Synthesis and Spectroscopic Studies of some Schiff bases Derived from Benzidine and their Conversion to 1, 3-oxazepine Derivatives Throughout [2+5] Cycloaddition Reactions (II) .

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Abstract
The present work is oriented towards synthesis of some new series of 1,3-oxazepine derivatives through out two pathways .The first one is reaction of Benzidine with different substituted aldehyde such as (p-hydroxyl, p-methoxy, o-bromo benzaldehyde and vaniline ) throughout condensation reaction under refluxing condition in presence of absolute ethanol, acidic to produced imines derivative(s) (w5-w8) .The second one is reactions of the prepared imines (w5-w8) with maleic and phthalic anhydride under inert N2 gas and refluxing conditions to produces a new series of 1,3-oxazepine derivatives (w5m-w8m) and (w5ph-w8ph) respectively . All the preparing compounds well monitored and identified by TLC and spectroscopic tools such as IR, 1H-NMR and Elemental analysis.

Key words: imines, benzylidene and 1, 3-oxazepine-4,7-dione :

Introduction
compounds have an importance as pharmaceutical drugs, active substances in biological systems. [(Aiello et al, 2004, Ott et al, 2004 and Smith et al, 2006] and liquid-crystalline compounds [Yeap et al, 2010]. Therefore the synthesis these kinds of organic compounds have became our interesting.

Experimental

The characterizations of the prepared compounds were accomplished by FT-IR spectra Perkins Elmer with (KBr) disk and an interval ranging from 450-4400 cm\(^{-1}\). \(^1\)H-NMR spectra was obtained using Bruker 300 MHz spectrometer in the Jordanian University. The samples were in (DMSO-d\(_6\)) with tetramethylsilane (TMS) as reference. Elemental analysis was carried out using a EuroEA Elemental Analyzer/ university of Kufa. Melting points were recorded on a Stuart Scientific- SMP3 apparatus and are uncorrected.

General procedure and spectroscopy

The mixture of 1 mmole of Benzidine and 2 mmole of substituted aldehyde were heated in presence of approximately 10-15 ml of absolute ethanol with 2 drops of glacial acetic acid in water bath at 70-80°C for approximately 30-60 min. The process of reaction was followed by TLC, then filtration or evaporation of the solvent then recrystallized from suitable solvent.[Santosh K, et al, 2010].

(I) Synthesis of imines derivatives:

1) Bis (4-methoxybenzylidene) biphenyl-4,4'-diamine (w\(_3\)):

2 mmole (0.368 gm) of Benzidine was solvated in absolute ethanol with 4 mmole (0.54 gm) of p-methoxy benzaldehyde in presence of drops of glacial acetic acid under refluxing for 60 min, yellow-orange precipitate, after work up of compound the percentage yield was (87%) , m.p= (255-256)°C. IR spectrum show two adsorption bands appear in the range of 2958.90 and 2839.31 cm\(^{-1}\) which belong to C-H aromatic and C-H aliphatic respectively, while (C=N) appear at 1620 cm\(^{-1}\), (C-O-CH\(_3\)) appear in the range 1249.91 cm\(^{-1}\), (-C-N) appear at stretching frequency 1168.90 cm\(^{-1}\), beside that the (aromatic C=C) appear at range 1419 – 1573 cm\(^{-1}\). On the other hands \(^1\)H-NMR in DMSO-d\(_6\) as a solvent showed sharp singlet at \(\delta= 8.409 \text{ ppm (s,2H)}\), (dd,4H) at \(\delta=7.82-7.79 \text{ ppm} , (d,4H) \text{ of biphenyl at } \delta= 7.47-7.27 \text{ ppm}, (d,4H) \text{ at } \delta= 7.22-7.05 \text{ ppm} , (d,4H) \text{ at } \delta= 7.90-6.67 \text{ ppm} \text{ and(s,6H, 2CH\(_3\)) at } \delta= 3.41 \text{ ppm}. The elemental analysis of the molecular formula C\(_{28}\)H\(_{24}\)N\(_2\)O\(_2\) (calculated /found): (C, 79.98 / 80.51; H, 5.75 / 6.32; N, 6.66 / 7.47).

2) Bis (4-hydroxybenzylidene) biphenyl-4, 4'-diamine (w\(_6\)):

2 mmole (0.368gm) of Benzidine was solvated in absolute ethanol with 4 mmole(0.50g) of p-hydroxy benzaldehyde in presence of drops of glacial acetic acid under refluxing conditions for about 33 min. Orange- brown color of precipitate was obtained, after filtration and drying the (yield = 68 %) and the m.p = (276-278)°C. IR data shows two absorption band at 3355-3290 cm\(^{-1}\) (2OH, phenolic) , 3032-3010 cm\(^{-1}\) (C-H, aromatic), 1606 cm\(^{-1}\) (C=N), 1458-1589 cm\(^{-1}\) (C=C, aromatic), 1255 cm\(^{-1}\) (C-O), and 1165 cm\(^{-1}\) (C-N). The \(^1\)H-NMR in DMSO-d\(_6\) as solvent showed (s,2H,for OH) at \(\delta= 10.13 \text{ ppm} \text{ also (s,2H, azomethane) at } \delta= 8.40 \text{ ppm} \text{ and (d,8H) for biphenyl group at } \delta= 7.63-7.80 \text{ ppm} \text{ and(d,4H) aromatic at } \delta= 7.90-8.00 \text{ ppm} \text{ while (d,4H) aromatic relatively shielded at } \delta=7.32-7.42 \text{ ppm} \text{ beside the sharp singlet at 2.36 ppm represent DMSO solvent }\text{. Elemental analysis of the molecular formula C}_{28}H_{26}N_{2}O_{2} (calculated /found): C, 79.57/80.32; H, 5.14/5.89; N, 7.14/7.98).

3) Bis (3-methoxy-4-hydroxybenzylidene) biphenyl-4, 4’-diamine (w\(_7\)):

Benzidine 2 mmole (0.368 gm) was dissolved by absolute ethanol then 4 mmole(0.6 g) of vanillin (3-methoxy -4hydroxy benzaldehyde) was added in presence of HOAC glacial. This type of reaction needed more time than the others about 2 hr of refluxing.
after workup bright yellow precipitation observed with m.p= 226 -228 C° and yield = 75% . IR spectra shows the following bands ( broad band with week intense appear at 3423-3396 cm⁻¹ ( 2OH ) , 1624 cm⁻¹ (C=O) , 1429-1585 cm⁻¹ ( aromatic C=C ) , 1284 cm⁻¹ (C-O-CH3) , 1153-1118 cm⁻¹ (C-O) , and 1030 cm⁻¹ (C-N).¹H-NMR in DMSO-d₆ showed (s,2H, OH ) of phenolic group deshielded at δ= 10.23 ppm ,(s,2H,azomethane) deshielded at δ= 8.42 ppm ,(dd,14H) aromatic groups at δ= 7.79-6.67 ppm and (s,6H)for methoxy groups in meta position at δ = 3.40 ppm . Elemental analysis of the molecular formula C₂₈H₂₄N₂O₄ (calculated /found): C, 74.32 /75 ; H, 5.35 /5.98; N, 6.19 /6.76).

4) Bis (2-bromobenzylidene) biphenyl-4, 4'-diamine (w₈);

2mmole (0.36 gm ) of ortho-bromobenzaldehyde and 1 mmole (0.18 g) of Benzidine were dissolved in absolute ethanol with drops of glacial acetic then refluxing for 35 min slightly yellow precipitate with m.p = 184-186 C° was obtained, (yield = 78 %) , IR data shows, weak absorption band at 3053, 2910 cm⁻¹ ( C-H, aromatic), 1616 cm⁻¹ (C=N), 1435-1593 cm⁻¹ ( aromatic C=C ) ,1024 cm⁻¹ (C-Br ) ¹H-NMR in DMSO-d₆ showed (s,2H) at 8.76 ppm refer to azomethane proton , (d,2H,aromatic) which belong to ortho to azomethane at δ=8.19 -8.21 ppm , (m,12H,aromatic rings) at the range between δ= 7.64-7.43 ppm beside (d,2H,aromatic) at δ = 7.19 -7.16 ppm. Elemental analysis of the molecular formula C₂₆H₁₈N₃Br₂ (calculated /found): ( C, 60.26 /61.12; H, 3.50 /4.21; N, 5.41)

II) Cycloaddition Reaction of the imines derivatives with maleic and phthalic anhydride:

General procedure:

1mmole of desired imine’s (w₃-w₈) was dissolved in suitable solvent under N₂ flow, followed by addition with drop wise the cyclic anhydride under refluxing conditions and monitored with TLC to determine the completion of the reaction. Filtration or evaporation under reduces pressure was done and yielded is dried and recrystilized by a proper solvent.[Mahrath A.J. etal, 2012].

* With maleic anhydride

(1) 3, 3’-(biphenyl-4, 4’-diyl) bis (2-(4-methoxyphenyl) -2, 3-dihydro-1, 3-oxazepine-4, 7-Dione) (w₅m)

reaction of 1mmole (0.42g) of compound w₅ was dissolved in dry THF with 2mmole ( 0.2 g ) maleic anhydride adding with drop wise within N₂ flow and stirring under refluxing condition for about 5 hr ,after evaporating the solvent the oily product was treated with n-Hexane to obtained orange –yellow precipitate with percentage yield = 81.9 % ,m.p = ( 112-113)C° ,IR spectra shows the following bands ; two stretching absorption bands at 1718 and 1640 cm⁻¹ due to ( C=O ,ring ) , 1604- 1500 cm⁻¹ (C=C, aromatic and alkene’s ) , 1396 cm⁻¹ (CH₃-O-C ) , 3010-2877 cm⁻¹ (C-H , aromatic and alkene’s ) . Elemental analysis of the molecular formula C₉₆H₂₈N₂O₈ of the compound w₅m (calculated /found) C, 70.12 / 70.91; H, 4.58 / 5.32; N, 4.54 /5.11.

(2) 3, 3’-(biphenyl-4, 4’-diyl) bis (2-(4-hydroxyphenyl)-2, 3-dihydro-1, 3-oxazepine-4, 7-Dione) (w₆m)

1mmole ( 0.39 g) of w₆ in presence of dichloromethane as solvent was reacted with 2mmole (0.2g) of maleic anhydride under drying and refluxing conditions for about 2-3hr . After work up of the reaction mixture give a yellow precipitate with the percentage yield = 82.7% and m.p = (389-390)C° , IR spectra shows as usual two stretching frequency at 1693 and 1626 cm⁻¹ which belong to (C=O ,ring) respectively ,3248 cm⁻¹ ( OH ) , 3182cm⁻¹ ( C-H ,azomethane ) 3055( C-H ,aromatic) 1558 -- 1505 cm⁻¹ belong to (C=C ,aromatic and
aliphatic). Elemental analysis for the molecular formula C_{34}H_{32}N_{2}O_{6} of the compound w6m (calculated /found) C , 69.38 / 70.10 ; H , 4.11 / 4.76 ; N, 4.76 / 5.29.

(3)3, 3’-(biphenyl-4, 4’-diyl) bis (2-(4-hydroxy-3-methoxyphenyl)-2, 3-dihydro-1, 3-oxazepine-4, 7-Dione) (w7m)

Reaction of (1mmole , 0.45 g) of the compound w7 in THF with (2mmole ,0.2 g) of maleic anhydride under drying and refluxing conditions for about 3-4 hr .after work up of the reaction mixture an orange precipitate with the percentage yield = 71.3 % , m.p= (385-387,dec)C° , IR-spectra show two sharp absorption bands in the rang of 1695 & 1627 cm\(^{-1}\) (C=O ,ester & amide) respectively .broad absorption band stretching at 3433 cm\(^{-1}\) ( OH) , 3269-3184 cm\(^{-1}\) ( C-H-Ar) , 3063-3012 cm\(^{-1}\) ( C-H , aromatic and alkenes’s ) ,1572-1521 cm\(^{-1}\) ( C=C ,aromatic & alkene’s ) , 1393 &1327 cm\(^{-1}\) (C-O-C , ether and phenolic) respectively .Elemental Analysis of the molecular formula C_{36}H_{28}N_{2}O_{10} (calculated /found) C, 66.66/67.21 ; H, 4.35 / 4.92 ; N,4.32 / 4.87.

(4) 3, 3’-(biphenyl-4, 4’-diyl) bis (2-(2-bromophenyl)-2, 3-dihydro-1, 3-oxazepine-4, 7-Dione) (w8m)

2.1 mmole (0.20 g) maleic anhydride in 12 ml dichloromethane was added drop wise with stirring to 1 mmole ( 0.50 g) of w8 under drying by N\(_2\) flow and refluxing conditions . after 3.5 hr work up the reaction mixture to obtain a yellow precipitate with percentage yield = 55.7 % , and m.p= (200-202)C°. From IR spectra two medium sharp bands observed at 1693 and 1627 cm\(^{-1}\) belong to (C=O , ester and amide) respectively , 3055 & 3010 cm\(^{-1}\) (C-H , aromatic and aliphatic) , 1500-1521 cm\(^{-1}\) ( C=C , aromatic and aliphatic) , 1257 cm\(^{-1}\) ( C-O ) and medium sharp band at 831 cm\(^{-1}\) (C-Br ) . on the other hand \(^1\)H-NMR- in (DMSO) solvent showed clearly (d,2H,alkene) at \(\delta= 6.64-6.77\) ppm and (d,2H,alkene) at \(\delta= 7.16-7.19\) ppm, (s,2H,heterocyclic ring) at 9.82-9.90 ppm beside (m ,6H ) aromatic at \(\delta= 7.47 -7.58\) ppm, (d,2H) aromatic near C-Br bond appear at \(\delta= 7.61-7.64\) ppm and (dd,8H ) aromatic appear at \(\delta= 7.77-7.97\) ppm and finally sharp singlet peak for DMSO solvent at \(\delta= 2.50 -2.54\) ppm . Elemental Analysis of the molecular formula C_{34}H_{32}Br_{2}N_{2}O_{6} (calculated /found) C, 57.17 /57.98; H, 3.10 /4.21; N, 3.92 / 4.55.

**With phthalic anhydride:**

(5)4, 4’-(biphenyl-4, 4’-diyl) bis (3-(4-methoxyphenyl)-3, 4-dihydrobenzo[e] [1, 3] oxazepine-1, 5-dione) (w5ph)

Reaction of 1mmole (0.42 g) of compound w5 with 2mmole (0.3 g) phthalic anhydride in presence of THF as a solvent with stirring and refluxing conditions and dried after 7hr ,work up the reaction mixture ,evaporation of the solvent and treated the oily mixture with DMSO and petroleum ether (40-60°C) directly a precipitate observed wit percentage yield = 72.7% , m.p=(82-83)C° ,IR-spectra shown two stretching absorption at 1718 and 1604 cm\(^{-1}\) due to (C=O, ring ) of the oxazepine ring , 1522-1505 cm\(^{-1}\) ( C=C, aromatic ) 2958- 2875 cm\(^{-1}\) (C-H , aromatic and aliphatic),1288-1259 cm\(^{-1}\) ( CH3-O-C , C-O-C) . Elemental analysis of the molecular formula: C_{44}H_{32}N_{2}O_{6} (calculated /found) C, 73.73 /74.32; H, 4.50 / 4.91; N, 3.91 / 4.25.

(6) 4,4’-(biphenyl-4,4’-diyl) bis (3-(4-hydroxyphenyl)-3,4-dihydrobenzo [1,3] oxazepine -1,5-dione) (w6ph)

Dissolve 1mmole ( 0.392 gm) of compound w6 in CH\(_2\)Cl\(_2\) ,and 2mmole (0.3 gm) of phthalic anhydride adding drop wise with stirring under refluxing and drying condition for about 5.3 hr , when the reaction completion, work up to produce brown precipitate with percentage yield = 87% and m.p =313-315C°.IR spectra showed broad band of ( OH) group in the stretching frequency 3352 cm\(^{-1}\) and two absorption bands at 1712 and 1658cm\(^{-1}\) which belong to (C=O ester and amide), 3034 to 2926 cm\(^{-1}\)( C-H ,aromatic ) ,1597-1502
cm$^{-1}$ (C=C, aromatic), 1301 and 1255 cm$^{-1}$ (O-C-O and -N-C), and 1170 cm$^{-1}$ (C-O). Elemental analysis of the molecular formula C$_{42}$H$_{28}$N$_2$O$_8$ (calculated / found ) C, 73.25 / 73.76; H, 4.10 / 4.98; N, 4.07 / 4.31.

(7) 4, 4′-(biphenyl-4, 4′-dial) bis (3-(4-hydroxy-3-methoxyphenyl)-3, 4-dihydrobenzo [1, 3] oxazepine-1, 5-dione) (w$_7$ph)

In 12 ml THF 1 mmole (0.45 g) of compound w$_7$ with stirring then added 2 equivalent mmole of phthalic anhydride (0.3 g) drop wise under refluxing and N$_2$ drying condition. After 6hr evaporating the solvent directly precipitate observed ,filtration and drying under vacuum to yielded about 57% . m.p= (205-207)C° .IR spectra shown the following bands , broad absorption band at 3396 cm$^{-1}$ (2OH) phenolic ;1699 and 1606 cm$^{-1}$ ( C=O ) ester and amide carbonyl , 3036 cm$^{-1}$ ( C-H) aromatic , 2947-2891 cm$^{-1}$ (C-H) alkene’s , 1500 cm$^{-1}$ (C=C ) aromatic , 1332 cm$^{-1}$ (CH3-O-C ) , on the other hand Elemental analysis of the molecular formula, C$_{44}$H$_{32}$N$_2$O$_{10}$ (calculated / found ) C 70.58 / 71.21; H, 4.31 / 4.76 ; N, 3.74 / 4.13 .

8) 4, 4′-(biphenyl-4, 4′-dial) bis (3-(2-bromophenyl)-3, 4-dihydrobenzo [1, 3] oxazepine -1, 5-Dione) (w$_8$ph)

1 mmole (0.51 g) of compound w$_8$ dissolved in dioxin with stirring, then adding to 2.0 mmole(0.3 g ) phthalic anhydride drop wise under refluxing and N$_2$ flow condition for about 3hr .after completion of reaction and evaporation of the solvent ,treated the oily compound with n-hexane directly orange – yellow precipitate observed with percentage yield = 68.7% , and m.p=387 C°dec. Infra red spectra showed as usual two stretching absorption bands coupled at 1699 and 1634 cm$^{-1}$ (C=O, ester and amide ) 3059-2926 cm$^{-1}$ (C-H , aromatic) 1527-1502 cm$^{-1}$ (C=C, aromatic) 1321and 1280 cm$^{-1}$ (C-O-C ,for both side) and 738 cm$^{-1}$ (C-Br). Elemental analysis of the molecular formula C$_{46}$H$_{26}$Br$_2$N$_2$O$_6$ of the compound w$_8$ph was (calculated / found) C, 61.94 /62.64; H, 3.22 / 3.87; N, 3.44 /4.82.

Discussion

It’s well known that 1,3-oxazepine-4,7-dione is a seven-member ring containing nitrogen, oxygen and two carbonyl groups. In previous work a series of 1,3-oxazepine derivatives were prepared from substituted imines with maleic and phthalic anhydride throughout concerted reaction of the type (2+5) cyclization reaction[Mahrrath et al .,2012]. In the same manner a new series of imines were prepared via condensation reaction of Benzidine with substituted aromatic aldehyde in presence of absolute ethanol and glacial acetic acid (w$_5$-w$_8$) (scheme 1). The prepared compounds in scheme 1 were reacted with each of maleic and phthalic anhydride to forming seven member ring of oxazepine derivatives (w$_5$m-w$_8$m) and (w$_5$ph-w$_8$ph) respectively (scheme2). The structures of the prepared compounds were determined on the basis of their FT-IR, $^1$H-NMR and Elemental analysis data .Recall to the generation of azomethine derivatives (w$_5$-w$_8$). IR-spectra of compounds showed appearance of azomethane group in the range of 1616 – 1624 cm$^{-1}$ and disappearance of ($\text{NH}_2$) absorption bands in the range 3460-3250 cm$^{-1}$ which were belonging to asymmetric and symmetric stretching frequency of NH$_2$ , beside to the presence of OH group in case of w$_6$ and w$_7$ which appear clearly in the range of 3419-3424 cm$^{-1}$ (figure 2) . On the other hand $^1$H-NMR spectra confirmed the chemical structure azomethine compounds. such as for compound ( w$_5$,w$_6$,w$_7$,and w$_8$) in the (figure 2-6) . For instance $^1$H-NMR in DMSO-d$_6$ of compound w$_6$ shows sharp singlet peak in 10.10 ppm which belong to two (OH) phenolic groups which clearly deshielded and disappearance when D$_2$O was used leading to exchangeable (O-H to O-D) . Also the singlet peak at 8.45
ppm is assigned to the proton of azomethine (CH=N-) group [Issam, 2006]. The azomethine group appeared at higher field, i.e. deshielded because the nitrogen atom is bonded to an aromatic ring and the nitrogen has a lone pair of electrons that enables it to delocalize into the aromatic ring. On the other hand reaction of azomethine with cyclic anhydride goes through cycloaddition reaction between imine (−N=C−) and five membered ring of the maleic anhydride, i.e. (2+5) concerted cyclization reaction [Cary, et al., 2007]. IR spectra of these compounds (w5m-w8m) showed clearly disappearance of stretching absorption bands of imine groups at 1616-1624 cm⁻¹ and appearance of two sharp (medium –strong) stretching absorption bands at range of 1626 -1718 cm⁻¹ which belong to (C=O) for amide and ester in the seven membered oxazepine ring, figure (7,8, and 9). also the ¹H-NMR spectra clarified the formation of oxazepine ring as example formation of compound w8m. figure (10) showed clearly (d,2H) of alkene type Hₐ in the two rings appear at δ = 6.64-6.77 ppm and another (d,2H) of alkene type H₉ in the two rings which appear at δ= 7.16-7.19 ppm. On the other hand sharp singlet peak of two protons of chiral center of oxazepine rings (H*) appear at δ= 9.84-9.90 ppm which clearly deshielded due to chiral carbon attached to oxygen and nitrogen oxazepine ring [Kategaonkar A. H., 2010], beside the rest of peaks (m,6H) aromatic at δ= 7.47 -7.58 ppm, (d,2H) aromatic H₈ appear at δ= 7.61-7.64 ppm and (dd,8H)H₉, H₁₂ aromatic appear at δ=7.77-7.97 ppm. unfortunately the rest of ¹H-NMR spectra of other compound are not reach yet.

Also elemental analysis of the prepared compounds were agreement with calculated value. on the other hand the default structure of (w8m) compound in 3D view shows the orientation of oxazepine rings in perpendicular of plane of the symmetry of biphenyl molecule which give an indication that there is no steric factor between Br atom and
The only disadvantage was long time of reaction and low percentage yield. By the way, the biological study for some of these compounds is under studies in the near future.

(Scheme 1: Generation of imine derivatives ($w_5$-$w_8$))
(Scheme 2: Generation of Oxazepine derivatives w₅m-w₆m and w₅ph-w₆ph)
Figure (1) IR-spectrum of compounds (W₅-W₈)

W₅: bis(4-methoxybenzylidene)biphenyl-4,4'-diamine.
W₆: Bis (4-hydroxybenzylidene) biphenyl-4, 4’-diamine.
W₇: Bis (3-methoxy-4-hydroxybenzylidene) biphenyl-4, 4’-diamine.
W₈: Bis (2-bromobenzylidene) biphenyl-4, 4’-diamine.
Figure (2): $^1$H-NMR spectrum of bis(4-methoxybenzylidene)biphenyl-4,4'-diamine (w₂) in DMSO solvent

Figure 3: $^1$H-NMR-spectra of Bis (4-hydroxybenzylidene) biphenyl -4, 4'-diamine in DMSO-d₆ solvent (w₆)

Figure 4*: $^1$H-NMR-spectra of Bis (4-hydroxybenzylidene) biphenyl -4, 4'-diamine of (w₆) with D₂O
Figure (5): $^1$H-NMR spectrum of 1,3-bis(3-methoxy-4-hydroxybenzylidene) biphenyl-4, 4'-diamine ($w_7$) in DMSO-d$_6$.

Figure (6): $^1$H-NMR spectrum of 1,3-bis(2-bromobenzylidene) biphenyl-4, 4'-diamine ($w_8$) in DMSO.
Figure (7) : IR-spectrum of 4,4'-(biphenyl-4,4'-diyl)bis[3-(4-methoxyphenyl)-3,4-dihydrobenzo(1,3) oxazepine-1,5-dione] \( w_5 \)ph

Figure (8) : IR spectrum of 3,3'-(biphenyl-4,4'-diyl)bis(2-(4-hydroxyphenyl)-2,3-dihydro-1,3-oxazepine-4,7-dione) \( w_6 \)m

Figure (9) : IR-spectrum 3,3'-(biphenyl-4,4'-diyl)bis[2-(4-hydroxy-3-methoxyphenyl)-2,3-dihydro-1,3-oxazepine-4,7-dione] \( w_7 \)m
Figure (10): IR-spectrum of 3,3'-(biphenyl-4,4'-diyl)bis[2-(2-bromophenyl)-2,3-dihydro-1,3-oxazepine-4,7-dione] w\textsubscript{8}m

Figure (11): IR-spectrum of 4,4'-(biphenyl-4,4'-diyl)bis[3-(2-bromophenyl)-3,4-dihydrobenzo (1,3) oxazepine-1,5-dione] w\textsubscript{sp}h

Figure (12): 1H-NMR spectra of 3,3'-(biphenyl-4,4'-diyl)bis[2-(2-bromophenyl)-2,3-dihydro-1,3-oxazepine-4,7-dione] in DMSO-d\textsubscript{6} (w\textsubscript{8}m)
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