Sys Rev Pharm 2021;12(2):323-335
A multifaceted review journal in the field of pharmacy

Synthesis, Characterization and Antioxidant Activity of Some New Schiff base Derived from Cytosine

Ali A. Mahmood[1], Farah. Kh. H. Al-Juboory[2*], Hala M. Garib Al–Zahwi[3]

[1]Presidency of the University of Kirkuk, Kirkuk, Iraq,
[2]College of Science, Department of Chemistry, University of Kirkuk, Kirkuk, Iraq,
[3]College of Science, Department of Chemistry, University of Kirkuk, Kirkuk, Iraq,
farah_aljibory2003@yahoo.com

Abstracts

Cytosine is used to synthesize several derivatives of Schiff base when reacted with some aldehydes which are refluxed by using ethanol as a solvent and non solvent with adomestic microwave (Compounds A_1 – A_4). These products of the Schiff base are treated first with chloroacetyl chloride to synthesize four-membered heterocycles (Compounds B_1 – B_4). After that, they treated with hydroxyl acetic acid to synthesize five-membered heterocyclic (Compounds C_1 – C_4). In the third step, the products are used to react with amaleic acid anhydride to produce seven-membered heterocyclic (Compound D_1 – D_4). The antioxidant activity of the compounds (A_1 – A_4) and two of the compounds (B_1, B_3), (C_1, C_3) and (D_1, D_3) in different concentrations of (100, 200, 300, 400 and 500 mg/ml) are tested with *1,2 – Di Phenyl – 2 – Picryl Hydrazyl* (DPPH) for scavenging a radical activity. Finally, these compounds are diagnosed by several technical devices such as IR, proton^{1}HN.M. R and^{13}C N.M.R. spectroscopy.

Keywords: Synthesis; Cytosine; Schiff Base; Antioxidant; % DPPH Radical Scavenging Activity.

1 INTRODUCTION

It is well known that the nucleic acids are built from nucleotides. Furthermore, nucleic acid consists of anitric base, sugar molecule and phosphate. The nitricbase includes two types of heterocyclic compound pyrimidines and purines. Additionally, Pyrimidine is similar to diazines six-membered heterocyclic compound which contains two atoms of nitrogen in position 1,3. Cytosine (4 – amino – 2 – oxopyrimidine) is a derivative of pyrimidine and one of the forth members of diazines which was discovered in 1894 by Kossel. Moreover, this compound was firstly synthesized in laboratories in the year (1903) [1].

Cytosine was prepared by Peter J. and Leonard Nicholl from treating *B*-ethoxyacrylo nitrile (prepared by reaction of isoxazole with diethyl sulfate in alkaline solution) with urea in a sodium alcoholate solution [2]. The alkylation of the free amino group in some pyrimidine derivatives (6–amino thiouracil) can be successfully synthesized in good yield when it is treated with one equivalent of RCH_2X in DMF. This test is performed by radiating it with microwave – assisted method under solvent-free condition.

Using the same starting material in the similar condition, as mentioned above, by using of (Na_2CO_3 and Bu_4NI) as catalysts, alkylation occurs on the nitrogen of the heterocyclic ring in excellent yield [3]. Another derivative of (6–amino–4–phenyl–2–thioxo–5 cyano–1,2,3,4-tetrahydro pyrimidine) is refluxed with (ethyl–2–chloroacetate). Then, KOH and ethanol are added as solvents to the thioxo group, and the yield is (87%) [4]. An antioxidant is that material defined as the substance which is capable of stabilization (or deactivation) of free radicals (before they attack living cells) [5]. Francisco J. Martinez and Rodrigo Said Razo – Hernandez synthesized eight derivatives of (3–carboxycoumarin). The derivatives were assayed by quantitative (DPPH) radical scavenging activity methods. Two of the derivatives showed the best radical – scavenging [6], whereas some derivatives of prenylated phenol manifested antioxidant activity scavenging with DPPH radical. Mauricio Osorio, Jacqueline Aravenaand Alejandra Vergara synthesized 26 prenylated phenol and their acetylated derivatives in two steps. In addition, all of these compounds were compared with Trolox™. Furthermore, inactive derivatives of these compounds were the acetylated derivatives. Moreover, other derivatives showed antioxidant similar to Trolox™. Besides, the dialkyl derivatives compound revealed better

activity than monoalkyl of the phenol derivatives [7].

In this work, the derivative of pyrimidine (cytosine) was used as starting material and treated with fourtypes of aldehyde. There of these types are aderivative of benzaldehyde,and the latteris furfural (five-membered heterocyclic aldehyde). Clearly, results revealed a good yield of four Schiff base derivatives (A_1 – A_4). Then, these products were treated with three types of reagents to synthesize the four-, five- and seven-membered heterocyclic compounds. The steps we used as follows; firstly, the products of Schiff base were treated with the reagent chloro acetyl chloride to synthesize four-membered heterocyclic compounds (B_1 – B_4). Secondly, the Schiff base was treated with hydroxyl acetic acid, and the products were five-membered heterocyclic compounds (C_1 – C_4). Thirdly, treating malic acid anhydride with Schiff base was seven – membered heterocyclic compound (D_1 – D_4). Lastly, the antioxidant of some of these compounds was tested with *Antioxidant Assay by Scavenging activity of 1,2–Diphenyl–2–Picrylhydrazyl (DPPH) Radical.*

2 EXPERIMENTAL RESULTS AND INTERPRETATION

2.1 Materials and Analysis

All materials are of high purity and were purchased from Sigma Aldrich which used without any further purification. The compounds were synthesized and characterized by using UV, IR, ^{1}HNMR and ^{13}CNMR spectroscopy analysis. The IR spectra were recorded on Perkin – Elmer spectrum inthe form of KBr pellet. ^{1}H NMR was recorded in DMSO using TMS as internal standard from Ahl–Albait University 300MHz. The melting point of all compound was incorrect and measured by Electrothermal 9300 melting point apparatus.

2.2 Synthesis

2.2.1 Preparation of Schiff Base

The derivativeswere prepared through the reaction between cytosine and a set of aldehydeswith proportions of mole (1: 1) of each cytosine and aldehyde, respectively. In the (100 ml) round flask, we added(1 ml, 0.1 mole) of the aldehyde with few drops of ethanol absolute and two drops of glacial acetic acid. Then, (1.08 gm) of cytosine added after mixing and stirring of the solutions. After that, the mixing is radiated with domestic ***(economic)*** microwave with monitoring the changes of the color every (10 secs). Besides, the reaction followed up using (T. L. C.) technique to complete the reaction. At the end of the reaction, the solution is dried for one day. A colorcrystal of the compound **(A_1)** is formed, washed and filtered with cold ethanol to remove non-reacted aldehydes; additionally, in order to separate the solid precipitate by filtrate and re–crystallize with absolute ethanol. By the same methods, we can synthesize the derivative compounds from **(A_2 – A_4)**. The obtained yield of the products is in the range (73 – 93%). Accordingly,the physical properties of the compounds are shown in Table1[8].

2.2.2 Preparation of Azetidine

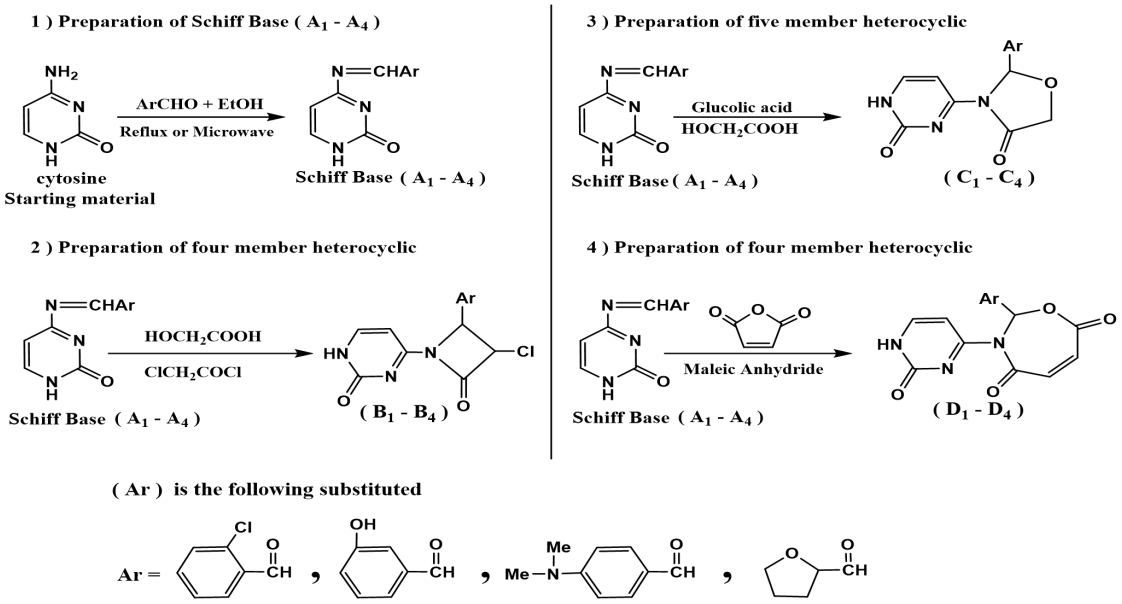
Firstly, dissolving (0.005 mmole) of prepared Schiff base **(A_1 – A_4)** in (40 ml) of dioxane. Secondly,adding (1.4 ml, 0.01mole) tri-ethylamineandput the mixture in anice bath with astirrer.After that, gradually add(0.8ml,0.01 mole) chloroacetyl chloride for (20 min). Then, stir the solution for 3 hours and leave it atroom temperature for two days. In order to complete the precipitate of the solid product, the productis added to crushed ice, filtered, dried, and re-crystallized from rectified spirit. The yield of the products**(B_1 – B_4)** is between(60 – 75) %. Consequently, the physical properties are listed in Table 2[9].

2.2.3 Preparation of Oxazolidine

The first step is mixing(0.05 mmole) of prepared Schiff base **(A_1– A_4)** with (25ml) of the solvent dioxane with (0.01 mole) hydroxyl acetic acid dissolved in the same solvent. Later,puttingthe mixture in (100ml) round flask and reflux for 5 hoursto cool to room temperature.After that, thecolored solid product is precipitated,filtered, dried, and re–crystallized from ethanol absolute. Accordingly, the yield of the product**(C1 - C_4)**is between(65–83) %. Finally, Table 3 shows the physical properties of the compounds[10].

2.2.4 Preparation of Oxazepene

Putting(0.05 mmole) of Schiff base **(A_1 – A_4)** with(0.01 mmole) Malic acid anhydride in mortar casserole and grinding itwell until the mixed material become homogenous.Afterthat, the mixture is radiated in a domestic microwave for about 1 to 2 minutes.Then, the product will be cooled to room temperature at the end of the radiation. The final product appears as a color solid which is washed with cold benzene and filtrate. Lastly, the productre–crystallized with ethanol absolute[11].The yield of the product **(D_1 – D_4)** isbetween(63- 89) %.Finally, the physical properties of the products are shown in Table 4.



Scheme Show the Route of Synthesis of Compound **(A_1) to (D_4)**

3 Antioxidant Assay by Scavenging activity of (1,2–Diphenyl–2–Picrylhydrazyl) (DPPH) Radical

The study of DPPH (1,2–Diphenyl–2–Picrylhydrzil) radical scavenging activity is a standard examination in antioxidant activity. This technique is a fast method used toinvestigate radical scavenging activity of specific compounds [13].

The effects of free radical scavenging on Schiff base derivatives with (DPPH) radical were assessed with different concentrations of (100, 200, 300, 400 and 500 mg/ml) of the test compound in (1 ml) DMF.After that, we added (1 ml) of 0.4 mM of amethanol solution of (DPPH). The solution must then stirredcarefully forhalf of hour in the time of incubation period at room temperature. The antiradical power of an antioxidant of the scavenging ability is determined by measuring the decrease in the absorbance of DPPH at 517 nm. The standard drugs were used in this work is ascorbic acid. The following equation calculates the percentage inhibition (I %) of free radical production from (DPPH).

$$DPPHScavengingAbility(\%) = \frac{Abscontrol - Abssample}{Abscontrol} \times 100$$

4 Results and Discussion

Schiff base (A_1 – A_4) was prepared by reaction of cytosine with three substitute of benzaldehyde (ortho chloro, meta hydroxyl),(para N,N-dimethylamino benzaldehyde) and the fourth aldehyde is furfural.These products were used ***first ttime*** to prepare four ring heterocyclic compound by treating it with substituting acid chloride (B_1 – B_4). In the ***second time*** we prepared from it five ring heterocyclic compound by reaction with aglycheterocyclic ring$_4$). Lastly,we prepared seven rings heterocyclic compound by reaction with maleic anhydride (D_1 – D_4). These compounds were identified by some technical instrument like IR, ^{1}H NMR, and ^{13}C NMR spectroscopic. Firstly we use IR techniques for the compounds ***(B_1) ,(B_2), (B_3), (B_4), (C_1), (C_2), (C_3), (C_4), (D_1), (D_2), (D_3) and (D_4), the value of IR*** is appear in below table (5):

The second techniques that be used in this work is (^{13} C *NMR) spectrometric* for the compounds (B_1) , (B_3), (C_2) and (D_4) as show in table (6) [12].

Finally, the third techniques that be used in this research is (^{1}H NMR) spectroscopic for the compounds (B_1), (B_3) , (C_2) and (D_4) as show in below table 7.

According to Figure 1, the compounds (A_1 – A_4) show the same activity of scavenging of free radical except the compound A_3 where the activityis lower than the others. It was because of some hindrance effect of two methyl group on (N) comparing with other group which is alone and less hindrance. On the other hand, as showing in Figure 2, the activity of compound B_3 is higher than doublets in comparing with compound B_1 because of the different functional group on four ring heterocyclic . Furthermore, Figure 3 shows that the %DPPH radical activity in the compound (C1, C3) is similar approximately. Moreover, Figure 4 illustrates that the activity of the compound D1 is higher than D3.

5 CONCLUSION

In the first step of our research we prepare Schiff base (A_1 – A_4), and from it in the second step we synthesis three type of compounds four, five and seven heterocyclic compounds (B_1 – D_4) . In the final step of this study after the analysis and identification of some compounds with (IR, ^{1}HNMR, ^{13}CNMR) spectroscope. The IR υ (cm $^{-1}$) in the compound (B_1, B_2, B_3, B_4, C_1, C_2, C_3, C_4, D_1, D_2, D_3, D_4) of (C=N) bond show value between (1560–1672), while the (C=C) bond show (1425–1506), but the (C–H $_{Aromatic}$) show value between (3010–3093), the Bond (O=C–O$_{Cytosine}$) show approximate value between (1630–1641). The ^{1}H NMR for the compounds (B_1), (B_3), (C_2) and (D_4) appear that a signal for (1H,d) at (4–4.7) ppm, and another signal for (1H,d) show at (4.3–4.5) ppm, the signal of (1H,s)$_{of\ cytosine}$ show tow value at (3.8) and (4.1)ppm, the signal of (1H,d)$_{quartet\ ring}$ appear at (3.7) and (3.9) ppm, while the signal for (2H,s)$_{azule\ and\ seven\ ring}$ appear at (2.8) ppm only. The proton NMR for (B_1, B_3, C_2) show signal of (1H, dd) $_{benzene}$ at (7.1–7.5), (6.5–6.9) and (7.1–7.6) ppm. The ^{13}C NMR for the compounds (B_1), (B_3), (C_2) and (D_4) show these value ppm: the bond (C–N) in these compound show signal at (65,66,42,51) ppm, (C=O) $_{cytosine}$ show the signal at (195) ppm for (B_1),(B_3),(C_2) and (197) ppm for (D_4).

The bond (C=C) show signal between (118–146) ppm, the bond (C–N) $_{quartet\ ring}$ show signal at (72,71), while the bond (C–N) $_{azule\ and\ seven\ ring}$ show signal at (55,58) ppm. We study the Antioxidant Assay by Scavenging activity of (DPPH) Radical with the compound (A_1 – A_4), (B_1, B_3) ,

(C_1 , C_3) , (D_1 , D_3) in several concentration (100, 200, 300, 400 and 500 mg/ml) . According to the figure (1 – 5) show that all these compounds have a good Scavenging activity with (DPPH).

ACKNOWLEDGMENTS

We would like to express thanks to all of the participant researcher in this study and thanks to who help me to complete this paper.

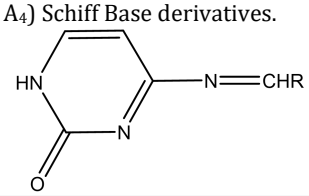
Significance of Research

Cytosine is one of four nitrogen base who has important role in a variety range of application. The goal of this study is synthesis of Schiff base derived from cytosine in good yield and then from it we synthesis (4,5 and 7) heterocyclic ring, after identification of some new Schiff base and heterocyclic ring with the spectroscopic methods like *IR*, H^1 *NMR* and C^{13} *NMR*, then we go to with some of these compounds and applied it to show the activity of Radical Scavenging with the compound DPPH (**of 1,2–Diphenyl–2–Picrylhydrazyl**). These compounds appear that they have a good Scavenging activity with (DPPH).

REFERENCES

1. Kluska, M., Prukała, D., Prukała, W., Kondrzycka-Dąda, A., Komasińska, M., & Małkiewicz, K. (2014). Successful separation and determination of isomers of cytosine derivatives for HPLC. Journal of Liquid Chromatography & Related Technologies, 37(15), 2172-2181.
2. Contribution from Kay Fries Chemical, Ink Peter J. Tarsio and Leonard Nicholl, (July – 31 – 956). Preparation of Cytosine, V22, page 192.
3. Rodriguez, Hortensia, Perez, Rolando, Suarez, Margarita, Lam Anabel, Cabrales, Nilda, Loupy & Ander. Alkylation of some Pyrimidine and Purine Derivatives Using Microwave Assisted, heterocyclic 55 (2001) 2, 291 – 301.
4. Fadda , A. A. ; El – Latif ; E. A. ; Bondock , S. ; Samir, A. ; Synth. Common. (2009). Synthesis of Some New Pyrimidine and Pyrimido [4,5] Pyrimidine Derivatives, chem. inform 40(18) ,4352 – 4368,
5. Al-Saedi, J. A. M., Al-Diwan, M. A., & Al-Masoudi, W. A. (2016). Antioxidant Activity of Schiff Base Derived from Methionine. Research Journal of pharmaceutical biological and chemical sciences, 7(1), 611-617.
6. Martínez-Martínez, F. J., Razo-Hernández, R. S., Peraza-Campos, A. L., Villanueva-García, M., Sumaya-Martínez, M. T., Cano, D. J., & Gómez-Sandoval, Z. (2012). Synthesis and in vitro antioxidant activity evaluation of 3-carboxycoumarin derivatives and QSAR study of their DPPH• radical scavenging activity. Molecules, 17(12), 14882-14898.
7. Osorio, M., Aravena, J., Vergara, A., Taborga, L., Baeza, E., Catalán, K., ... & Espinoza, L. (2012). Synthesis and DPPH radical scavenging activity of prenylated phenol derivatives. Molecules, 17(1), 556-570.
8. Yang, H. J., Sun, W. H., Li, Z. L., & Ma, Z. (2002). The rapid synthesis of Schiff-base without solvent under microwave irradiation. Chinese chemical letters, 13(1), 3-6.
9. K. H. Patel and A. G. Mehta, synthesis and antifungal activityazetidinons and thiazolidinones derivative of. [2 – amino – 6 – (2 – naphthalenyl) thiazolo (3,3 – 2 – 2 – d) thiadiazole] , E. J. Chem.,Vol. 3, No. 13 , pp 267-273 (2006).
10. V Gupta, A Pandurangan, [synthesis, characterization and antimicrobial activity of (4 – oxo oxazolidine derivatives] , world journal of pharmacy and pharmaceutical science Vol.3Issue 11 , 541 – 549 (2014).
11. Hameed, A. (2012). Microwave synthesis of some New 1, 3-oxazepine compounds as photostabilizing additives for PMMA films. Journal of Al-Nahrain University-Science, 15(4), 47-59.
12. L. D. Field; S. Sternhell , JR Kalman, Organic Structures from spectra , 5th Ed. Jonh WIELY and Sons (2013).
13. Al-Amiery, A. A., Kadhum, A. A. H., & Mohamad, A. B. (2012). Antifungal and antioxidant activities of pyrrolidone thiosemicarbazone complexes. Bioinorganic Chemistry and Applications, 2012.

Table 1. The properties of the compound (A_1 – A_4) Schiff Base derivatives.



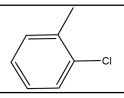
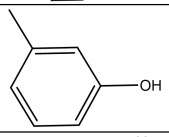
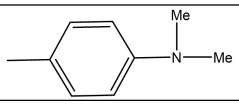
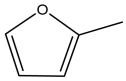
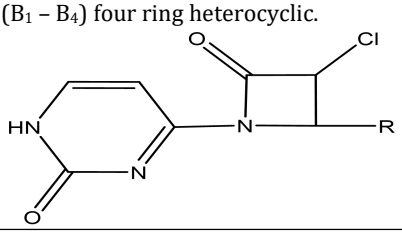
Comp. No.	R	Name of Compound	Color	Reaction Time	M.P. °C	Yield
A_1		4-((2-chlorobenzylidene) amino) pyrimidin-2(1H)-one	Milky	4 min	110 – 113	73
A_2		4-((3-hydroxybenzylidene) amino) pyrimidin-2(1H)-one	White Green	3.5 min	97 -100	90
A_3		4-((4-(dimethylamino) benzylidene)) (amino) pyrimidin-2(1H)-one	Yellow	3 min	150 – 152	82
A_4		4-((furan-2-ylmethylene) amino) pyrimidin-2(1H)-one	White	4 min	176 – 178	93

Table 2. The properties of the compounds (B_1 – B_4) four ring heterocyclic.



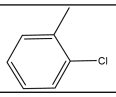
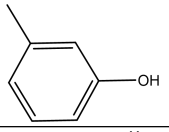
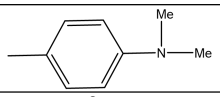
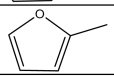
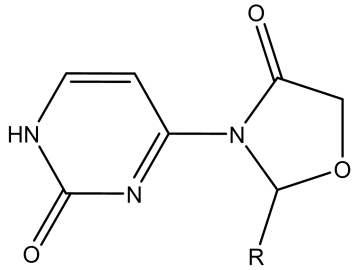
Comp. No.	R	Name of Compound	Color	M.P. ° C	Yield
B_1		4-(3-chloro-2-(2-chlorophenyl)-4-oxoazetidin-1-yl) pyrimidin-2(1H)-one	White	250 - 253	68
B_2		4-(3-chloro-2-(3-hydroxyphenyl)-4-oxoazetidin-1-yl) pyrimidin-2(1H)-one	White Yellow	140 – 143	65
B_3		4-(3-chloro-2-(4-((dimethylamino)phenyl)-4-oxoazetidin-1-yl) pyrimidin-2(1H)-one	Orange Yellowish	165 – 168	75
B_4		4-(3-chloro-2-(furan-2-yl)-4- oxoazetidin-1-yl) pyrimidin-2(1H)-one	Yellow	260 dec.	60

Table 3. The properties of the compounds (C1 – C4) five ring heterocyclic.



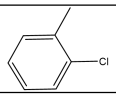
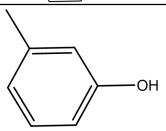
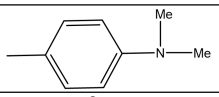
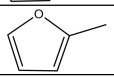
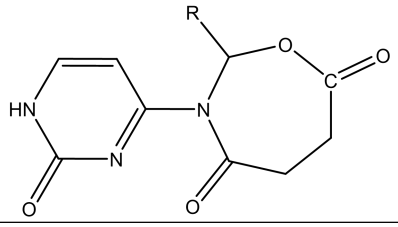
Comp. No.	R	Name of Compound	Color	M.P. ° C	Yield
C_1		2-(2-chlorophenyl)-3-(2-oxo-1,2- dihydropyrimidin-4-yl) oxazolidine-4-one	White	170 – 172	68
C_2		2-(2-hydroxyphenyl)-3-(2-oxo-1,2- dihydropyrimidin-4-yl) oxazolidine-4-one	Light Yellow	178 – 180	79
C_3		2-(4-(dimethylamino) phenyl)-3-(2-oxo-1,2-dihydropyrimidin-4-yl) oxazolidine-4-one	Milky	Oily	65
C_4		2-(furan-2-yl)-3-(2-oxo-1,2- dihydropyrimidin-4-yl) oxazolidine-4-one	Light Brown	185 dec.	83

Table 4. The properties of the compound (D1 – D4) seven ring heterocyclic.



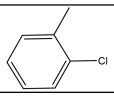
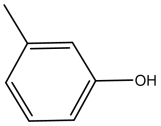
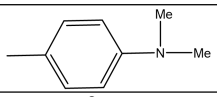
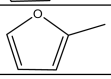
Comp. No.	R	Name of Compound	Color	Reaction Time	M.P. ° C	Yield
D_1		2-(2-chlorophenyl)-3-(2-oxo-1,2-dihydro pyrimidin-4-yl)-1,3-oxazepane-4,7-doine	Milky	3 min	96 – 99	63
D_2		2-(2-hydroxyphenyl)-3-(2-oxo-1,2-dihydro pyrimidin-4-yl)-1,3-oxazepane-4,7-doine	Brown	4 min	150 – 153	85
D_3		2-(4-(dimethylamino) phenyl)-3-(2-oxo-1,2-dihydro pyrimidin-4-yl)-1,3-oxazepane-4,7-doine	Orange	3.5 min	108 – 11	76
D_4		2-(furan-2-yl)-3-(2-oxo-1,2-dihydro pyrimidin-4-yl)-1,3-oxazepane-4,7-doine	Light Yalow	3 min	165 – 168	89

Table 5.

The Bond	**(C=N)**	**(C=C)**	**(C – $H_{Aro.}$)**	**(O=C – $N_{of\ cytosine}$)**	**(C – Cl)**	Compound B_1
IR υ (cm^{-1})	1588	1506	3045	1630	760	
The Bond	(C=N)	(C=C)	(C – $H_{Aro.}$)	(O=C – $N_{of\ cytosine}$)	(C – OH)	Compound B_2
IR υ (cm^{-1})	1615	1472	3065	1640	3256	
The Bond	(C=N)	(C=C)	(C – $H_{Aro.}$)	(O=C – $N_{of\ cytosine}$)	[C –N $(CH_3)_2$]	Compound B_3
IR υ (cm^{-1})	1579	1425	3025	1641	845	
The Bond	(C=N)	(C=C)	(C – $H_{Aro.}$)	(O=C – $N_{of\ cytosine}$)	– C – O – C – furan	Compound B_4
IR υ (cm^{-1})	1590	1462	3019	1638	1250	
The Bond	(C=N)	(C=C)	(C – $H_{Aro.}$)	(O=C – $N_{of\ cytosine}$)	(C – Cl)	Compound C_1
IR υ (cm^{-1})	1560	1471	3010	1632	780	
The Bond	(C=N)	(C=C)	(C – $H_{Aro.}$)	(O=C – $N_{of\ cytosine}$)	(C – OH)	Compound C_2
IR υ (cm^{-1})	1609	1458	3093	1635	3230	
The Bond	(C=N)	(C=C)	(C – $H_{Aro.}$)	(O=C – $N_{of\ cytosine}$)	[C –N $(CH_3)_2$]	Compound C_3
IR υ (cm^{-1})	1603	1490	3040	1641	860	
The Bond	(C=N)	(C=C)	(C – $H_{Aro.}$)	(O=C – $N_{of\ cytosine}$)	– C – O – C – furan	Compound C_4
IR υ (cm^{-1})	1672	1450	3060	1637	1256	
The Bond	(C=N)	(C=C)	(C – $H_{Aro.}$)	(O=C – $N_{of\ cytosine}$)	(C – Cl)	Compound D_1
IR υ (cm^{-1})	1610	1470	3075	1634	775	
The Bond	(C=N)	(C=C)	(C – $H_{Aro.}$)	(O=C – $N_{of\ cytosine}$)	(C – OH)	Compound D_2
IR υ (cm^{-1})	1611	1460	3072	1640	3290	
The Bond	(C=N)	(C=C)	(C – $H_{Aro.}$)	(O=C – $N_{of\ cytosine}$)	[C –N $(CH_3)_2$]	Compound D_3
IR υ (cm^{-1})	1590	1473	3057	1639	855	
The Bond	(C=N)	(C=C)	(C – $H_{Aro.}$)	(O=C – $N_{of\ cytosine}$)	– C – O – C – furan	Compound D_4
IR υ (cm^{-1})	1560	1464	3087	1633	1247	

Table 6.

The Bond	(C – N)	(C=C)	(C = O.) Cytosine	(C - N) Quartet ring	C – C	(C=O)	(C=C) benzene ring	C – Cl	– CH_3	Compound	from
^{13}C ppm	65	122	195	72	41	79	130 – 145	85	–	B1	Fig. 6
The Bond	(C – N)	(C=C)	(C = O.) Cytosine	(C - N) Quartet ring	C – C	(C=O)	(C=C) benzene ring	C – N	– CH_3	Compound	From
^{13}C ppm	66	146	195	71	42	186	126 – 143	75	36	B_3	-
The Bond	(C – N)	(C=C)	(C = O.) Cytosine	(C - N) Azule ring	C – O	(C=O)	(C=C) benzene ring	C – OH	– CH_3	Compound	From
^{13}C ppm	42	121	195	55	75	205	115 – 139	90	-	C_2	Fig. 8
The Bond	(C – N)	(C=C)	(C = O.) Cytosine	(C - N) Seven ring	C – C	(C=O)	C – O	(C=C) furan ring	C – O furan	Compound	From
13C ppm	51	118	197	58	36	189	65	132	81	D_4	Fig. 10

Table 7.

Position	a (1H,d)	b (1H,d)	c (1H, s) cytosine	d (1H,d) quartet ring	e (1H , d)	f (1H ,dd) benzene	h (1H , dd)	g (1H ,s)	Compound	From
Signals ppm	4	4.3	3.8	3.7	3.2	7.1 – 7.5	7.6 – 8.0	-	B_1	Fig. 7
Position	a (1H,d)	b (1H,d)	c (1H,s) cytosine	d (1H ,d) quartet ring	e (1H , d)	f (1H ,dd) benzene	h (1H , dd)	g (1H ,s)	Compound	From
Signals ppm	4.2	4.4	4.1	3.9	3.1	6.5 – 6.9	7.1 – 7.5	-	B_3	-
Position	a (1H,d)	b (1H,d)	c (1H,s) cytosine	d (2H ,s) azule ring	e (1H , s)	f (1H ,dd) benzene	h (1H , dd)	g (1H ,s)	Compound	From
Signals ppm	4.7	4.5	4.1	2.8	3.2	7.1 – 7.6	7.9 – 8.0	10.1	C_2	Fig. 9
Position	a (1H,d)	b (1H,d)	c (1H,s) cytosine	d (2H ,s) seven ring	e (2H , t)	f (1H , s) furfural	h (1H , d)	g (1H , t)	Compound	From
Signals ppm	4.1	4.4	3.8	2.8	2.6	2,9	6.5	6.1	D_4	Fig. 11
Position	I (1H, d)	-	-	-	-	-	-	-	Compound	From
Signals ppm	6.7	-	-	-	-	-	-	-	D_4	Fig. 11

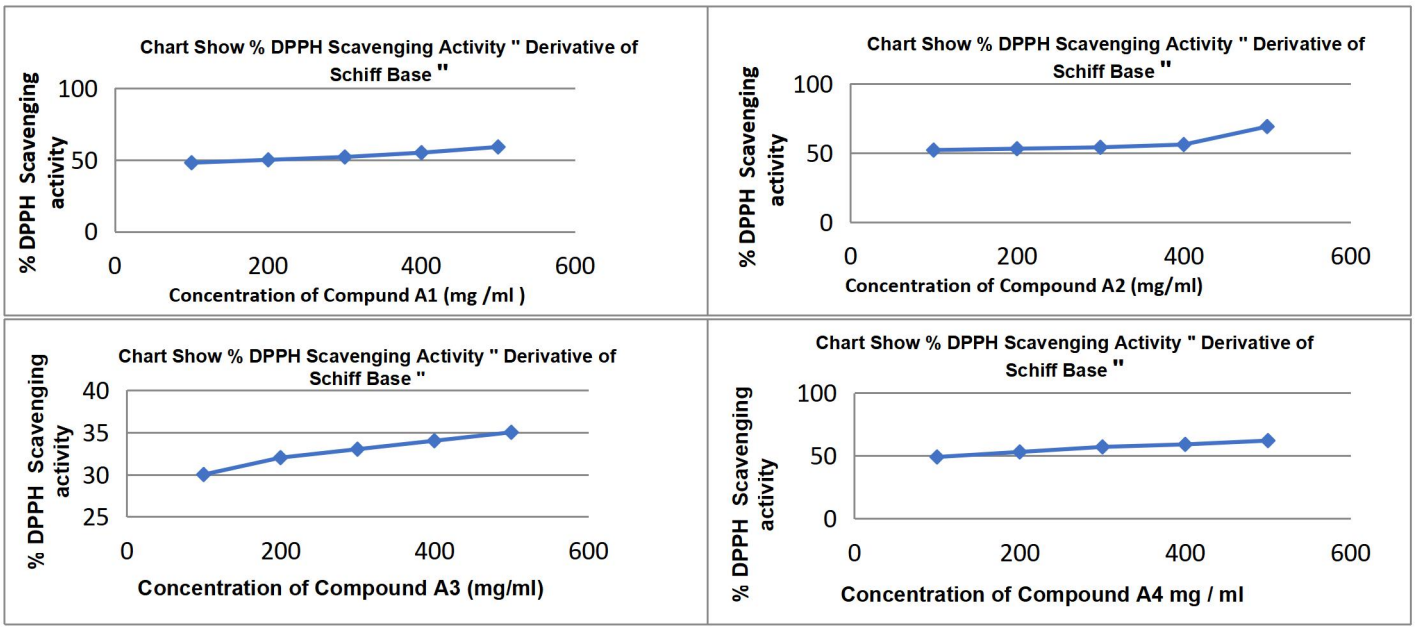


Fig. 1. The (% DPPH) Radical Scavenging Activity for Compound (A_1 – A_4).

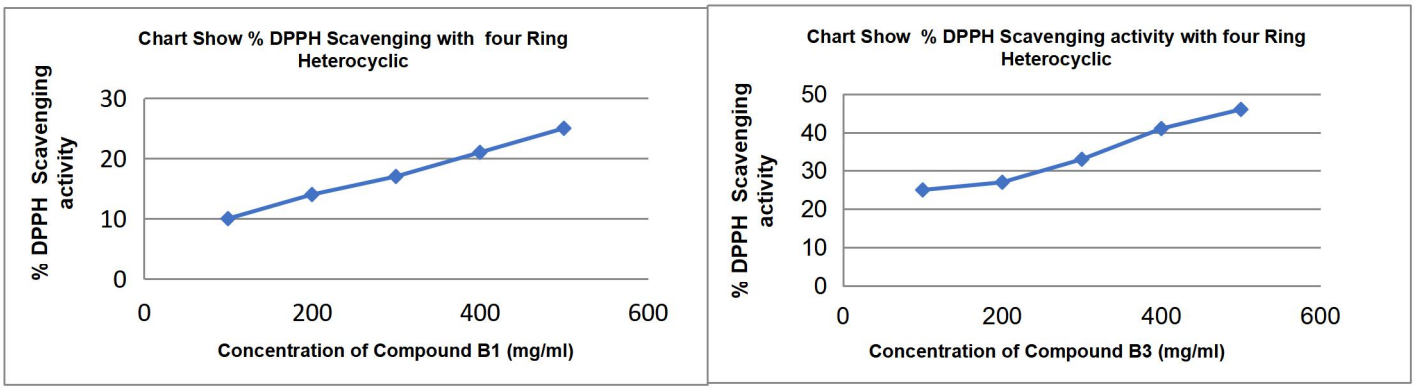


Fig. 2. The (% DPPH) Radical Scavenging Activity for Compound (B1, B3).

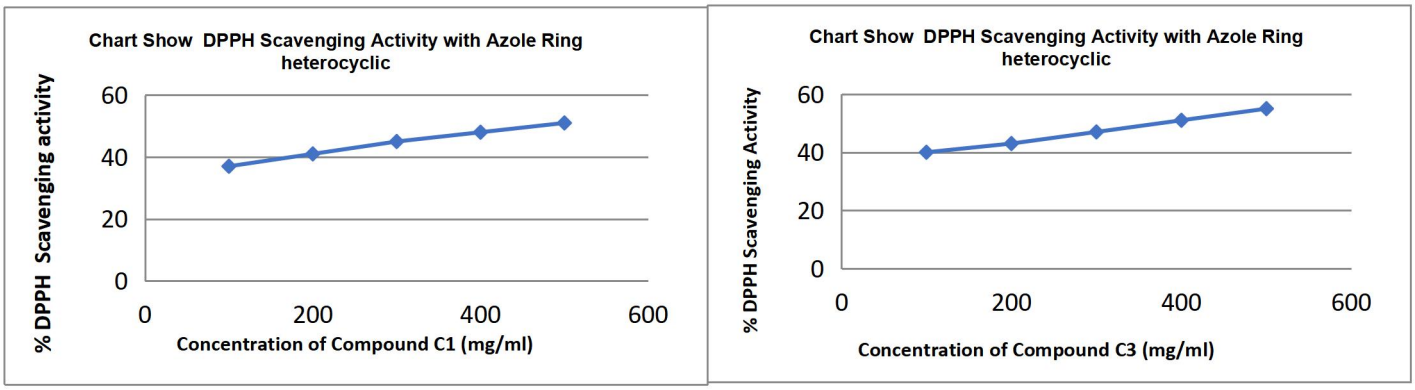


Fig. 3. The (% DPPH) Radical Scavenging Activity for Compound (C1, C3).

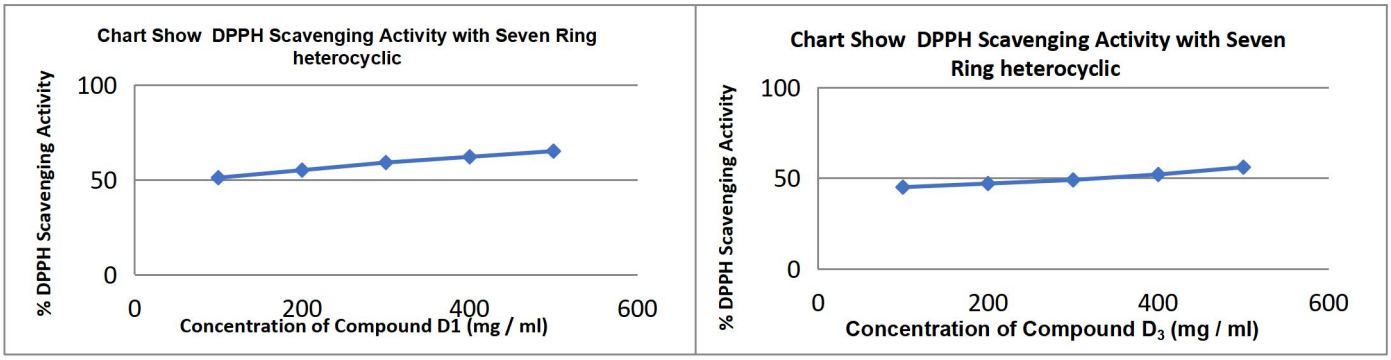


Fig. 4. The (% DPPH) Radical Scavenging Activity for Compound (D1, D3).

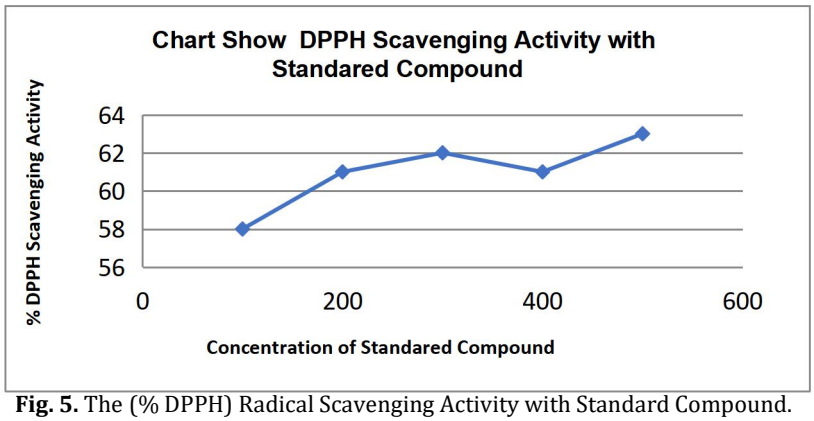


Fig. 5. The (% DPPH) Radical Scavenging Activity with Standard Compound.

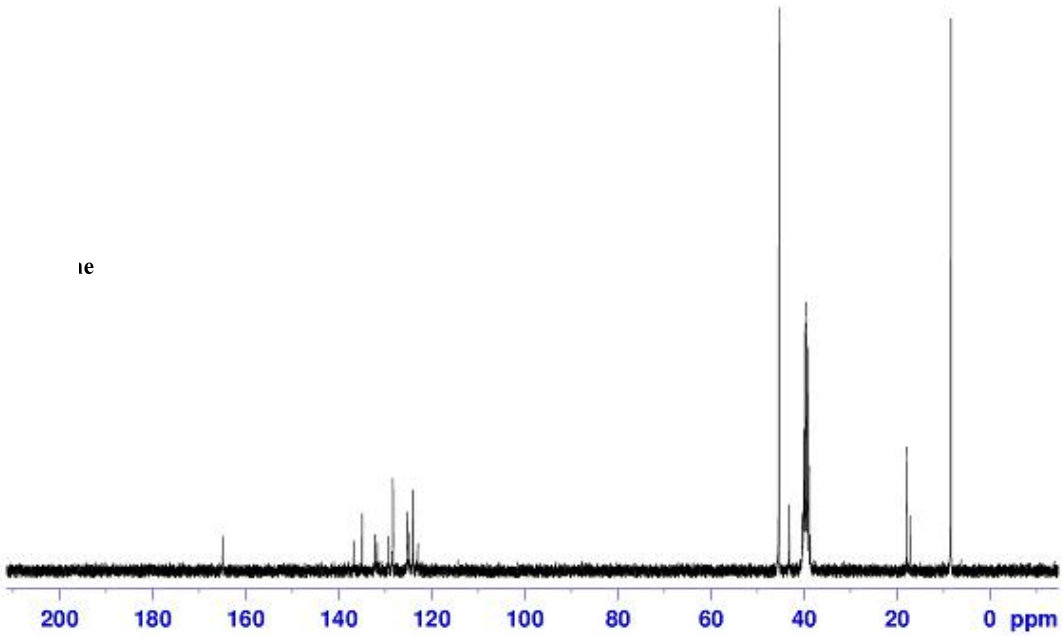


Fig. 6. The 13 C NMR for compound B1.

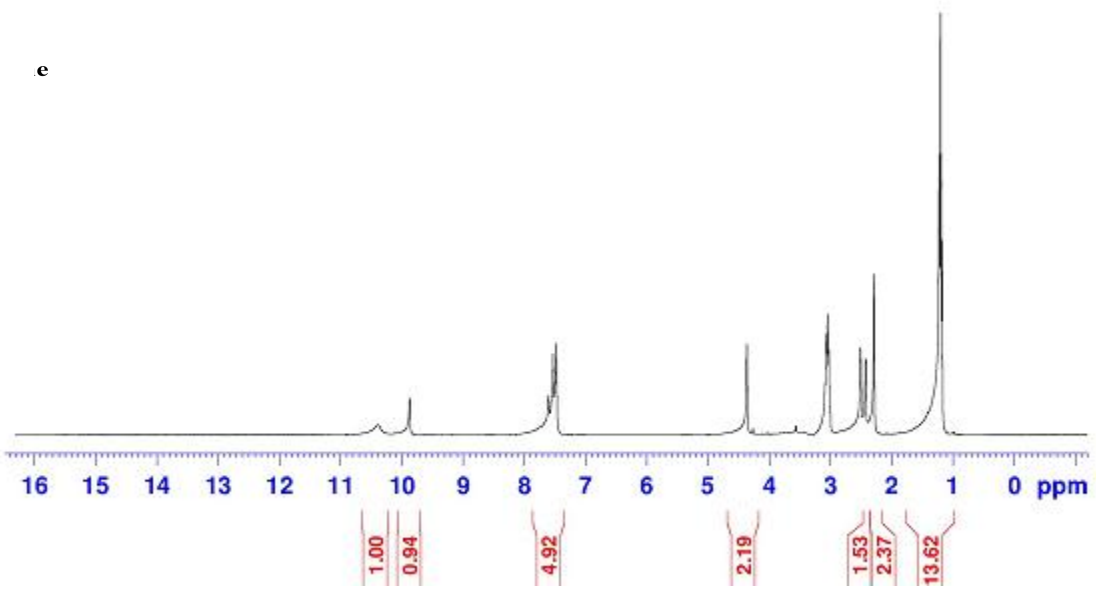


Fig. 7. The 1 H NMR for compound B1.

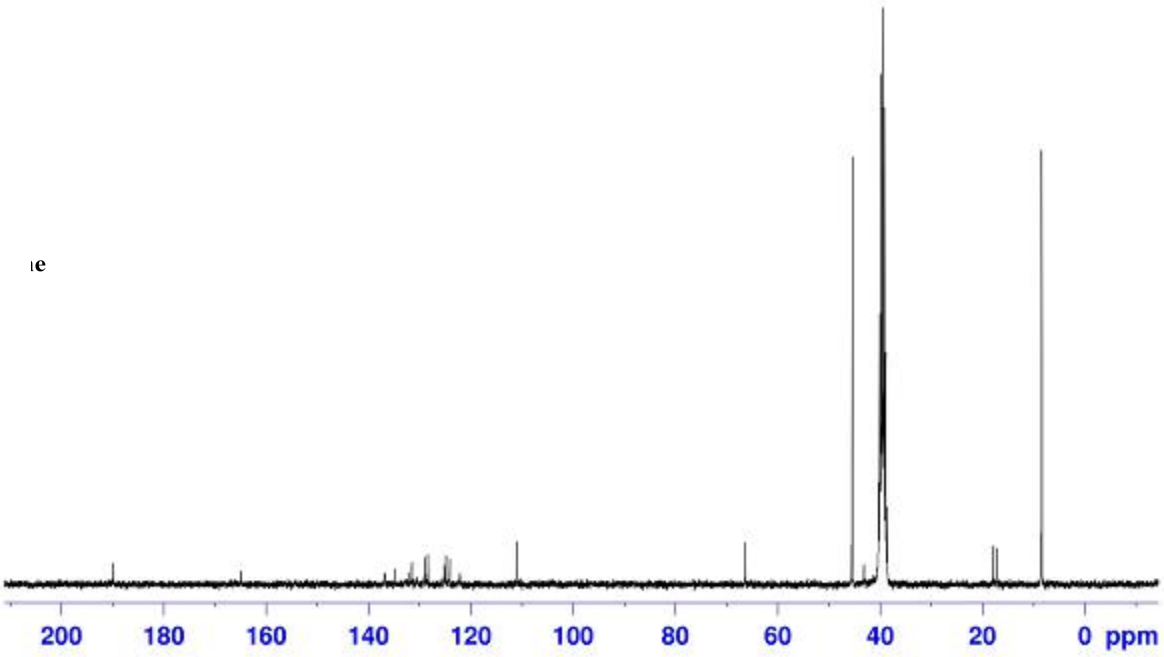


Fig. 8. The 13 C NMR for compound C2.

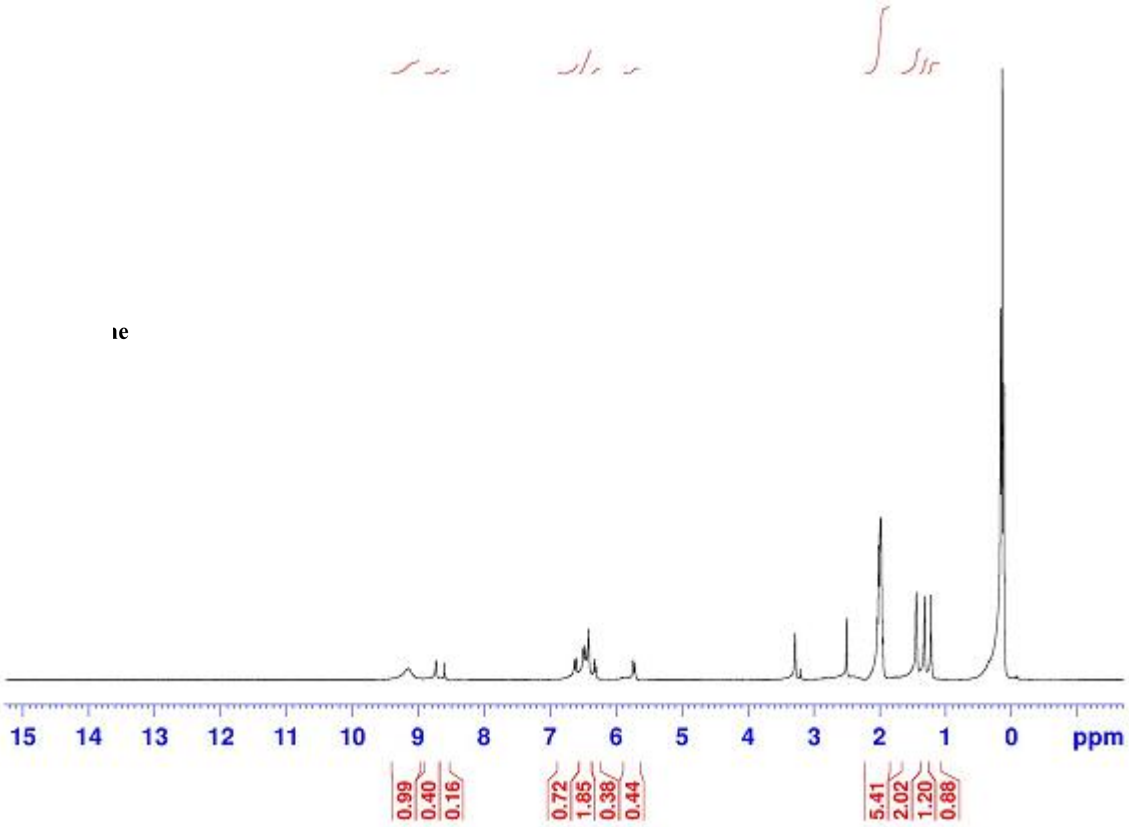


Fig. 9. The 1 H NMR for compound C2

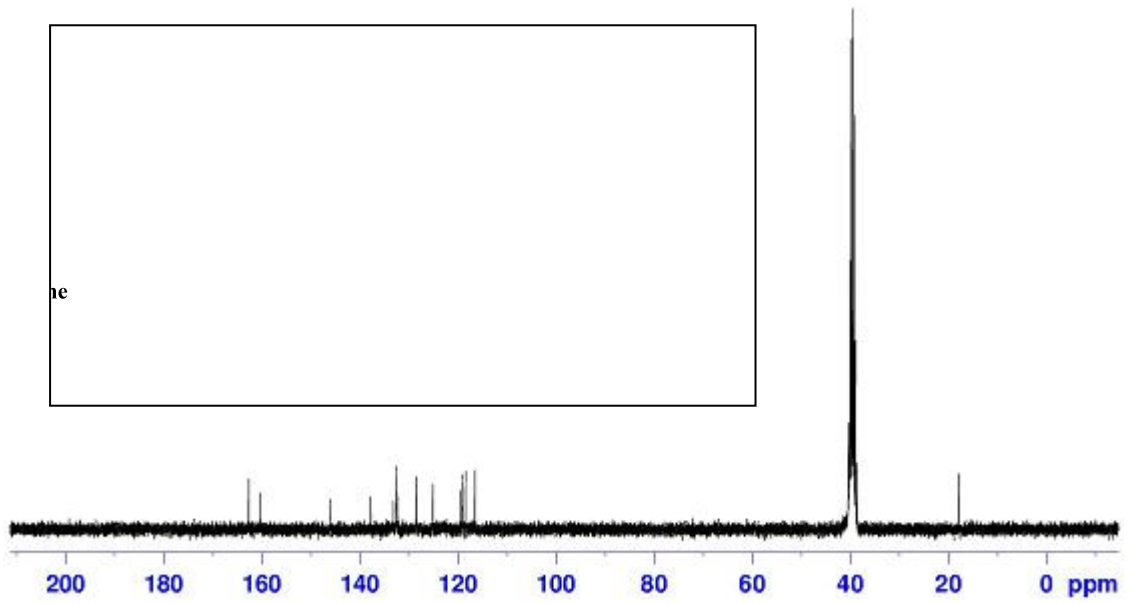


Fig. 10. The 13 C NMR for compound D4.

4,7-dione

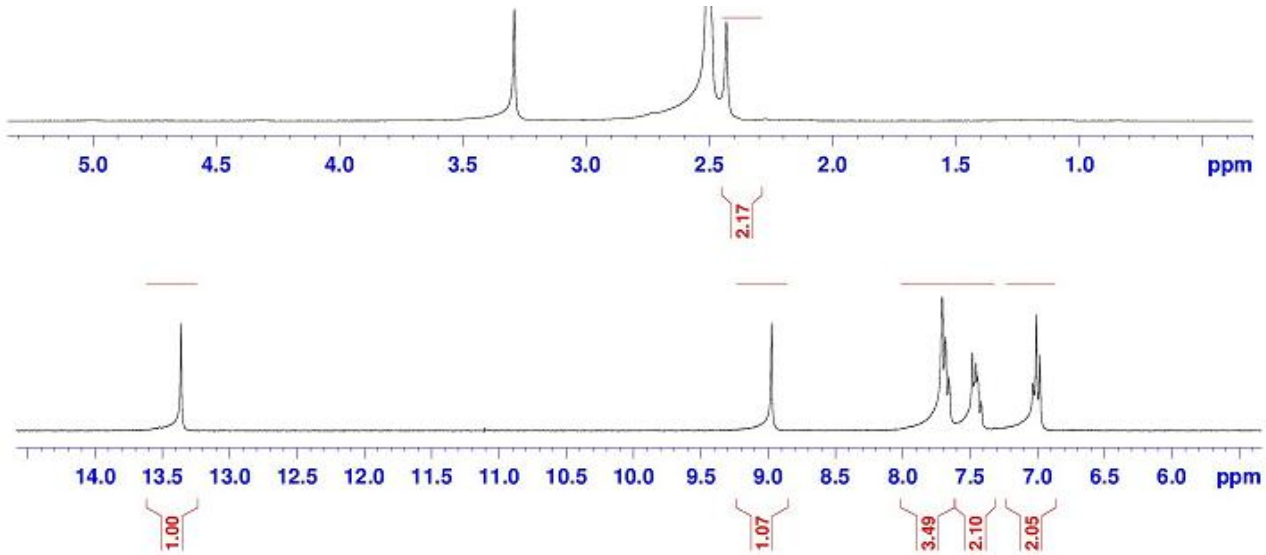


Fig. 11. The 1 H NMR for compound D4.