Ibn Al-Haitham Journal for Pure and Applied Sciences
Journal homepage: jih.uobaghdad.edu.iq
PISSN: 1609-4042, EISSN: 2521-3407
IHJPAS. 2024, 37(3)

Synthesis Identification of the New Heterocyclic System from Lactam

Suad M. Ali[1*] and Sanaa A. ALsahib[2]
[1]Laboratory of the General Company for Construction Industries, Baghdad, Iraq.
[2]Department of Chemistry, College of Science for Women, University of Baghdad, Baghdad, Iraq.
*Corresponding Author.

Received: 7 March 2023 Accepted: 18 May 2023 Published: 20 July 2024
doi.org/10.30526/37.3.3318

Abstract

The importance of heterocyclic compounds has long been recognized, and the use of chemicals has remained constant, including in the manufacturing of pharmaceuticals. Several lactam synthesis methods have been developed. Among the essential compounds in our lives are lactams from amines and aldehydes and the preparation of Schiff bases. Schiff bases are prepared in two ways, including the reaction of hydrazine and various aldehydes with tetraethylamine and the production of a Schiff base, which leads to the formation of two types of lactams and the preparation of a kind of reaction of different amines and aldehydes. Three techniques prepared the lactams, the first being Schiff bases with acetyl chloride and triethylamine as catalysts and using dioxane as the solvent; The second is from Schiff bases with carboxylic acids; The third is aldehydes with amines. It produces beta-lactam derivatives (azetidine), and this research focuses on the production of lactams and their polymerization through their reaction with ethanol once and with ethanol and the base to form industrial polymers, which are polymers that are produced in the form of a final product with an active end and are used in many industries. These polymers have moderate to high antioxidant activity, and after being treated with safer natural materials, they are environmentally friendly compared to other materials. Its chemical composition was evaluated by the following required tests (FTIR, HNMR).

keywords: Acryle amide, β-lactam, poly vinyl alcohol, Schiff base.

1. Introduction

β-lactams are a well-known class of chemicals of great organic importance. Being an exciting catalyst, they also function as flexible organic chemical compounds. Indeed, due to its accessibility through multiple technologies and its inherent reactivity due to ring compaction, the β-lactam ring is the most sought-after substrate in the natural-synthetic chemists' armamentarium. Many reagent, heat, and light companies sell ring-forming and ring-creating merchandise [1]. Azole compounds are a family of substances that have a solid organic impact, and they are heterocyclic compounds containing nitrogen atoms [2], several nonantibiotics [4].

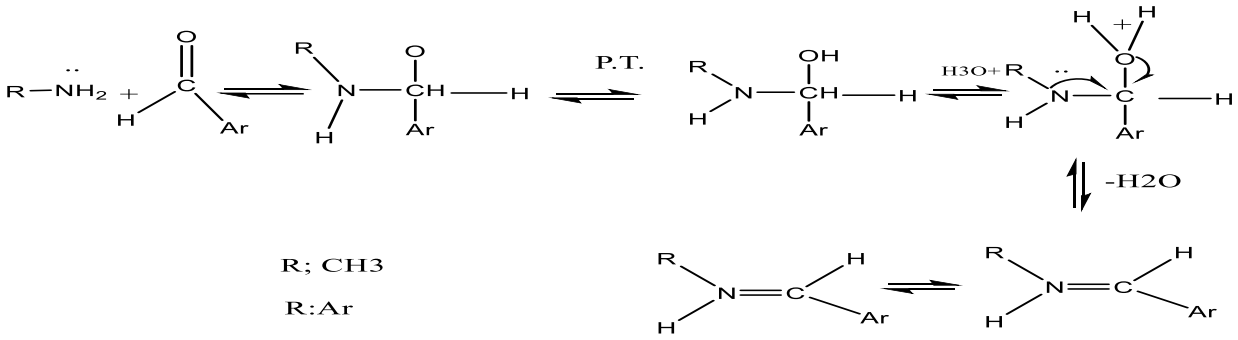
β Lactam, a type of Molecule, has influenced the advancement of chemical transformation tools [3]. The β-lactam-the-azetidinone ring technique is also employed in the creation of Tetrazoles are derivatives of oxazepines, which are a heterogeneous ring of (O and N) atoms to which an oxygen atom has been inserted. While the atom of nitrogen can be found at positions Tetrazoles are derivatives of oxazepines, which are a heterogeneous ring of (O and N) atoms to which an oxygen atom has been inserted. While the atom of nitrogen can be found at positions -2, -3, or -4 [5]. β-lactam is a heterocyclic amide ring composed of one nitrogen atom and three carbon atoms [6]. The synthetic route for azomethine compounds comprises the condensation of ammonia, first amines, and amino acids with carbonyl compounds using azeotropic distillation while simultaneously removing water [7]. The azomethine structural feature is recognized in these substances [8,9]. Schiff bases and their metal complexes played an essential role in our understanding of the coordination chemistry of transition metallic ions. Schiff bases and their structural counterparts, asligating compounds with acyclic and cyclicine C=N linkages, are essential in coordination chemistry [10,11].

2. Materials and Methods

All chemicals and solvents were obtained from the BPC-Analysis Center. FT-IR (Fourier Transform Infrared Spectrophotometer) measurements were made using a KBr disk on a SHIMADZU FT-IR-8300 spectrophotometer. The experiments were carried out at room temperature, and the FT-IR spectra were acquired in the 400–4000 cm^{-1} range to estimate the functional group of chemical compounds. The HNMR studies were performed at the Iran, University of Tehran.

2.1 Synthesizing Schiff (1-5)[6, 9,12,13]

About (0.5 g, 0.01 mol) of hydrazine hydrate with different aliphatic and aromatic aldehydes (formaldehyde, acetaldehyde, propionaldehyde, pnitrobenzalde, benzaldehyde) (0.3 g, 0.01 mol), (0.4 g,0.0 mol), (0.58 g,0.01 mol), (1.5 g.0.01 mol), (1.3.0.01 mol) respectively in 25 mL absolute ethanol and then added few drops of glacial AcOH and reflexed at 0°C stirring for (6-8) hours This mix has been filtered, allowed to cool at the room temperature.

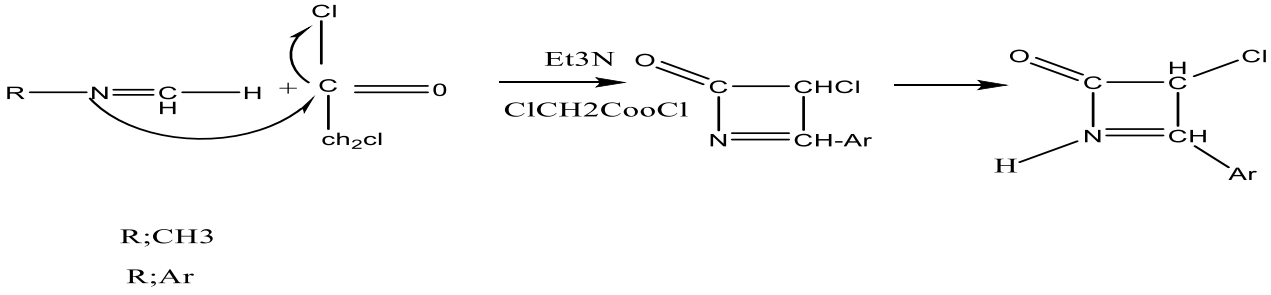


Scheme 1. Synthesis mechanism of Schiff base with glacial acetic acida sacatalys (N'(benzylidene)hydrazide.

2.2 Synthesis of β-lactam from Schiff base and aldehyed compounds (6-10)[10,11,13,14]

About (0.1 g,0.01 mol), (0.4 g,0.01 mol), (0.45 g, 0.01 mol), (1.4 g,0.01 mol), (1g, 0.01 mol) Schiff's base of (methylenehydrazine, ethylidenehydrazine, propylidenehydrazine, 4-nitrobenzylidene hydrazine, benzylidenehydrazine) respectively in 20 mL dioxane when applied to mixture a few drops of Et3N, then (0.5 mL) of chloroacetyl chloride was of add dropwise. The mixture was mixed well at -0°C, stirring for (6-8) hours; after that, the reaction mixture was kept at room temperature for two days, after which it was poured into crushed ice. Experimental 41

water. This product was filtered, followed by washing with water, and purified from methanol (1:1).



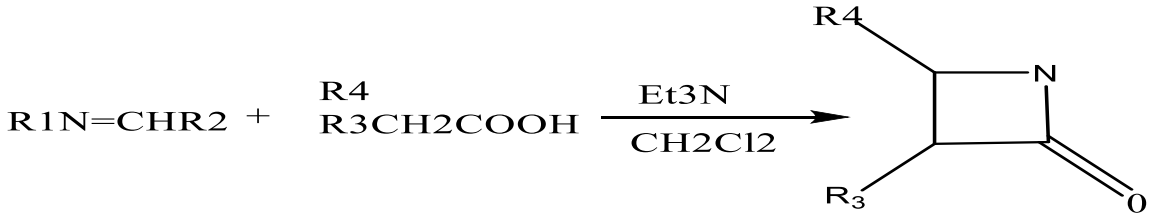
R;CH3

R;Ar

Scheme 2. Mechanism synthesis of β-lactam (1-amino-4-phenylazetidin-2-one).

2.3 Synthesis of B-lactam from Schiff baseand carboxlic acid compound (10-15) [12,13,15,16]

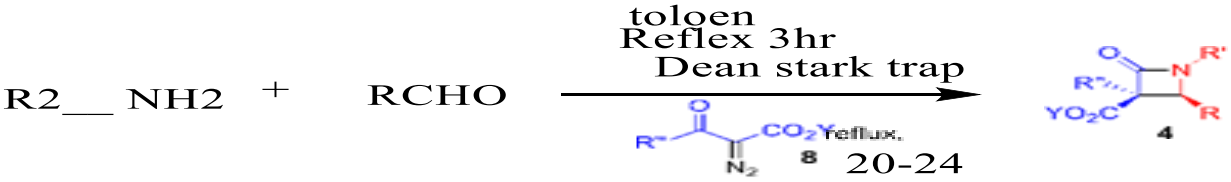
About (0.4 g, 0.01 mol) of Schiff bases (ethylidenehydrazine) and (0.46 g.0.01 mol), (0.6 g, 0.01 mol), (0.8 g, 0.01 mol), (1.4 g, 0.01 mol), (2.6 g, 0.01 mol) respectively of (formic acid, acetic acid, butyric acid, octanoic acid, palmitic- Experimental 42 acid) derivatives were prepared, then 10 mL of DMF was added to (0.22 g, 1.2 mol) of TCT, cyanuric chloride-2,4,6-trichloro-1,3,5-triazine, and The resulting. The suspension had been agitated for 5 minutes at room T. Along with the Dry Et_3N, the required EtOH (1.2 mol) was added to the (TCT, DMF) solution (0.6 mL, 0.4 mol). Overnight, the reaction mixture was agitated at r.T. Before being dried over (Na_2SO_4) and filtered; the solution was washed with sat. 4 mL of $NaHCO_3$ and 4 mL marinade. The raw material was synthesized. After the solvent evaporated at low pressure. β-lactams were purified by recrystallization from EtOAc and by brief-column chromatography.



Scheme 3. Mechanism synthesis of β-lactam (1-methyl-4-propylazetidin-2-one).

2.4 Synthesis of β-lactam fromamin and aldehyed compounds (16-18) [13,14-19]

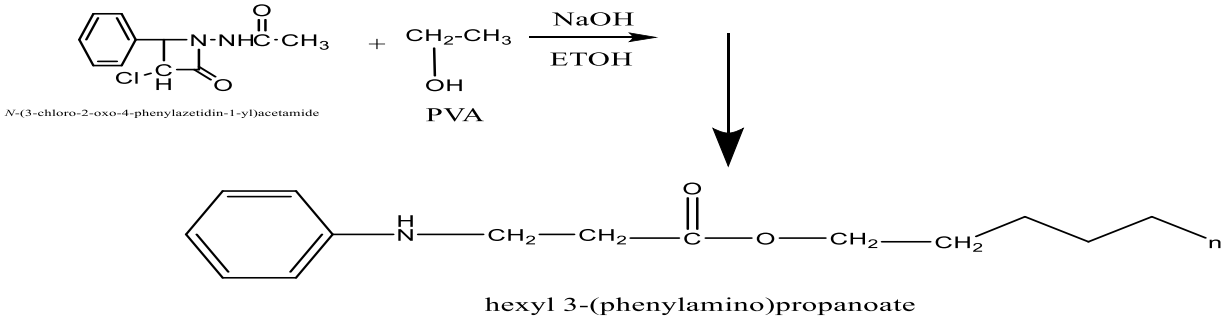
Preparation of (0.5 g, 0.01 mol) in hydrazinehydrate with different aliphatic and aromatic aldehydes (propionaldehyde, 3- methylbutanal, phenylacetaldehyde (0.3 g, 0.01 mol), and (0.4 g, 0.01 mol, 0.58 g) respectively in round-bottom flask, was toluene is dissolved in 10 mL and azeotropic water removal refluxed. Half of the solvent was distilled off after 1 hour, and acyl - diazoacetate (0.8 g, 0.1 mmol, 1.2 g) was included. After that, the mixture was refluxed overnight. Meanwhile, the reaction progress was observed (TLC). When the compound was no longer traceable (diazo), the solvent was evaporated in vacuo, and the remaining aggregate column chromatography on silica gel with a linear gradient was used to purify (0-25%) of (hexane in acetone overall. The amount of eluent required to produce natural compounds was 450 mL.



Scheme 4. Mechanism synthesis of β-lactam (1-aminoazetidin-2-one).

2.5 Synthesis of hexyl 3-phenylamino propanoate [15-20,23-25]

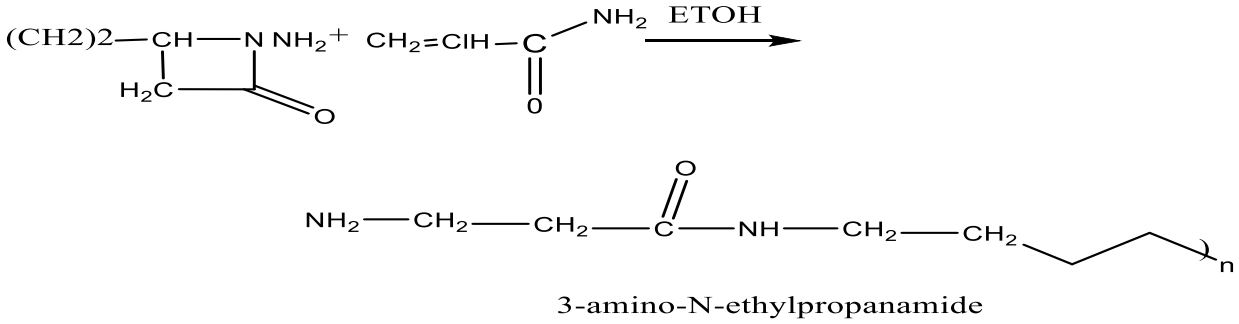
About (1 mol, 0.5 g), (1 mol, 0.6 g), (1 mol, 0.75 g), respectively of lactam about 1 g of polyvinyl alcohol, both dissolved in (EtOH, NaOH), have been refluxed for six hours at 70 °C, the crystalline substance became filtered cease detergent the result to (10 mL) diethyl welkin to oust unpolished last impurities, an apparent white precipitate turned into obtained. This was honored by filtering and drying.



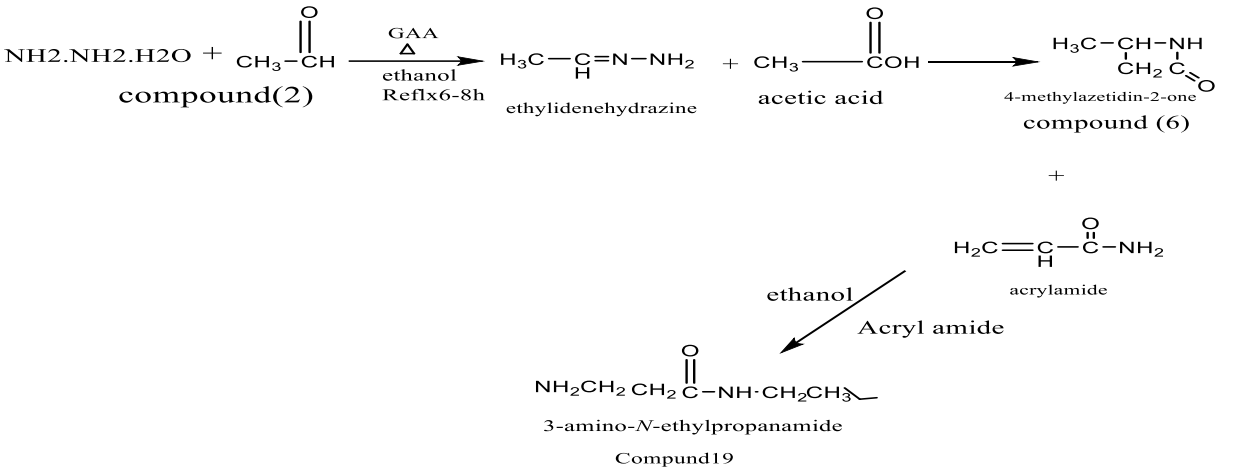
Scheme 5. Mechanism synthesis of poly hexyl 3-phenylaminopropanoate.

2.6 Synthesis of 3-amino-N-ethylpropanamide [25,26,28-31].

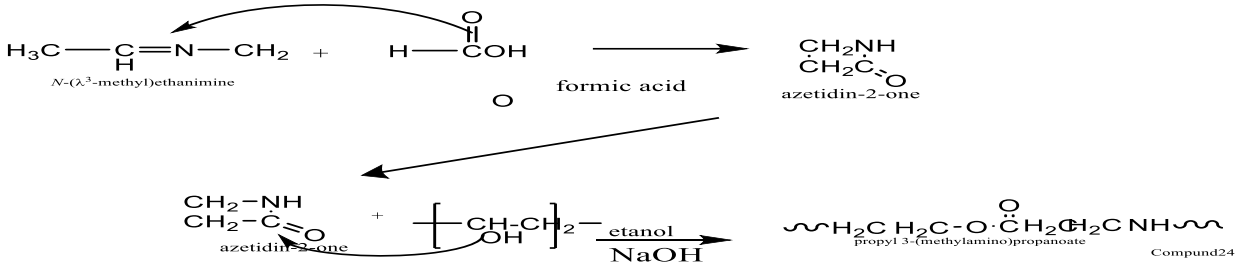
About (0.01 mol, 0.5 g) of lactam mixed with one gram of acryl amide, both dissolved in EtOH, had been refluxed for 6 hours at 70 °C. After washing the product with (10 mL) diethyl ether to remove any last impurities, an apparent white precipitate was received. This turned out to be accompanied by the filtering and drying method.



Scheme 6. Mechanism synthesis of poly 3-amino-N-ethylpropanamide.

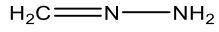
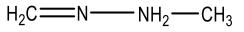
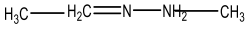
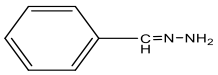
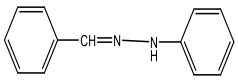
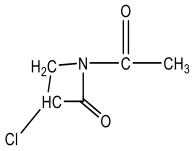
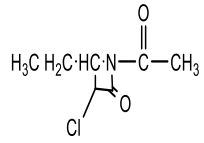
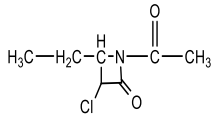
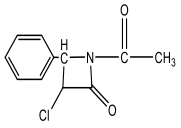
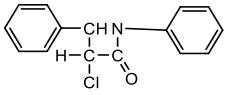
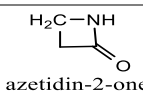
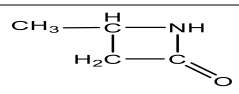


Scheme 7. Synthesis poly amid of lactam of hydrazine with aldehydes formed (Schiff base and carboxylic acidand acrylamide).



Scheme 8. Synthesis of Schiff base and formic acid to form a lactam and its conjugation with PVA.

Table 1. Synthesized chemicals' physicochemical characteristics and FT-IR spectral data cm^{-1} (1-18).

physicochemical characteristics					Major FT-IR absorption cm^{-1}					
No. of comp.	**Compound composition**	**m.p. °C**	**Color**	**Yield%**	**(N-H)**	**(C-H) Arom.**	**C-H Aliph**	**C=0**	**C=N**	**Other bands**
1	 methylenehydrazine	90	Grae	90	3414	…	2974-2850	-	1624	
2	 N'-ethylidenehydrazide	80	White	82	3240	…	2978	-	1627	
3	 N'-propylidenehydrazide	95	Dark brown	74	3136	…	2978	-	1627	
4	 N'(benzylidene)hydrazid	75	Yellow	97	3236	3047	2943-2858	-	1620	
5	 1-benzylidene-2-phenylhydrazine	73	Light green	76	3385	3059	2900-2885	-	1642	
6	 1-acetyl-3-chloroazetidin-2-one	77	Grae white	66	3410	…	2924-2850	1678	-	υ(C-Cl) (756)
7	 1-acetyl-3-chloro-4-ethylazetidin-2-one	60	Light Brown	67	3194	-	2924-2850	1674	-	(C-Cl) 752
8	 1-acetyl-3-chloro-4-ethylazetidin-2-one	55 - 57	Brown	71	3460	-	2931-2873	1670	-	υ(C-Cl) 752
9	 1-acetyl-3-chloro-4-phenylazetidin-2-one	120	Light yellwo	80	3741	3194	2939	1678	-	(C-Cl) 748
10	 3-chloro-1,4-diphenylazetidin-2-one	130	Yellow gare	78	3400	3059-3024	2885	1624	-	(C-Cl) 759
11	 azetidin-2-one	70	White	59	3387	-	2954.94-2827.64	1670	-	(C-N) 1346
12	 4-methylazetidin-2-one	88	White	80	3228.83	-	2954-2846	1670	-	(C-N) 1346

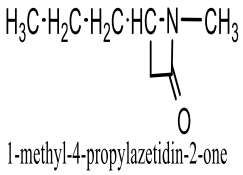
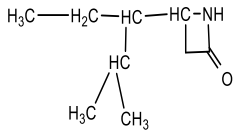
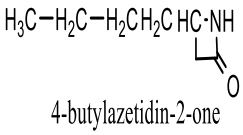
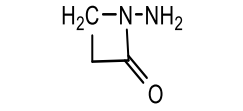
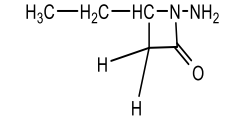
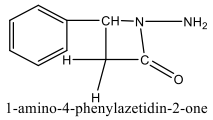
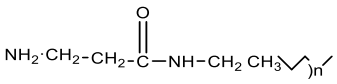
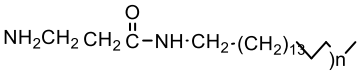
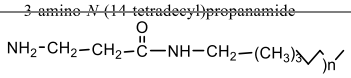
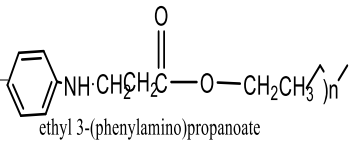
13	 1-methyl-4-propylazetidin-2-one	0ily	Dark brawn	76	3379.29	-	2954.54-2850	1658	-	(C-N) 1388
14	 4-(2-methylpentan-3-yl)azetidin-2-one	Stick	White	70	3328	-	2924-2854	1712.79	-	(C-N) 1350
15	 4-butylazetidin-2-one	93	White	90	3221.12	-	2920-2846	1674	-	(C-N) 1346
16	 1-aminoazetidin-2-one	Oily	White	66	3398		2970- 2877	1678	-	(C-N) 1350
17	 1-amino-4-ethylazetidin-2-one	Oily	Brawn	60	3332.99	-	2978	1593	-	(C-N) 1350
18	 1-amino-4-phenylazetidin-2-one	Stick	Yellow	80	3323	3051	2947	1666	-	(C-N) 1303 (C=C) 1620

Table 2. The physicochemical characteristics, and FT-IR cm-1 spectrum data of produced chemicals.

	The physicochemical characteristics,				**Major, FT-IR absorption cm^{-1}**				
No. of comp	Compound composition	Softing	Color	Yield	(N-H)	(C-H) Arom.	(C-H) Aliph	C=0	(C-N)
Acry amid **APLS61**	 3-amino-*N*-ethylpropanamide	97-105	peach	69	3425	-	2947..23-2885	1681	1311
APLS102	 3-amino-*N*-(14-tetradecyl)propanamide	180-189	Light whit	72	3425	-	2954.95-2843.07	1678	1300
APLS113	 3-amino-*N*-ethylpropanamide--ethane (1/1)	110-115	Pig ping	77	3485	-	2927.94-2854.65	1693	1303
Vniyl alcohol **PLS44**	 ethyl 3-(phenylamino)propanoate	156-150	Light brown	79	3429	3051	2947.23-2850.79	1739	1303

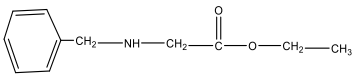
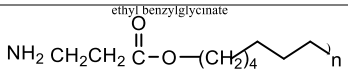
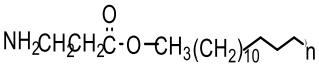
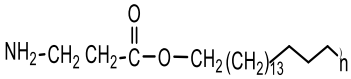
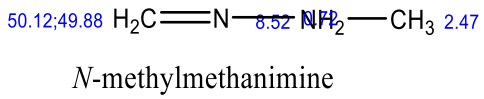
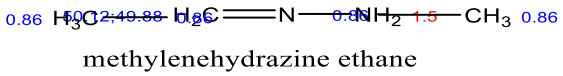
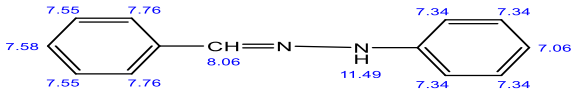
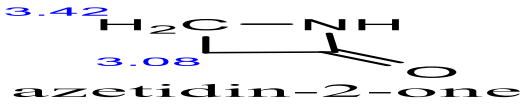
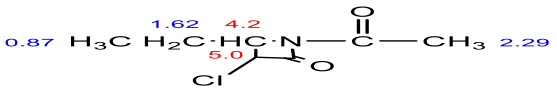
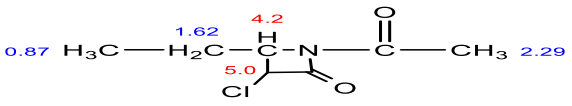
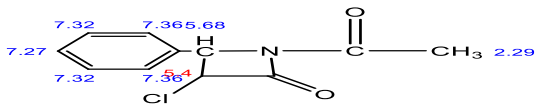
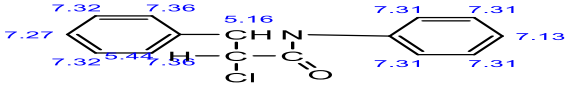
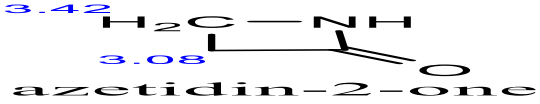
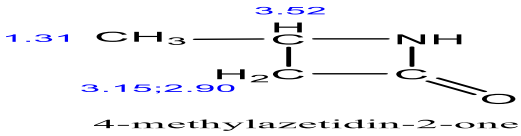
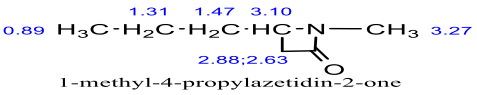
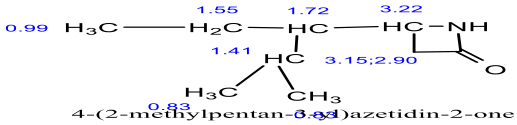
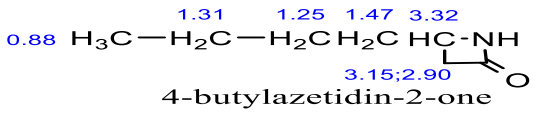
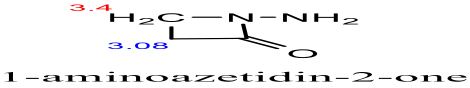
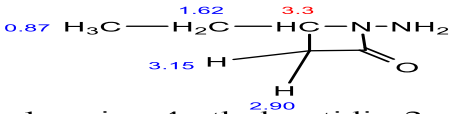
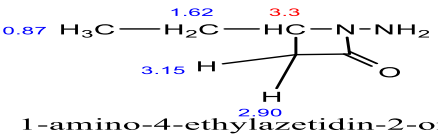
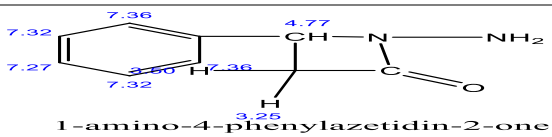
PLS55		165-159	Light yelow	77	3417	3059	2950-2885.51	1732	1311
PLS66	ethyl benzylglycinate  poly methyl 3-aminopropanoate	180-188	Light grean	69	3456	-	2954-2831	1712	1346
PLS77	 poly methyl 3-aminopropanoatedecan	170-177	white	80	3456	-	2958.80-2846.93	1681	1346
PLS108	 poly-tetradecyl 3-aminopropanoate	188-190	Light white	77	3417	-	2954.95-2846..93	1681	1350

Table 3. The ^{1}H-NMR spectra (ppm) data for several substances.

Comp. No.	Compound composition	^{1}H-NMR (δ-H) data in ppm
S1	 methylenehydrazine	DMSO 300 MHz): NH 1.55 amine
S2	 *N*-methylmethanimine	Solvent= DMSO 300 MHz: NH_2 8.52 1.50 amine,CH_3 2.47 0.86 methyl, H-C-H 1.61 1 alpha -
S3	 methylenehydrazine ethane	0.8-2.5 (d,2H,C<u>H</u>$_3$2.6DMSO (S3.38H,O=C-C<u>H</u>$_3$);8.401H, CH_2N=NH)
S4	 benzylidenehydrazine	2.50DMSO ,CH3-C=O,H_3)2.7 (S,1H,H-C=N-N-<u>H</u>),7.38-8.74(H,arom (m,) 8.73 (S,H,HN=C-H)
S5	 1-benzylidene-2-phenylhydrazine	Solvent=DMSO 300 MHz):NH 11.49, 1.50 sec amine,fromamineCH) 7.34 - 7.26 , 1-benzene, CH =7.76 - 7.62 benzylidenimin,1 -N-N=C 0.30 , benzylidenimin 7.5 - 7.29
LS6	 azetidin-2-one	Solvent= DMSO 300 MHz: NH 7.1 (propiolactam) CH_2 (3.08), β-lactam -N-C=O 0.46
LS7	 1-acetyl-3-chloro-4-ethylazetidin-2-one	Solvent-DMSO 300 MHz: (CH) 5.0, 3.08 propiolactam, 1.98 1 α-Cl from , methane CH 4.2, CH_3 3.42 ,CH_2 1.62 ,methylene, N(C=O) C=O 0.22 1 β-
LS8	 1-acetyl-3-chloro-4-ethylazetidin-2-one	Solvent= DMSO 300 MHz: CH 5.0, 3.08 propiolactam,alpha -Cl from methane 1.98 Propiolactam 3.42 ,C(=O)R from N-CH 1, β-Lactam -N-C=O 0.35
LS9	 1-acetyl-3-chloro-4-phenylazetidin-2-one	1.9 (s, 1H, C<u>H</u>);3.5(S, N-H,1H); 3.2 (S, 3H, C<u>H</u>$_3$); 4.2(CH-Cl)7.5-8.5. (m, 4H, Ar-H),8.75(d,1H,NH-NH-C=O,β-Lactam -N-C=O 0.41
LS10	 3-chloro-1,4-diphenylazetidin-2-one	1.2(s, 3H,C<u>H</u>$_3$); 3. (S, 1H,CH2=); 6.51 (S, 6H, N-(C<u>H</u>$_3$)$_2$; 6.92-7.99 m, (7H, (Ar-H)) and 8.75(,NH, H,) 5.6 (CH-Cl),β-Lactam -N-C=O 0.32
LS11	 azetidin-2-one	Solvent=DMSO 300 MHz): NH 7.1 propiolactamCH2 3.42 , β-Lactam -N-C=O 0.37

LS12	 4-methylazetidin-2-one	Solvent=DMSO 300 MHz): NH =7.1,CH 3.52 , propiolactam , 3.42, CH2 3.15,CH3 1.31, 0.86 methyl 0.34 β-Lactam -N-C(=O)C 022
LS13	 1-methyl-4-propylazetidin-2-one	Solvent=DMSO 300 MHz):,CH 3.10 propiolactam CH2 2.88;2.635 3.08 propiolactamCH3 3.27 alpha(-N(C)-C=O) 0.34
LS14	 4-(2-methylpentan-3-yl)azetidin-2-one	Solvent=DMSO 300 MHz): NH 7.0 ,CH 3.22,propiolactam CH2 3.15;2.895 3.08 propiolact 1 β-C from -0.06 methylene CH 1.72 1.50 methine (0.62 , β-Lactam -N-C=
LS15	 4-butylazetidin-2-one	Solvent=DMSO 300 MHz):,NH 7.2 CH 3.3 propiolactamCH2 3.15;2.895 3.08 propiolactammethylene CH2 1.47 , 1.37 (CH=) methyle, β-Lactam -NC(=O)-C 0.38
LS16	 1-aminoazetidin-2-one	Solvent= DMSO 300 MHz: NH2 7.1CH2 3.4 3.42 propiolactam
LS17	 1-amino-4-ethylazetidin-2-one	Solvent=DMSO 300 MHz): NH2 =7.0 (CH) 3.3, 3.42 propiolactam (CH2) 1.62 1.37 methylene , β-Lactam -NC(=O)-C 0.24
LS18	 1-amino-4-ethylazetidin-2-one	Solvent=DMSO 300 MHz): NH2 7.0 ,CH 3.3, 3.42 propiolactam CH2 1.62 ,β-Lactam -NC(=O)-C 0.22 methyl β-Lactam -N-C=O 0.4
LS19	 1-amino-4-phenylazetidin-2-one	Solvent= DMSO 300 MHz: NH2 7.0 ,,CH 4.77, 3.42 propiolacta CH 7.36 , 7.26 1-benzene1 CH 7.32 , 7.26 1-benzene2, β-Lactam

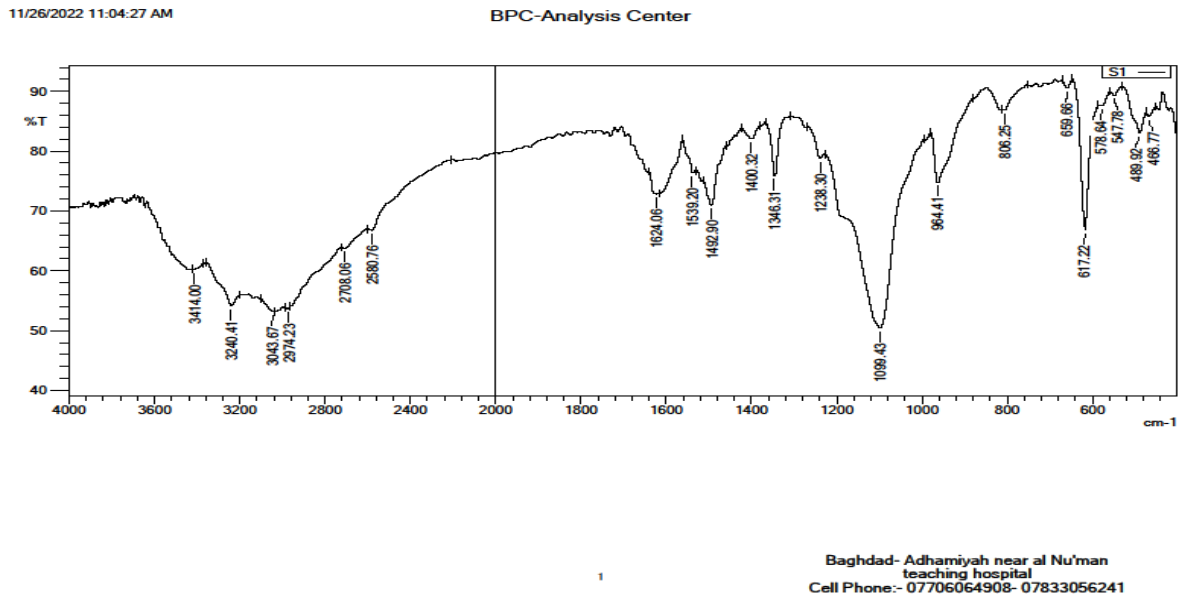


Figure 1. The FT-IR data Schiff base for compound 1.

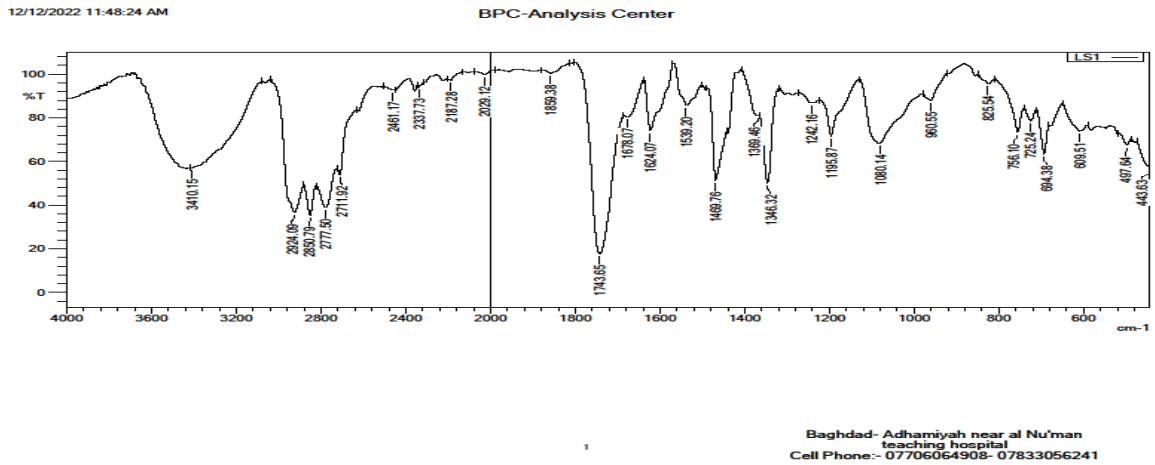


Figure 2. The FT-IR data lactam for compound 6.

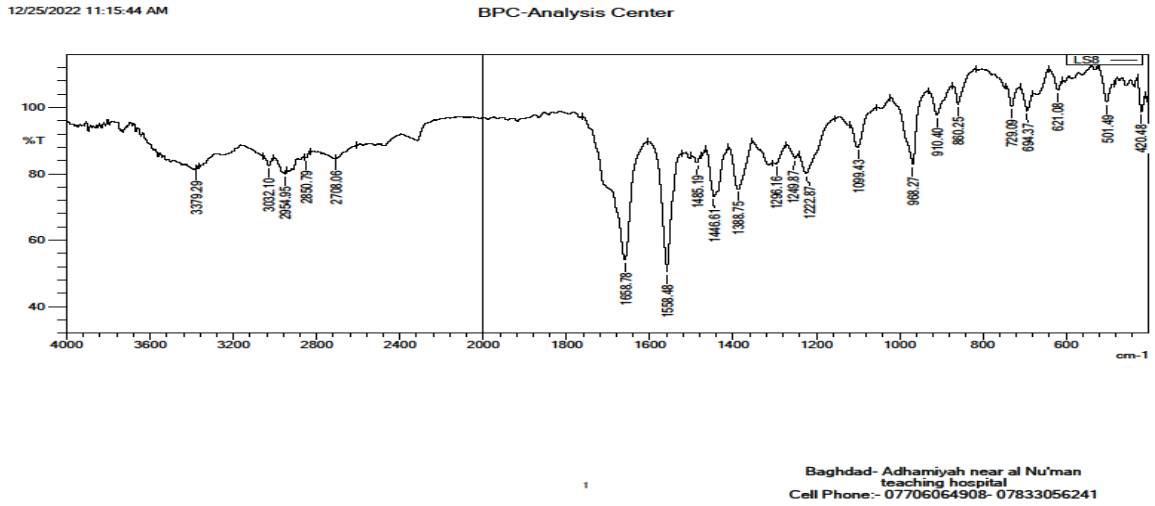


Figure 3. The FT-IR data lactam for compound 13.

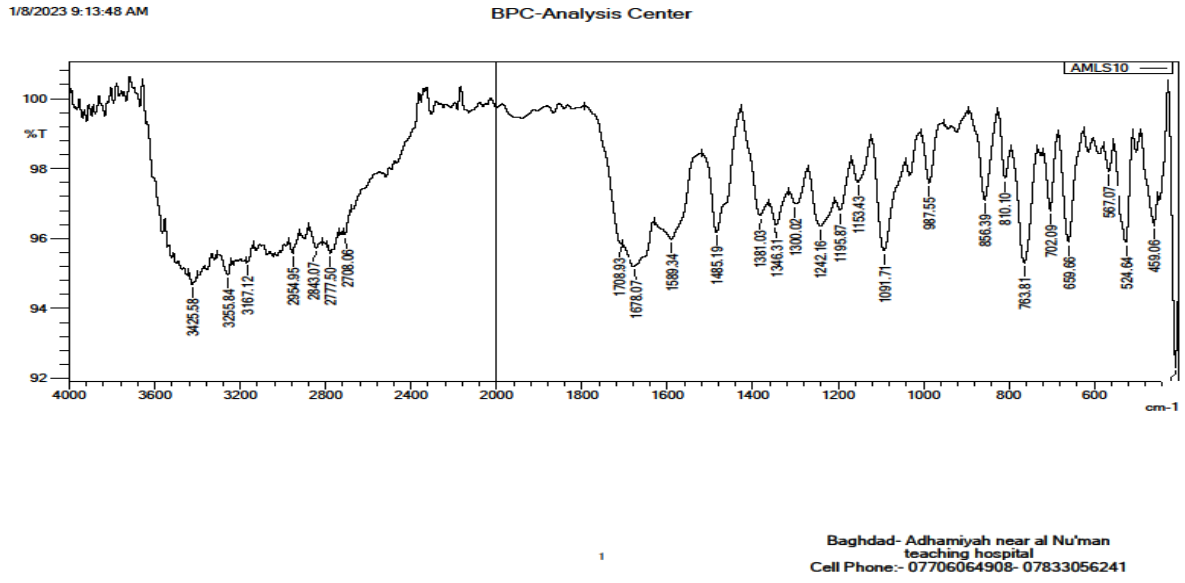


Figure 4. The FT-IR data for compound 27 (poly 3-amino-N-ethylpropanamide).

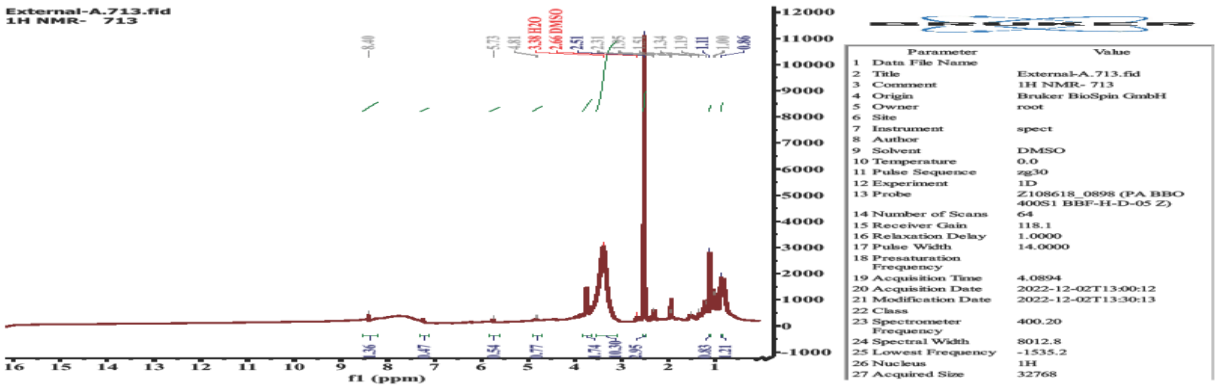


Figure 5. Compound 3 (H-NMR) spectrum.

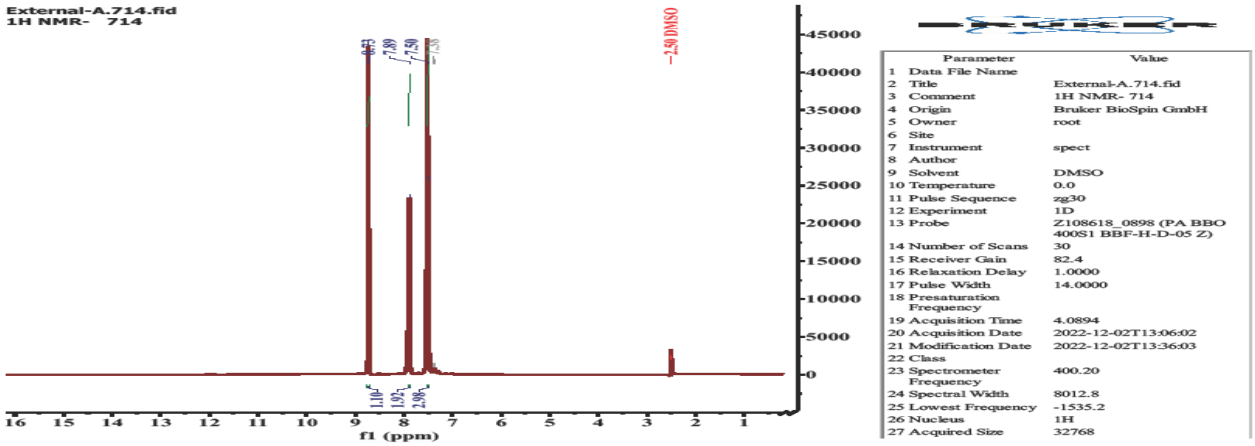


Figure 6. Compound 4 (H-NMR) spectrum.

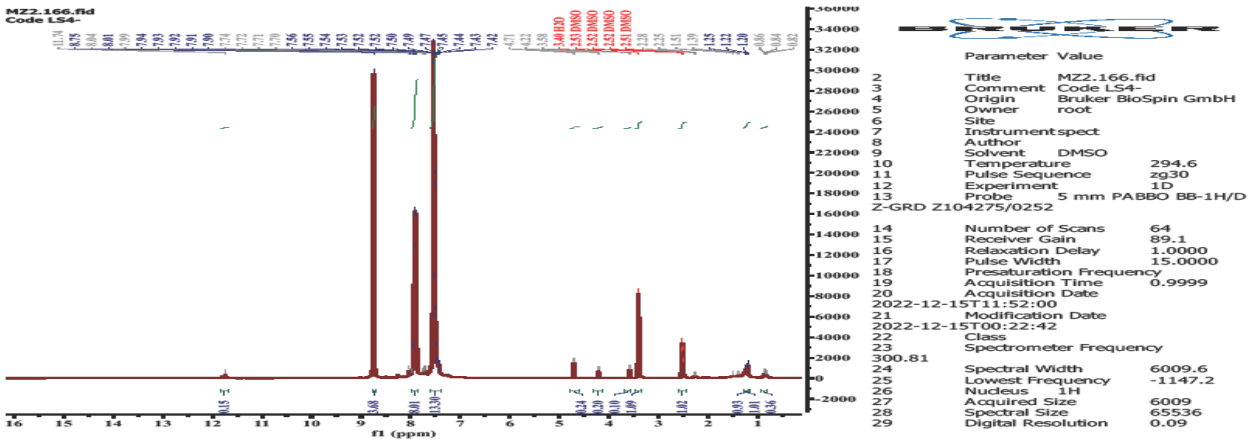


Figure 7. Compound 9 (H-NMR) spectrum.

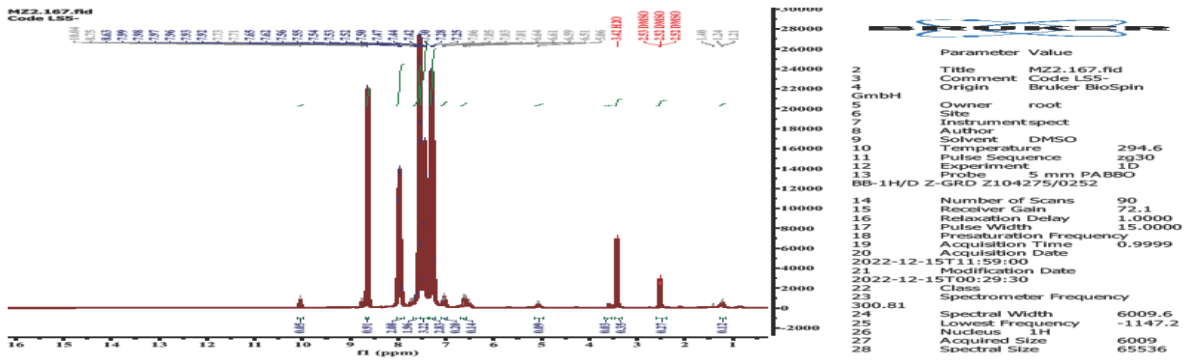


Figure 8. Compound 10 (H-NMR) spectrum.

3. Results

Infrared radiation absorption in chemical bonds is the basis spectroscopy. The bond is connected, to changes in the constant,dipole moment (such as stretching and bending). The FTIR is frequently used in product identification to determine certain functional groups or chemical compound bonds.

4. Discussion

The characteristic peaks in the FTIR spectra of all produced derivatives are presented below. **Table 1** and **Figures 1-4**. The structural equation, yield, percentage, melting point, and color were all displayed. This chemical has the highest yield. Compounds (1–5) melting point was 73–90 °C. The melting point was compounds (6–18). 60–90 °C Som stik The components (1–5) were created for reacting (hydrazine and anilen) with various chemicals (aliphatic and aromatic). In the presence of a solvent (ethanol), aldehydes (acetyldehyde, formaldehyde, propionaldehyde, and benzaldehyde) were produced. The produced chemicals (1–5) were identified using the FTIR spectrum shown in **Table 1.** These are the spectra. Showed absorption, (NH), respectively at (3240.41, 3240.41) cm^{-1}, ν(C=O) respectively at (1624.06, 1627.92) cm^{-1}. **Table 1** contains other absorption chemicals. By reacting Schiff bases (1–5), Et3N, and chloroacetyl chloride, the compound (6–10) was created. These spectra revealed (NH) at bsorption (3410.15, 3194.12) cm^{1}.ν (C=O) at (1678.07,1624.06) cm^{-1}, ν(C-H) aliphatic at (2954-2885.64) cm^{-1}, (CH aromatic) at (3091) cm^{-1}, υ(C=N) at (1597.06),. Other absorptions and compounds are found in **Table** 1. Compounds 11–15 were made by reacting Schiff base with acetic acid in In the case of DMF, Et3N as a solvent, and CH_2Cl_2, ring of absorption (3387.00, 3390.85) cm^{-1} belong to υ (NH) and show (C=O) at (1670.35,1670.35) cm^{-1} also υ and other, responding compounds or (16-18) are found in **Table** 1.

The compounds were created by combining hydrazine with aldehyde in existence as a solvent and showed responding υ(NH) at (3441.01, 3332.99, and 332.32) cm^{-1}, the (CH aliphatic) in (2920–2854) cm^{-1} activation of the C=O group[13] . υ (C=o) at (1678.07,1593.20, and 1620.21) cm^{-1} and other responding compounds are found in **Table 2**. Because its backbone has numerous primary amido corporations. Polymer PAA provides support with respect to one-of-a-kind second-choice chattels organizations, including COOH, NH_2, and -C=O. Poly (acrylamide) is a hydrophilic, high-molecular-weight fabricated polymer with NH_2 businesses on its up-chain drift, similar to chitosan[15]. Softening point (110–190) of the compounds in **Table 2** (1-3) lactam and acrylamide, both dissolved in EtOH. These spectra revealed absorption. υ (NH)at (3425.58,3425,and 3483.44) cm^{-1}.ν(C=O) at (1681.93,1678.07,and 1693.50) cm^{-1}, ν(C-H) aliphatic at (2947.23-2885, 2954.95-2843.07, 2927, and 94-2854.65) cm^{-1}, υ(C-N) at (1311.59,1300.02, and 1303.88) cm^{-1}. The compounds in **Tables 2.** (4–8) were prepared by reacting lactam with polyvinyl alcohol and EtOH NaOH in ethanol's existence as a solvent.These spectra showed responding υ (NH) at These spectra showed a responding υ (NH) at (3429.43, 3417.86, 3456.44, 3456.44, and 3417.86) cm^{-1}, ν(C=O) at (1739, 1732, 1712.79, 1681.93, and 1681.93) cm^{-1}, ν(C-H) aliphatic at (2947.23-2850.79, 2950-2885.51, 2954-2831, and 2958.80-2846.93) cm^{-1}, υ(C-N) at (1303, 1311.59, 1346, 1346.31, and 1350) cm^{-1}. For compound (4,5) (CH aromatic) at (3051.39, 3059.10-3028.24) cm^{-1}. The H-NMR chemical spectra of compounds in solvent ethanol is illustrated in **Table 3** and **Figures 5-8**.

5. Conclusion

Heterocyclic compounds are molecules with organic activity. Beta-lactam is a type of molecule discovered in chemical improvements and its effectiveness with many compounds to prepare new polymers of lactam prepared in different ways linked to heterocyclic rings. It can be used in various industries, including industrial and pharmaceutical, after preparing from several materials and forming it with lactam. They are manufactured materials that are safer and more environmentally friendly compared to other various materials. Different lactams have been prepared and polymerized for subsequent cross-linking to different synthetic polymers. In this research, light was shed on the preparation of lactams in various ways and their polymerization in two ways: the first with vinyl chloride alcohol and the base, and the second with acrylamide, where only alcohol was used.

Acknowledgment

The authors would like to thank everyone who contributed to the success of this review article. Department of Chemistry, College of Science for Women, Baghdad University, Prof. Dr. Sanaa Abdul Sahib Ministry of Higher Education & Scientific Research and Ministry of Science.

Conflict of Interest

None

Funding

There is no financial support.

Ethical Clearance

This work has been approved by the Scientific Committee at the University of Baghdad/ College of Science for Women.

References

1. Ombito, J.O.; Singh, G.S. Recent Progress in Chemistry of β-lactams. *Mini Reviews in Organic Chemistry*. **2019**, *16*(*6*), 544-567. http://dx.doi.org/10.2174/1570193X15666180914165303..
2. Qiu, M.; Fu, X.; Fu, P. Huang , J. Construction Of Aziridine, Azetidine, Indole and Quinoline-Like Heterocycles: Via Pd-Mediated C-H Activation/Annulation Strategies. *Organic and Biomolecular Chemistry*. **2022**, *20*(*7*), 1339–1359. .https://doi.org/10.1039/d1ob02146j.
3. Khan, S.A.; Zain, Z.M.; Mansoor, M.; Mahfuz, M.M.H.; Rahman, A.; Rashid, M.A.N.; Rais, M.S. Performance Investigation of Zno/PVA Nanocomposite Film for Organic Solar Cell. *Materials Today: Proceedings*. **2021**, *47(11)*, 2615-2621. https://doi.org/10.1016/j.matpr.2021.05.197.
4. Linder, M.R.; Podlech, J. Synthesis Of B-Lactams From Diazoketones And Imines:The Useofmicrowaveirradiation. *OrganicLetters*. **2001**, *12*, 18491851. https://doi.org/10.1021/ol015891.
5. Riemer, N.; Riemer, M.; Krüger, M.; Clarkson, G.; Shipman, M.; Schmidt, B. Synthesis of Arylidene-β-Lactams Via Exo-Selective Matsuda-Heck Arylation of Methylene-B-Lactams. *Journal of Organic Chemistry*. **2021**, *86*(*13*), 8786–8796. https://doi.org/10.1021/acs.joc.1c00638.
6. Shweish, B.K.; Narran, S.F. Preparation, Characterazation, Study Biological Activities with Some Newchalcone Derivatives. *NVEO-NATURAL VOLATILES & ESSENTIAL OILS Journal| NVEO*. **2021**, *8*(*4*), 3765-3782. https://doi.org/index.php/journal/article/view/970

7. Muslim, R.F.; Tawfeeq, H.M.M.O. ACTA Pharmaceutica Synthesis, Characterization and Evaluation of Antifungal Activity of Seven-Membered Heterocycles. *Journal of Saudi Chemical Society*. **2018**, *15*(10.23893), 1307–2080. https://doi.org/10.23893/1307-2080.aps.05610.
8. Al-Mashhadan, H.A.A.; Al-Dahhan, M.W.; Hashim, H.; Yousif, E. Synthesized and Designed New Modified Poly (vinylchloride) Structures to Enhance their Photo Resistance Characteristics. *Chemistry*. **2022**, *4(4)*, 1101-1122. https://doi.org/10.3390/chemistry4040075.
9. Henary, M.; Kada, C.; Rotolo, L.; Savino, B.; Owens, A.; Cravotto, G. Benefits and Applications of Microwave-Assisted Synthesis of Nitrogen Containing Heterocycles in Medicinal Chemistry. RSC Advances. **2020**, *10(24)*, 14170–14197. https://doi.org/10.1039/d0ra01378a.
10. Radhiyah, K.; Ezet, H. Synthesis and Characterization of Some New β-Lactam Derivatives from Azosulphadiazine and their Biological Evaluation as Anticancer. *Orient J Chem.* **2018**, *34(1)*, 371–380. https://doi.org/10.13005/ojc/340140.
11. Cebeci, Y.U.; Bayrak, H.; Şirin, Y. Synthesis Of Novel Schiff Bases and Azol-B-Lactam Derivatives Starting from Morpholine and Thiomorpholine and Investigation of their Antitubercular, Antiurease Activity, Acethylcolinesterase Inhibition Effect and Antioxidant Capacity. *Bioorganic Chemistry*. **2019**, *88*, 102928. https://doi.org/10.1016/j.bioorg.2019.102928.
12. Mezaal, W.N.N.; ALsahib, S.A. Synthesis Characterization of New Derivatives using Schiff's Bases for Alcoholic Extract of (Cordia Myxa) Medical Plant. *Eurasian Chemical Communications*. **2022**, *4(11)*, 1054–1061. https://doiorg/10.22034/ecc.2022.343900.1473.
13. Zarei, M.; Jarrahpour, A. A Mild Efficient Route to 2-Azetidinones Using The Cyanuric Chloride-DMF Complex. *Synlett.* **2011**, *22(17)*, 2572–2576. http://dx.doi.org/10.1055/s-0030-1289517.
14. Henary, M.; Kananda, C.; Rotolo, L.; Savino, B.; Owens, EA.; Cravotto, G. Benefits and Applications of Microwave-Assisted Synthesis of Nitrogen Containing Heterocycles in Medicinal Chemistry. *RSC Advances.* **2020**, *10(24)*, 14170-14197. https://doi.org/10.1039/d0ra01378a.
15. Synofzik, J. α-Acyl-α-diazoacetates in Transition-Metal-Free β-Lactam Synthesis. *Journal of Organic Chemistry.* **2019**, *84(18)*, 12101–12110. https://doi.org/10.1021/acs.joc.9b02030.
16. Verdino, A. Synthesis and Biological Evaluation of the Progenitor of a New Class of Cephalosporin Analogues, with a Particular Focus on Structure-Based Computational Analysis. *PLOS ONE.* **2017**, *12(7)*, e0181563. https://doi.org/10.1371/journal.pone.0181563.
17. Thejeel, K.A .; Ascar, I.; Hussein, M. Synthesis of New Polymers Linked to Heterocyclic using Zinc Oxide with Nanostructures Extracted from Natural Sources. *Egyptian Journal of Chemistry*. **2022**, *65(4)*, 579–589. https://doi.org/10.21608/EJCHEM.2021.92971.4644.
18. Elamri, A., A.; Zdiri, K.; Harzallah, O. Chitosan: A Biopolymer for Textile Processes and Products. *Textile Research Journal.* **2023**, *93(56)*, 1456-1484. https://doi.org/10.1177/00405175221127315.
19. Kumar, A. Synthesis of Some New Schiff Bases of Pharmaceutical Interest. *Annals of Advances in Chemistry*. **2017**, *1(2)*, 053–056. https://doi.org/10.29328/journal.aac.1001006.
20. Azeez, H.N., Al-kadhimi, A.A.H.; Tapabashi, N.O. Synthesis, Characterization and Biological Evaluation of Some Azo and Azo-Schiff Compounds. *Kirkuk Journal of Scientific Researches.* **2019**, *14(1)*, 97–119. https://doi.org/10.32894/kujss.2019.14.1.8.

22. Grabrijan, K.; Stanislav, G. Synthesis of 3-Amino-4-substituted Monocyclic ß-Lactams Important Structural ORCID. Synthesis of 3-Amino-4-substituted Monocyclic ß-Lactams—Important Structural Motifs in Medicinal Chemistry. *International Journal of Molecular Sciences*. **2022**, *23(1)*, 360. https://doi.org/10.3390/ijms23010360.
23. Faltracco, M.; Sukowski, V.; van Druenen, M.; Hamlin, T.A.; Bickelhaupt, F.M.; Ruijter, E. Diastereoselective Synthesis of β-Lactams by Ligand-Controlled Stereodivergent Intramolecular Tsuji-Trost Allylation. *Journal of Organic Chemistry*. **2020**, *85(15)*, 9566–9584. https://doi.org/10.1021/acs.joc.0c00575.

24. Beatriz, A.; Mondino, M.G.; de Lima, D. P. Lactams, Azetidines, Penicillins, and Cephalosporins: An Overview on the Synthesis and Their Antibacterial Activity. *N-Heterocycles: Synthesis and Biological Evaluation.* **2022**, 97–142. http://dx.doi.org/10.1007/978-981-19-0832-3_3.
25. Blizzard, T.A.; Chen, H.; Kim, S.; Wu, J.; Bodner, R.; Gude, C. Imbriglio, J.; Young, K.; Park, Y-W.; Ogawa, A.; Raghoobar, S.; Hairston, N.; Painter, R.E.; Wisniewski, D.; Scapin, G.; Fitzgerald, P.; Sharma, N.; Lu, J.; Ha, Sh.; Hermes, J.; Hammond, M.L. Discovery of MK-7655, A β- Lactamase Inhibitor for Combination with Primaxin®. *Bioorganic & Medicinal Chemistry Letters.* **2014**, *24(3)*, 780–785. https://doi.org/10.1016/j.bmcl.2013.12.101.
26. Nagel, K.; Spange, S. Polyamide/Silica Hybrid Materials by Anionic Melt Polymerization of Lactam-Substituted Silane Monomers with E-Caprolactam. *European Polymer Journal*. **2019**, *113*, 385–394. https://doi.org/10.1016/j.eurpolymj.2019.01.072.
27. Cheibas, C.; Cordier, M.; Li, Y.; El Kaïm, L. A Ugi Straightforward Access to Bis-βlactam Derivatives. *European Journal of Organic Chemistry*. **2019**, 27, 4457–4463. https://doi.org/10.1002/ejoc.201900678.
28. Devalina S, A. K. Conducting Polymer-Based Ternary Composites for Super capacitor Applications. *Egyptian Journal of Chemistry*. **2019**, *10(2)*, 301–332. https://doi.org/10.1002/ejoc.201900678.
29. Faltracco, M.; Sukowski, V.; van Druenen, M.; Hamlin, T.A.; Bickelhaupt, F.M.; Ruijter, E. Diastereoselective Synthesis of β-Lactams by Ligand-Controlled Stereodivergent Intramolecular Tsuji-Trost Allylation. *Journal of Organic Chemistry*. **2020**, *85(15)*, 9566–9584. https://doi.org/10.1021/acs.joc.0c00575.
30. Gan, Y.; Ma, S.; Guo, X.; Chen, B.; Jassby, D. Photolysis Of Chloral Hydrate In Water With 254 Nm Ultraviolet: Kinetics, Influencing Factors, Mechanisms, and Products. *Chemosphere*. **2019**, *218(2)*, 104–109. https://doi.org/10.1016/j.chemosphere.2018.11.065.
31. Gaume, J.; Wong-Wah-Chung, P.; Rivaton, A.; Thérias, S.; Gardette, J-L. Photochemical Behavior Of PVA as an Oxygen-Barrier Polymer for Solar Cell Encapsulation. *RSC Advances.* **2011**, *1(8)*, 1471–1481. http://dx.doi.org/10.1039/C1RA00350J.
32. Hasan, N.A.; Baqer, Sh.R. Preparation, Characterization, Theoretical and Biological Study of new Complexes with mannich base , 2chloro –N-5-(Piperidin -1-ylmethylthio)-1, 3, 4- Thiadiazol-2-yl)acetamide. *Ibn AL-Haitham Journal For Pure and Applied Sciences.* 2023, *36(1)*, 260-271. https://jih.uobaghdad.edu.iq/index.php/j/article/view/2983.