular, bactericidal and fungicidal activity. The following compounds (15, 16) were found in literature to be fungicidal [31].

![Chemical structure of compound 15](image1)

![Chemical structure of compound 16](image2)

Ping et al. [32] studied bactericidal action of silver nanoparticles and amoxicillin on *Escherichia coli*. When amoxicillin and silver nanoparticles are combined, it results in greater bactericidal efficiency on *Escherichia coli* cells than when they were applied separately. 1-[5-(N10-phenothiazinomethyl)-1,3,4-thiadiazol-2'-yl]-4-substituted-2-azetidinones (17) as antifungal agents have been reported by Rawat et al. [33]

![Chemical structure of compound 17](image3)

Vaccaro, Wayne D. and co-workers [34] prepared some novel azetidinone derivatives as cholesterol absorption inhibitors. Mckittrick Brain A. and co-workers have prepared some new azetidinones display potent cholesterol absorption inhibitory activity [35]. H. S. Joshi et al. [36] have synthesized some 2-azetidinone derivatives as antitubercular and antimicrobial agents (18).
Parmar et al. [37] reported synthesis of azetidinones from hydrazinopyrimidine as potential antimicrobial agents. Compound (19) which exhibited promising activity with ampicillin and chloramphenicol against P. fluorescens. Levinine et al. [38] synthesized and reported its antiviral activity against influenza virus A-PR8 and hepatitis virus MHV3.

B) Anticancer activity:

Park et al. [39] synthesized and evaluated two known phenolic metabolites of paclitaxel. C3-phenolic metabolite of paclitaxel was prepared from 7-(triethylsilyl)-baccatin III and enantio enriched N-benzoyl-2-azetidinone. Both the metabolites were found to have good anticancer activity.

Takayanagi et al. [40] studied various substituted azetidinones and tested for anticancer activity, and observed no any cytostatic activity for compounds. Boge et al. [41] synthesized and evaluated novel cyclohexyl analogues of taxol and taxotere. Compound 2-(cyclohexyl carbonyl)-2-debenzoylbaccatin was prepared from baccatin by hydrogenation. Subsequent coupling of 2-(cyclohexyl carbonyl)-2-debenzoylbaccatin with N-t-BOC-3-[(tert-butyldimethylsilyl)oxy]-4-phenyl-2-azetidinone, followed by removal of the protecting groups afforded 2-(cyclohexyl carbonyl)-2-debenzoyl taxotere. In a similar synthetic sequence, 3-cyclohexyl-3-dephenyl taxol was prepared from N-benzoyl-3-[(tert-butyldimethylsilyl) oxy]-4-cyclohexyl-2-azetidinone and (triethylsilyl) baccatin. All analogues exhibited strong activity in the microtubule assembly assay and cytotoxicity comparable to taxol against B16 melanoma cells. Different authors [42-45] have reported the synthesis of anticancer β-lactams & their mechanism of action.
C) **Antiinflammatory activity:**

Doherty et al. [46] and co-workers have prepared some azetidinones and reported for antiinflammatory activity. Peter W. et al. [47] synthesized a number of azetidinones and tested for antiinflammatory action. Azetidinones of the following type (21) have been shown to have antiinflammatory activity.

\[ \text{R}_1 \text{N} \left( \text{H}_2 \text{C}_2 \right) \text{O} / \text{N} / \text{CH} \text{n} - \text{R} \]

Several compounds like 1-[5-(carbazolylmethyl)-1,3,4-thiadiazol-2-yl]-4-(substituted phenyl) -3-chloro-2-oxo-azetidines (22, 23) have been synthesized and evaluated for their anti-inflammatory activity by Srivastava et al. [48, 49].

![Chemical structures of 22 and 23](image)

Tandon et al. [50] synthesized new azetidinones and tested for pharmacological effects and toxicity in rats and mice. Moderate antiinflammatory and analgesic activities were observed along with low toxicity.

D) **Anticonvulsant activity:**

Peter et al. [51] synthesized a number of azetidinones (24, 25) and tested for anticonvulsant activity against electroshock and metrazole induced convulsions.

![Chemical structures of 24 and 25](image)

Testa E. et al. [52] prepared a number of azetidin-2-ones (26) and found them to possess sedative, hypnotic and anticonvulsant activity in rat.

![Chemical structure of 26](image)
The substances had a general depressant action on the nervous system manifested by various tests. Testa et al. [53] synthesized a series of 3, 3, disubstituted 2-azetidinones for sedative action.

Emilio et al. [54] prepared azetidinones and screened for possible C. N. S activity. Emilio et al. in a review on the hypnotic action of azetidinones have indicated that azetidin-2-ones substituted at C-3 and N, form a class of compounds which were definitely and significantly active on C. N. S. This activity could assume various aspects and pass from the plain sedative action to various kinds of hypnotic and tranquillizing effects.

E) Antitubercular activity:

Synthesis and antitubercular activity of 2-(4-aryl-3-chloro-2-azetidinon-1-yl-amino)-6-(4-chlorophenyl)-5-cyano-3-N-methyl-3,4dihydropyrimidin-4-ones (27) was reported by Modha et al. [55].

\[ \text{Chemical Structure of 27} \]

Parekh et al. [56] described antitubercular activity of 4-aryl-3-chloro-1-(Benzimidazole-21-yl-benzamido)-2-azetidinones (28).

\[ \text{Chemical Structure of 28} \]

Recently, incorporation of these compounds have witnessed a great upsurge in the treatment of tuberculosis and other chemotherapeutic diseases [57]. Sharma et al. [58] reported synthesis and antibacterial activity of some N-sulphonamoylphenylamino-3-chloro-4-phenylazetidin-2-ones. Udupi et al. [59] prepared a series of 2-(6-Methoxynapthyl) propioanamidoazetidin-2-one (29) derivatives and reported for antibacterial and antitubercular activity.
Patel et al. [60] have reported synthesis and antitubercular activity of 2-[4-(4-substitutedphenyl)-3-chloro-2-azetidinon-1-yl]-4-[2-(4-chlorobenzene-sulphona-mido)phenyl] thiazoles (30).

Fluorescent analogues of the cholesterol absorption inhibitor (CAI), have been synthesized by Burnett et al. [61] as enantiomers. Biological testing revealed that they were potent cholesterol absorption inhibitors (CAI’s) and were suitable tools for the investigation of the azetidinone cholesterol absorption inhibiting mechanism of action. Different authors [62-63] have reported the β-lactam derivatives as cholesterol lowering agents.
4.3 Present Work:

This chapter deals with the synthesis of 2-azetidinones having wide range of biological activities.

2-Azetidinones, commonly known as β-lactams, are well-known heterocyclic compounds. The 2-azetidinone ring system is a common structural feature of a number of wide spectrum β-lactam antibiotics including penicillins, cephalosporins, carbapenems, nocardicins and monobactams, which have been widely used as chemotherapeutic agents to treat bacterial infections and microbial diseases.

Compounds containing 2-azetidinone ring shows different biological activities include antifungal, antitubercular, antitumor, cholesterol absorption inhibition and enzyme inhibition activity. There is a continuous need for the functionised β-lactams.

2-Azetidinones can be synthesized as, to a mixture of Schiff base (10 mmol) and triethylamine (30 ml) in 1,4-dioxane, was added chloroacetyl chloride (12 mmol) drop wise at below 10 °C. The reaction mixture was stirred at room temperature for 5 hr. and then 50 °C at 1 hr. After usual workup obtained 2-azetidinones (Scheme-III).
Synthesis of 2-Azetidinones

Schiff base + chloroacetyl chloride → 2-Azetidinones

Scheme-III

<table>
<thead>
<tr>
<th>R₁ (Amine)</th>
<th>R₂ (Aldehyde)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td>a <img src="image2.png" alt="Image" /></td>
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<tr>
<td><img src="image3.png" alt="Image" /></td>
<td>b <img src="image4.png" alt="Image" /></td>
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<tr>
<td><img src="image5.png" alt="Image" /></td>
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<tr>
<td><img src="image6.png" alt="Image" /></td>
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<td><img src="image7.png" alt="Image" /></td>
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<tr>
<td><img src="image8.png" alt="Image" /></td>
<td></td>
</tr>
<tr>
<td><img src="image9.png" alt="Image" /></td>
<td></td>
</tr>
</tbody>
</table>
4.4 Experimental:

Melting points were determined using open glass capillaries and were uncorrected. $^1$HNMR spectra were recorded on NMR-Spectrometer (Bruker 300 MHz). The $^1$H-chemical shifts are expressed in ppm relative to tetramethylsilane (Me$_4$Si). IR spectra were recorded on FT-IR Spectrometer (Lambda scientific). Mass spectra were obtained on Shimadzu GCMS-QP-2000 Mass Spectrometer.

Synthesis of 2-Azetidinones:

A mixture of Schiff base (10 mmol) and triethylamine (12 mmol) were dissolved in 20 ml of dioxane. Then chloroacetyl chloride (12 mmol) was added drop wise at below 10 °C. The reaction mixture was stirred at room temperature for 5 hr. and then 50 °C for 1 hr. It was then cooled; sticky mass was obtained, when the solvent was evaporated on hot water bath. The product was triturated with petroleum ether and crystallized from ethanol to yield substituted azetidinones.

4.5 Result and Discussion:

After Louis Pasteur had proved in the mid-19th century that many diseases are caused by germs and parasites, it was decided that substances can be investigated with these microorganisms and as a result, the molecule helping to overcome the disease would be identified. Currently, more than 200 antimicrobial agents are used in clinical practice for the treatment of infectious diseases.

Recently, the increase in bacterial resistance becomes the matter of growing concern. Due to growing resistance of microorganisms to various antimicrobial drugs, the efficiency of currently used antimicrobial agents comes at risk; therefore, it is necessary to continue the search for new active substances. An analysis of the structure of compounds synthesized previously showed that 2-azetidinones derivatives with sulfonamide pharmacophore are more active against bacteria than sulfanilamides themselves; also they are characterized by antifungal activity.

On the basis of successful results of previous research works, we decided to synthesize 2-azetidinones derivatives by attaching various fragments of amino moiety drugs and aldehydes, in the hope that the new compounds will exhibit higher antimicrobial activity.
2-Azetidinones can be synthesized via Schiff base. Different Schiff bases can be synthesized by using amino moiety drug derivatives and aromatic aldehyde. For this synthesis amino moiety drug like sulphadoxine, pyrazinamide, zonisamide, ethionamide, pyrimethamine, metochlopramide, tyramine were condensed with aromatic aldehydes like 2-hydroxy benzaldehyde and vanillin to form Schiff base. The synthesized Schiff base reacts with chloroacetyl chloride in presence of triethylamine. Chloroacetyl chloride was added drop wise at below 10 °C in reaction mixture taken in dioxane. The reaction mixture was stirred at room temperature for 5 hr. and then 50 °C for 1 hr. After usual workup 2-azetidinones was obtained.

For a model reaction if reaction runs at room temperature, it observed that reaction yield is poor and some of compound either impure or sticky is formed interestingly when reaction mixture stirred at room temperature about 4 to 5 hours and then further at 50 °C for one hour, it is found that reaction yield increases up to 80 % (Table-4.1). Hence all other 2-azetidinones synthesized using same procedure. Some of the azetidinones product so obtained was viscous oils.

Cycloaddition of monochloroacetyl chloride with Schiff base results in formation of 2-azetidinone (β-Lactum). The reaction involved direct acylation of imines with mono chloroacetyl chloride. The reaction carried out with base triethylamine gives β-lactum. Also the base catalyzed condensation of acetyl chlorides (bearing an electron withdrawing group and at least one hydrogen atom at the α-position) with N-arylaldimines occurs by initial acylation at the nitrogen atom and leads to β-lactams of interest in penicillin chemistry. Possible mechanism of reaction is as follows.
<table>
<thead>
<tr>
<th>Sr. No</th>
<th>2-Azetidinones</th>
<th>M.P. (°C)</th>
<th>Time (hr)</th>
<th>Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>![Image]</td>
<td>120</td>
<td>4</td>
<td>80</td>
</tr>
<tr>
<td>A2</td>
<td>![Image]</td>
<td>Oil</td>
<td>4.5</td>
<td>70</td>
</tr>
<tr>
<td>A3</td>
<td>![Image]</td>
<td>154</td>
<td>5</td>
<td>75</td>
</tr>
<tr>
<td>A4</td>
<td>![Image]</td>
<td>Oil</td>
<td>4.5</td>
<td>68</td>
</tr>
<tr>
<td>A5</td>
<td>![Image]</td>
<td>95</td>
<td>5</td>
<td>70</td>
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<td>A6</td>
<td>![Image]</td>
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</tr>
<tr>
<td>A7</td>
<td>![Image]</td>
<td>125</td>
<td>5.5</td>
<td>75</td>
</tr>
<tr>
<td>Sr.No</td>
<td>2-Azetidinones</td>
<td>M.P. (°C)</td>
<td>Time (hr)</td>
<td>Yield</td>
</tr>
<tr>
<td>-------</td>
<td>----------------</td>
<td>-----------</td>
<td>-----------</td>
<td>-------</td>
</tr>
<tr>
<td>A8</td>
<td></td>
<td>105</td>
<td>4.5</td>
<td>80</td>
</tr>
<tr>
<td>A9</td>
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<tr>
<td>A13</td>
<td></td>
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<td>5</td>
<td>80</td>
</tr>
<tr>
<td>A14</td>
<td></td>
<td>134</td>
<td>5</td>
<td>70</td>
</tr>
</tbody>
</table>
4.6 Spectral Analysis:

β-lactam ring showed characteristic absorption peak in the range of 1729-1741 cm\(^{-1}\) and \(^1\)H NMR spectra two doublet were appeared for (N-CH) and (CH-Cl) in the range of δ 5.22-5.37 and 4.22-4.68 ppm respectively. The IR absorption and \(^1\)H NMR signal for N=CH have been disappeared. All above facts strongly indicate the formation of β- lactam compounds.

Compound [A-5]:

2-(2-Hydroxy-phenyl)-3-(pyrimidine-4-carbonyl)-thiazolidin-4-one

<table>
<thead>
<tr>
<th>IR (v) max cm(^{-1})</th>
<th>3321, 3166, 3082, 2949, 1718, 1610, 1516, 1436, 1383, 1151, 918, 747.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(^1)H NMR (DMSO)</td>
<td>2.8-2.9 (t, 2H, -CH(_2)-N)</td>
</tr>
<tr>
<td>300 MHz</td>
<td>3.2-3.4 (t, 2H, Ar-CH(_2))</td>
</tr>
<tr>
<td></td>
<td>4.05 ( d, 1H, CH-Cl of azetidinone ring )</td>
</tr>
<tr>
<td></td>
<td>4.62 (d, 1H, CH azetidinone ring having phenyl group)</td>
</tr>
<tr>
<td></td>
<td>7.02-7.27 (m, 8H, Ar-H)</td>
</tr>
<tr>
<td></td>
<td>8.3 ( broad, 2H, Ar-OH)</td>
</tr>
<tr>
<td>GC MS; ES(^+)</td>
<td>316 (M(^+), 5)</td>
</tr>
</tbody>
</table>

Compound [A-6]:

1-(Benzo[d]isoxazol-3-ylmethanesulfonyl)-3-chIoro-4-(2-hydroxy-phenyl)-azetidin-2-one

<table>
<thead>
<tr>
<th>IR (v) max cm(^{-1})</th>
<th>3331, 3160, 3092, 2954, 1721, 1615, 1518, 1456, 1393, 1161, 905, 740.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(^1)H NMR (DMSO)</td>
<td>2.52 (s, 2H, -CH(_2)-SO(_2))</td>
</tr>
<tr>
<td>300 MHz</td>
<td>4.17- 4.19 (t, 2H, Ar-CH(_2)-S)</td>
</tr>
<tr>
<td></td>
<td>4.8 ( s, 1H, CH-Cl of azetidinone ring )</td>
</tr>
<tr>
<td></td>
<td>5.30 (s, 1H, CH azetidinone ring of phenyl group)</td>
</tr>
<tr>
<td></td>
<td>7.2-7.7 (m, 8H, Ar-H)</td>
</tr>
<tr>
<td></td>
<td>7.99 ( broad, 1H, Ar-OH)</td>
</tr>
</tbody>
</table>
Compound [A-9]:

4-[3-Chloro-2-(4-hydroxy-3-methoxy-phenyl)-4-oxo-azetidin-1-yl]-isoxazolidin-3-one:

IR $\nu$ max cm$^{-1}$

| 3066.5, 2923.56, 2852.06, 1783.64, 1667.72, 1601, 1512.64, 1463.83, 1416.52, 1335.90, 1269.13, 1159.68, 1030.97, 941.61, 774.91. |

$^1$H NMR (DMSO) 300 MHz

| 3.95-4.01 (s, 3H, Ar-OCH$_3$) | 4.44 (d, 2H, -CH$_2$ of isoxazolidin ring) |
| 4.58 (t, 1H, -CH of isoxazolidin ring) | 4.74 (d, 1H, CH azetidinone ring having phenyl group) |
| 5.98 (d, 1H, CH-Cl of azetidinone ring) | 6.65 (broad, 1H, Ar-OH) |
| 7.0-7.34 (m, 3H, Ar-H) | 8.17 (s, 1H, NH of isoxazolidin ring) |

GC MS; ES$^+$

| 312 (M$^+$, 3) | m/z (%Rel. intensities) |
Synthesis of 2-Azetidinones


Name | Description
---|---
A- 5 | Sample 232 By Administrator Date Saturday, May 30 2015
Synthesis of 2-Azetidinones

Chapter 4

Ph. D. Thesis: S. K. Wasmatkar, 2015; SRTMU, Nanded

C_{17}H_{16}CINO_3

Mol. Wt.: 317.77

\begin{center}
\includegraphics[width=\textwidth]{diagram.png}
\end{center}
Synthesis of 2-Azetidinones

Ph. D. Thesis: S. K. Wasmakkar, 2015; SRTMU. Nanded

Page 113
<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-9</td>
<td>Sample 233 By Administrator Date Saturday, May 30 2015</td>
</tr>
</tbody>
</table>
Synthesis of 2-Azetidinones

Chapter 4

Ph. D. Thesis: S. K. Wasmatkar, 2015; SRTMU, Nanded
4.7 References: