Chapter-II

Synthesis of naphtho[2,1-6]furan-1,3,4-benzotriazepines
Introduction

Benzodiazepines are very important class of compounds because of their pharmacological properties\(^1 - 3\). Owing to their well-established role as psychotherapeutics\(^4\), benzodiazepines have been the object of intense investigation in medicinal chemistry. The area of biological interest of this family of compounds have been extended recently to various diseases such as cancer\(^5\), viral infections(HIV)\(^6\) and cardiovascular disorders\(^7, 8\). Some members of 1,4-benzodiazepine group have shown sufficient pharmacological and clinical activities, such as anxiolytics, hypnotics, sedatives, anticonvulsants, muscle relaxants, antipsychotic\(^9 - 17\) etc. Such a versatile biological activity of the benzodiazepine pharmacophere has prompted investigations into nitrogen homologues, the benzotriazepines\(^18, 19\) in order to find new therapeutical leads. Thus, the chemistry of triazepine nucleus has been the fascinating field of investigation in the heterocyclic chemistry during the past few years. In this lead, some of the derivatives of 1,3,5-benzotriazepines derivatives were reported to possess antibacterial, antiviral and psychotropic activity\(^20, 21\) and a few selected derivatives were used in the manufacture of plant protecting agents\(^22\), malaria therapy\(^23, 24\), acaricidal, herbicidal\(^25\). Insecticidal properties of 1,3,5-benzotriazepines analogues were also documented. On the other hand, the derivatives of 1,3,4-benzotriazepines have been reported to possess anticonvulsant\(^26\), anti-inflammatory and sedative properties\(^27\). Some of them have been in use as anxiolytics\(^28\). In view of the remarkable biological activity found with benzotriazepines, a wide variety of their derivatives have been synthesized and reported in the literature.
Reddy and coworkers reported that the synthesis of several derivatives of 2-phenyl-1,4-dihydro-5H-1,3,4-benzotriazepin-5-ones possessed considerable biological activities.

Francois-Rene Alexandre and his team reported the synthesis of substituted 1,3,4-triazepine-2,5-diones from 3,1-benzoxazin-4-ones as starting compound. Traditional thionation (P2S5) of the oxygenated congeners was also explored to afford novel 1,3,4-benzotriazepin-5-thiones and 1,3,4-benzotriazepine-2,5-dithiones in good yields. Rachid Jalal et al., synthesized several derivatives of ethyl 5-methyl-1-(4-methylphenyl)-6-oxo-5,6,11,11a-tetrahydro-1H-[1,2,4]triazolo[3,4-b][1,3,4]benzotriazepine-3-carboxylate by 1,3-dipolar cycloaddition reaction of nitrilimines, and found them to be biologically active.

\[
\begin{align*}
\text{R}_1 = \text{OCH}_3, \quad \text{R}_2 = \text{OCH}_3, \quad \text{R}_3 = \text{H}
\end{align*}
\]
Messaoudi et al., synthesized derivatives of 1,3,4-benzotriazepines 4 and 5 by 1,3-dipolar cycloaddition of nitrilimines and nitrile oxide with the 1,3,4-benzotriazepin-5-one. All these products were prepared to evaluate their activity on central nervous systems and on the HIV.

3H-1,3,4-Benzotriczepines have been prepared from 5-phenoxy methyl and 5-aryl thiotetrazoles by Artamonova et al., which are shown to be good antimicrobial activitives. Norton Peet et al., developed a new route to synthesize 3,4-dihydro-3-methyl-1H-1,3,4-benzotriazepine by treating 2-carboalkoxyphenyl isocyanate with methyl hydrazine and cyclizing semicarbazide ester with base. Franciszek S et al., carried out the synthesis of derivatives of 1,3,5-benzotriazepines and inferred them to be biologically active.

In recent years, Narahari Babu et al., prepared a very large number of 3-N-methyl-4(substituted phenyl)-1,3,5-benzotriazepine-2-thiols by the reaction of N-(2-aminophenyl)-N-methylthiourea with aromatic aldehydes in acetic acid medium and reported them to be antibacterial and antiviral. The naphtho[2,1-b]furan derivatives form an important class of O-heterocycles in that they display alternative application as pharmacological (e.g. antimicrobial drugs) as well as being general synthetic building.
blocks due to their chemical and biological relevance. Vaidya and his team reported the synthesis of compounds in which the heterocycles are annelated to naphtho[2,1-b]furan to get tetracyclic heterocyclic compounds naphtho[2,1-b]furo[3,2-e]-1,3,4-triazepin-2-one 7. These compounds were interesting as they exhibited good number of activities like antimicrobial, anatematic and analgesic. Because of this, till today, the synthesis and evaluation of biological activities of benzotriazepines condensed with different heterocycles remains an active research area for lead chemists.

Though many investigations have been carried out on the synthesis of heterocyclic system 1,3,4-benzotriazepines ring systems, the present work of synthesizing of 3-(naphtho[2,1-b]furan-2-ylcarbonyl)-3H-1,3,4-benzotriazepines is under taken with a novel approach to couple naphtho[2,1-b] with benzotriazepine.

More over in recent years, microwave irradiation has been demonstrated not only to dramatically accelerate many organic reactions, but also to improve yields and selectivity. Thus, the drive continues to find a better and improved methodology. In view of this and in continuation of our effort to synthesize different naphthofuran heterocyclic compounds, the synthesis of triazepines coupled with naphthofurans and investigation of their biological activities is described in the following pages.
Present work

The foregoing discussion reveals the importance of benzotriazepines as biologically, pharmacologically and industrially important molecules. It is thought that the combination of benzotriazepines and naphthofuran would lead to more potent new type of heterocyclic derivatives. The survey of the literature has revealed that there is hardly any report on the synthesis of naphthofuran coupled with benzotriazepines. Hence in the present work, we have focused on the synthesis of benzotriazepines involving naphtho[2,1-b]furan. The synthetic strategy for the synthesis of these compounds involve the following steps:


1. Synthesis of 2-hydroxy-1-naphthaldehyde

The starting compound, 2-hydroxy-1-naphthaldehyde 8 was synthesized from 2-naphthol by Reimer-Tiemann reaction under microwave for condition. The identity of the compound was ascertained by superimposable IR and \(^1\)H NMR spectra and determination of mixed melting point with the authentic sample.\(^{42}\)
2. **Synthesis of ethyl naphtho[2,1-b]furan-2-carboxylate**

The most suitable starting material for the synthesis of the desired biheterocyclic compounds is ethyl naphtho[2,1-b]furan-2-carboxylate 9. It was synthesized from 2-hydroxy-1-naphthaldehyd e8 and ethyl chloroacetate under microwave for 3-4 minute. The irradiation was done at power-40 (half of the power) in the unmodified domestic Whirlpool microwave oven. The irradiation was done for 30 sec at each shot and allowed the system to get cool at room temperature and then irradiated again. This was done for 3-4 minute until the completion of the reaction, which was monitored by the TLC. Both condensation as well as cyclization occurred in single step and produced ethyl naphtho[2,1-b]furan-2-carboxylate.

![Chemical structure](image)

The structure of 9 has been established by its IR and $^1$H NMR spectral data. IR spectrum of compound exhibited absorption frequency at 1732 cm$^{-1}$ for carbonyl group [Fig: 2.1]. The $^1$H NMR spectra substantiated the results of the IR analysis. The characteristic signals of an ester moiety confirm the presence of ester group in the structure by resonating as quartet and triplet for CH$_2$ and CH$_3$ at $\delta$ 4.45 ppm ($J$ = 7 Hz)
and δ 1.35 ppm (J= 7 Hz) respectively. The aromatic protons resonate as multiplets at δ 7.60-8.50 ppm, in particular 5-H & 6-H resonate as triplets at δ 7.60 ppm (J=7 Hz) and δ 7.70 ppm (J=7 Hz) respectively. 10-H and 11-H resonate as doublet at δ 7.90 ppm (J=9 Hz) & δ 8.45 ppm (J=8 Hz), 3-H resonate at δ 8.50 ppm as singlet and 4-H & 7-H at δ 8.05-8.15 ppm as a double doublet (J=8 Hz) confirms the structure of naphthofuran [Fig: 2.2].


The synthesis of naphtho[2,1-b]furan-2-carbohydrazide 10 from ethyl naphtho[2,1-b]furan-2-carboxylate 9 was a straightforward reaction, which was accomplished by reacting 9 with hydrazine hydrate in absolute ethanol under microwave irradiation for 4-5 minute in presence of catalytic amount of sulphuric acid.

The structure of 10 was confirmed by IR, 1H NMR and mass spectral techniques. IR showed the absence of ester stretching frequency, instead it exhibited a band at 1657 cm⁻¹ for carbonyl group and showed two broad absorption band in the region of 3304-2969 cm⁻¹ due to -NH & -NH₂ groups [Fig: 2.3]. 1H NMR spectrum of compound 10 exhibited no peaks corresponding to ester instead it showed signals at δ 10.15 ppm and δ 4.62 ppm for-NH₂ and -NH (D₂O exchangeable) of hydrazide respectively [Fig: 2.4]. The multiplet integrating at 7.51-8.53 for seven aromatic protons confirms the assigned structure to the molecule.
Scheme 1

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The reaction of naptho[2,1-b]furan-2-carbohydrazide 10 with various aromatic aldehydes in refluxing dioxane resulted in the formation of Schiff bases. The aromatic aldehyde selected for the study was 2-aminobenzaldehyde containing both electron withdrawing and electron releasing groups. To prepare Schiff bases \(N\)\-\{(2-aminophenyl)methylene\} naptho[2,1-b]furan-2-carbohydrazides 12a-l, the compound naptho[2,1-b]furan-2-carbohydrazide 10 was treated with various aldehydes of 2-aminobenzaldehydes 11a-l in presence of catalytic amount of acetic acid in ethanol under microwave irradiation for 4-5 minutes in good yields (Scheme-1).

The structure of compound 12a was elucidated by spectroscopic data. The IR spectrum exhibit absorption band at 1571 cm\(^{-1}\) due to -C=\(N\) and amide stretching frequency remained at 1663 cm\(^{-1}\) [Fig: 2.5]. \(^1\)H NMR of 12a exhibits multiplet at \(\delta\) 7.21-8.75 ppm for 11 aromatic protons. Whereas imine protons found to resonate at \(\delta\) 8.61 ppm and -NH (D\(_2\)O exchangeable) proton appeared at \(\delta\) 12.21 ppm and -NH\(_2\) (D\(_2\)O exchangeable) resonated at \(\delta\) 9.31-9.49 ppm as a singlet [Fig: 2.6].

5. **Synthesis of 3-(naptho[2,1-b]furan-2-ylcarbonyl)-3\-\(H\)-1,3,4-benzotriazepine.**

In order to obtain the title compounds, the Schiff base dissolved in triethylorthoformate was irradiated for 2-3 minutes with short intervals. It was interesting to observe that, Schiff base was found to be cyclized with the formation of triazepine i.e., 3-(naptho[2,1-b]furan-2-ylcarbonyl)-3\-\(H\)-1,3,4-benzotriazepines 13a-l. Similarly different substituted Schiff bases 12a-l were dissolved in excess of triethylorthoformate and was irradiated in microwave oven with short interceptions of 30 Sec to avoid the
excess evaporation of triethylorthoformate to get the 1,3,4-benzotriazepines in acceptable yields.

As a typical example, the structure of the resulting molecule 13a was confirmed by its IR, NMR and Mass spectral studies. The IR spectrum of the compound revealed two strong absorption bands at 1610 cm\(^{-1}\) and 1683 cm\(^{-1}\) for C=N & C=O group respectively [Fig: 2.7]. Further, \(^1\)H NMR spectrum exhibited multiplet in the region 7.41-8.90 for 11 aromatic protons. Two protons present in triazepines ring i.e. N-CH=N and –CH=N are found to resonate as singlets at 8.42 & 8.53 ppm respectively are found to merged in the aromatic region [Fig: 2.8]. Finally the structure of 13a was confirmed by the mass spectral analysis. It gave molecular ion peak at m/z 339 (M\(^+\)) (Scheme-2) with further fragmentation at 195, 166, 155, 132 and 77 confirms the assigned structure to the molecule [Fig: 2.9]. Similarly, all these compounds were purified by column chromatography and characterized on the basis of spectral studies. The spectral details of all the synthesized compounds are in agreement with the assigned structures assigned to the molecules.
Mass fragmentation pattern of compound 13a

Scheme-2
Fig: 2.2; $^1$H NMR Spectra of 9

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EXPNO  5
PROCNO 1

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FULLPROG zg
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SOLVENT DMSO
NS 128
DS 0
SWH 7246.417 Hz
FTDRSS 0.442286 Hz
AQ 1.1305460 sec
RG 2048
DW 69.000 usec
DE 86.25 usec
TE 300.0 K
HL1 1 dB
D1 1.00000000 sec
P1 11.50 usec
SP01 400.1395912 MHz
NUCLEUS 1H

F2 - Processing parameters
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SP 400.1362837 MHz
WQW EM
SSB 0
LB 0.00 Hz
GB 0
PC 0.60
Fig. 2.3: IR Spectra of 10
Fig: 2.4; \textsuperscript{1}H NMR Spectra of 10

![NMR Spectra of 10](image)
Fig: 2.6; $^1$H NMR Spectra of 12a

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PROCNO 1
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Time_ 15.24
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PULPROG zg
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FIDRES 0.391251 Hz
AQ 1.2780020 sec
RG 4096
DW 78.000 usec
DE 97.50 usec
TE 300.0 K
HL1 1 dB
DI 1.0000000 sec
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NUCLEUS 1H
F2 - Processing parameters
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SP 400.1343945 MHz
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SSB 0
LB 0.30 Hz
GB 0
PC 2.00
Fig. 2.8; $^1$H NMR Spectra of 13a

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EXPNO  3
PROCNO  1

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Time  13.36
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PULPROG  zg
TD  16384
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NS  128
DS  0
SWH  6410.256 Hz
FIDRES  0.391251 Hz
AQ  1.2780020 sec
RG  2048
DW  78.000 usec
DE  111.43 usec
TE  300.0 K
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D1  1.00000000 sec
F1  11.50 usec
SFO1  400.1392826 MHz
NUCLEUS  1H

F2 - Processing Parameters
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WDW  EM
SSB  0
LB  0.30 Hz
GB  0
PC  1.00
Fig. 2.9; Mass Spectrum of 13a
Experimental

**Ethyl naphtho[2,1-b]furan-2-carboxylate 9**

A mixture of 2-hydroxy-1-naphthaldehyde 8 (1.72 g, 10 mmol), ethyl chloroacetate (1.22 g, 10 mmol) and potassium carbonate (6.1 g, 50 mmol) in DMF (15 mL) was subjected to microwave for 3-4 min in a domestic oven (Whirlpool) at 500 W (50% of total power) as required to complete the reaction (TLC). The reaction mixture was cooled and poured into ice-cooled water. The solid obtained was recrystallized from ethyl acetate to obtain 9 in 80-90% yield.

**Naphtho[2,1-b]furan-2-carbohydrazide 10**

An equimolar mixture of 9 (2.2 g, 10 mmol) and hydrazine hydrate (99%) (0.50 g, 10 mmol) in absolute ethanol (10 mL) was irradiated for 4-5 min in presence of catalytic amount of acid. After completion of the reaction (TLC), the reaction mixture was cooled and poured into ice-cooled water. The product separated as solid was recrystallized from ethyl acetate to obtain 10 in 80-85% yield.

**N-{(2-aminophenyl)methylene}naphtho[2,1-b]furan-2-carbohydrazide 12**

The compound 10 (2.2 g, 10 mmol) and 2-amino benzaldehyde (1.2 g, 10 mmol) 11a in ethanol (10 mL) was exposed to pulsed microwave irradiation using an unmodified microwave oven for 2-3 min in presence of catalytic amount of acetic acid. After completion of the reaction (TLC), the reaction mixture was poured onto crushed ice, the solid mass that separated out was filtered, wash with water and dried to gave the desired compounds 12a in 70-75% yields. Similarly, compounds 12b-l were synthesized.
**Synthesis of 3-(naphtho[2,1-b]furan-2-ylcarbonyl)-3H-1,3,4-benzotriazepine 13a-l**

**General procedure:** A dilute solution of compound 12a-l (1.6 g, 5 mmol) in triethyl ortho formate (5 mL) was irradiated until completion (TLC monitoring, 5 min). After cooling, the reaction mixture was poured into ice-cold water to obtain solid, which was recrystallized from ethanol to get crude compound. The crude product was purified by column chromatography on silica gel {eluent: ethyl acetate: petroleum-ether (bp 40°C-60 °C)=1:9}.

**3-(Naphtho[2,1-b]furan-2-ylcarbonyl)-3H-1,3,4-benzotriazepine (13a)**

Brown solid, (65%), mp 173-174 °C, MS m/z: (M⁺) 339;

Anal. Calcd for C_{21}H_{13}N_{3}O_{2}: C 74.33, H 3.86, N 12.38,

Found: C 74.43, H 3.76, N 12.45; IR (KBr) γ_{max}/cm⁻¹:

1360 (C-N), 1532 (C=C), 1610 (C=N), 1683 (C=O); ¹H

NMR (400 MHz, DMSO): δ 7.41-8.90 (m, 11H, Ar-H),

8.42 (s, 1H, N-CH=N), 8.53 (s, 1H, HC=N); ¹³C NMR (DMSO) δ: 159.21 (C=N), 189.17 (C=O), [113.27 (C-9), 114.14 (C-3), 124.89 (C-5), 127.71 (C-4), 131.28 (C-8), 136.16 (C-11), naphthofuran carbons].

**8-Methyl-3-(naphtho[2,1-b]furan-2-ylcarbonyl)-3H-1,3,4-benzotriazepine (13b)**

Brown solid, (67 %), mp 173-179 °C, MS m/z: (M⁺) 353;

Anal. Calcd for C_{22}H_{15}N_{3}O_{2}: C 74.78, H 4.28, N 11.89,

Found: C 74.56, H 4.35, N 11.75; IR (KBr) γ_{max}/cm⁻¹:

1362 (C-N), 1531 (C=C), 1609 (C=N), 1684 (C=O); ¹H

NMR (400 MHz, DMSO): δ 1.15 (s, 3H, CH₃), 7.42-8.93 (m, 10H, Ar-H), 8.43 (s, 1H, N-CH=N), 8.51 (s, 1H, HC=N); ¹³C NMR (DMSO) δ: 36.23
(CH₃), 143.15 (C-CH₃), 159.19 (C=N), 189.20 (C=O), [113.26 (C-9), 114.12 (C-3), 124.87 (C-5), 127.73 (C-4), 131.27 (C-8), 136.15 (C-11), naphthofuran carbons].

7-Methyl-3-(naphtho[2,1-b]furan-2-ylcarbonyl)-3H-1,3,4-benzotriazepine (13c)

Brown solid, (72 %), mp 176-179 °C, MS m/z: (M⁺) 353; Anal.Calcd for C₂₂H₁₅N₃O₂: C 74.78, H 4.28, N 11.89, Found: C 74.65, H 4.32, N 11.79; IR (KBr) νmax/cm⁻¹: 1360 (C-N), 1536 (C=C), 1610 (C=N), 1683 (C=O); ¹H NMR (400 MHz, DMSO): δ 1.13 (s, 3H, CH₃), 8.41 (s, 1H, N-CH=N), 8.51 (s, 1H, HC=N), 7.43-8.90 (m, 10H, Ar-H); ¹³C NMR (DMSO) δ: 36.16 (CH₃), 143.16 (C-CH₃), 159.18 (C=N), 189.18 (C=O), [113.25 (C-9), 114.13 (C-3), 124.88 (C-5), 127.74 (C-4), 131.29 (C-8), 136.14 (C-11), naphthofuran carbons].

6-Methyl-3-(naphtho[2,1-b]furan-2-ylcarbonyl)-3H-1,3,4-benzotriazepine (13d)

Brown solid, (75 %), mp 175-178 °C, MS m/z: (M⁺) 353; Anal.Calcd for C₂₂H₁₅N₃O₂: C 74.78, H 4.28, N 11.89, Found: C 74.75, H 4.35, N 11.69; IR (KBr) νmax/cm⁻¹: 1361 (C-N), 1531 (C=C), 1608 (C=N), 1682 (C=O); ¹H NMR (400 MHz, DMSO): δ 1.12 (s, 3H, CH₃), 7.41-8.91 (m, 10H, Ar-H), 8.42 (s, 1H, N-CH=N), 8.53 (s, 1H, HC=N); ¹³C NMR (DMSO) δ: 36.13 (CH₃), 143.13 (C-CH₃), 159.21 (C=N), 189.17 (C=O), [113.26 (C-9), 114.11 (C-3), 124.89 (C-5), 127.73 (C-4), 131.28 (C-8), 136.15 (C-11), naphthofuran carbons].
8-Methoxy-3-(naphtho[2,1-b]furan-2-ylcarbonyl)-3H-1,3,4-benzotriazepine (13e)

Brown solid, (82 %), mp 180-183 °C, MS m/z: (M⁺) 369;
Anal. Calcd for C₂₂H₁₅N₃O₃: C 71.54, H 4.09, N 11.38,
Found: C 71.65, H 4.05, N 11.45; IR (KBr) γ_max/cm⁻¹:
1361 (C-N), 1532 (C=C), 1609 (C=N), 1684 (C=O); ¹H NMR (400 MHz, DMSO): 3.82 (s, 3H, OCH₃), 7.42-8.91 (m, 10H, Ar-H), 8.41 (s, 1H, N-CH=N), 8.54 (s, 1H, HC=N); ¹³C NMR (DMSO) δ:
56.26 (OCH₃), 159.18 (C=N), 159.92 (C-OCH₃), 189.18 (C=O), [113.25 (C-9), 114.14 (C-3), 124.87 (C-5), 127.71 (C-4), 131.25 (C-8), 136.17 (C-11), naphthofuran carbons].

7-Methoxy-3-(naphtho[2,1-b]furan-2-ylcarbonyl)-3H-1,3,4-benzotriazepine (13f)

Brown solid, (80 %), mp 183-185 °C, MS m/z: (M⁺) 369; Anal. Calcd for C₂₂H₁₅N₃O₃: C 71.54, H 4.09, N 11.38, Found: C 71.62, H 4.08, N 11.43; IR (KBr) γ_max/cm⁻¹: 1363 (C-N), 1532 (C=C), 1608 (C=N), 1682 (C=O); ¹H NMR (400 MHz, DMSO): 3.81 (s, 3H, OCH₃), 7.40-8.93 (m, 10H, Ar-H), 8.43 (s, 1H, N-CH=N), 8.52 (s, 1H, HC=N); ¹³C NMR (DMSO) δ: 56.16 (OCH₃), 159.21 (C=N), 159.90 (C-OCH₃), 189.16 (C=O), [113.26 (C-9), 114.12 (C-3), 124.87 (C-5), 127.73 (C-4), 131.27 (C-8), 136.15 (C-11), naphthofuran carbons].

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1, 3, 4-benzotriazepines

6-Methoxy-3-(naphtho[2,1-b]furan-2-ylcarbonyl)-3H-1,3,4-benzotriazepine (13g)

Brown solid, (83 %), mp 180-182 °C, MS m/z: (M⁺) 369; Anal.Calcd for C₂₂H₁₅N₃O₃: C 71.54, H 4.09, N 11.38, Found: C 71.52, H 4.02, N 11.45; IR (KBr) γmax/cm⁻¹: 1360 (C-N), 1533 (C=C), 1609 (C=N), 1684 (C=O); ¹H NMR (400 MHz, DMSO): 3.84 (s, 3H, OCH₃), 7.41-8.92 (m, 10H, Ar-H), 8.41 (s, 1H, N-CH=N), 8.53 (s, 1H, HC=N); ¹³C NMR (DMSO) δ: 56.28 (OCH₃), 159.15 (C=N), 159.95 (C-OCH₃), 189.19 (C=O), [113.25 (C-9), 114.14 (C-3), 124.87 (C-5), 127.71 (C-4), 131.25 (C-8), 136.17 (C-11), naphthofuran carbons].

8-Bromo-3-(naphtho[2,1-b]furan-2-ylcarbonyl)-3H-1,3,4-benzotriazepine (13h)

Brown solid, (85 %), mp 186-188 °C, MS m/z: (M⁺) 418; Anal.Calcd for C₂₁H₁₂N₃O₂Br: C 60.31, H 2.89, N 10.05, Found: C 60.45, H 2.83, N 10.15; IR (KBr) γmax/cm⁻¹: 1361 (C-N), 1532 (C=C), 1610 (C=N), 1683 (C=O); ¹H NMR (400 MHz, DMSO): δ 7.40-8.91 (m, 10H, Ar-H), 8.43 (s, 1H, N-CH=N), 8.51 (s, 1H, HC=N); ¹³C NMR (DMSO) δ: 125.51 (C-Br), 159.21 (C=N), 189.16 (C=O), [113.27 (C-9), 114.14 (C-3), 124.89 (C-5), 127.71 (C-4), 131.28 (C-8), 136.16 (C-11), naphthofuran carbons].
8-Chloro-3-(naphtho[2,1-b]furan-2-ylcarbonyl)-3H-1,3,4-benzotriazepine (13i)

Brown solid, (75 %), mp 196-198 °C, MS m/z: (M⁺) 373; Anal. Calcd for C₂₁H₁₂N₃O₂Cl: C 67.48, H 3.24, N 11.24, Found: C 67.35, H 3.28, N 11.56; IR (KBr) \( \gamma_{\text{max}}/\text{cm}^{-1} \): 1361 (C=N), 1532 (C=C), 1609 (C=N), 1682 (C=O); \(^1\text{H} \text{NMR (400 MHz, DMSO)}: \delta 7.43-8.93 (m, 10H, Ar-H), 8.43 (s, 1H, N-CH=N), 8.52 (s, 1H, HC=N); \(^{13}\text{C} \text{NMR (DMSO)}: \delta 134.52 (C-Cl), 159.21 (C=N), 189.17 (C=O), [113.26 (C-9), 114.12 (C-3), 124.87 (C-5), 127.73 (C-4), 131.27 (C-8), 136.15 (C-11), naphthofuran carbons].

7-Chloro-3-(naphtho[2,1-b]furan-2-ylcarbonyl)-3H-1,3,4-benzotriazepine (13j)

Brown solid, (78 %), mp 194-196 °C, MS m/z: (M⁺) 373; Anal. Calcd for C₂₁H₁₂N₃O₂Cl: C 67.48, H 3.24, N 11.24, Found: C 67.45, H 3.38, N 11.46; IR (KBr)

\( \gamma_{\text{max}}/\text{cm}^{-1} \): 1360 (C=N), 1531 (C=C), 1609 (C=N), 1685 (C=O); \(^1\text{H} \text{NMR (400 MHz, DMSO)}: \delta 7.40-8.91 (m, 10H, Ar-H), 8.42 (s, 1H, N-CH=N), 8.53 (s, H, HC=N); \(^{13}\text{C} \text{NMR (DMSO)}: \delta 134.55 (C-Cl), 159.23 (C=N), 189.15 (C=O), [113.25 (C-9), 114.13 (C-3), 124.88 (C-5), 127.74 (C-4), 131.29 (C-8), 136.14 (C-11), naphthofuran carbons].
7,8-Dimethoxy-3-(naphtho[2,1-b]furan-2-ylcarbonyl)-3H-1,3,4-benzotriazepine (13k)

Brown solid, (80 %), mp 183-185 °C, MS m/z: (M+) 339; Anal.Calcd for C_{23}H_{17}N_{3}O_{4}: C 69.17, H 4.29, N 10.52, Found: C 69.23, H 4.38, N 10.57; IR (KBr) \( \gamma_{\text{max/cm}^{-1}} \): 1361 (C-N), 1531 (C=C), 1608 (C=N), 1685 (C=O); \(^1\)H NMR (400 MHz, DMSO): 3.85 (s, 6H, OCH\(_3\)), 7.41-8.92 (m, 9H, Ar-H), 8.42 (s, 1H, N-CH=N), 8.52 (s, 1H, HC=N); \(^{13}\)C NMR (DMSO) \( \delta \): 56.16 (OCH\(_3\)), 159.17 (C=N), 159.93 (C-OCH\(_3\)), 189.17 (C=O), [113.25 (C-9), 114.14 (C-3), 124.87 (C-5), 127.71 (C-4), 131.25 (C-8), 136.17 (C-11), naphthofuran carbons].

7,8,9-Trimethoxy-3-(naphtho[2,1-b]furan-2-ylcarbonyl)-3H-1,3,4-benzotriazepine (13l)

Brown solid, (75 %), mp 180-183 °C, MS m/z: (M+) 429; Anal.Calcd for C_{24}H_{20}N_{3}O_{5}: C 67.13, H 4.46, N 9.79, Found: C 67.34, H 4.35, N 9.86; IR (KBr) \( \gamma_{\text{max/cm}^{-1}} \): 1362 (C-N), 1531 (C=C), 1610 (C=N), 1683 (C=O); \(^1\)H NMR (400 MHz, DMSO): 3.82 (s, 9H, OCH\(_3\)), 7.42-8.93 (m, 8H, Ar-H), 8.42 (s, 1H, N-CH=N), 8.52 (s, 1H, HC=N); \(^{13}\)C NMR (DMSO) \( \delta \): 56.28 (OCH\(_3\)), 159.16 (C=N), 159.91 (C-OCH\(_3\)), 189.21 (C=O), [113.26 (C-9), 114.12 (C-3), 124.87 (C-5), 127.73 (C-4), 131.27 (C-8), 136.15 (C-11), naphthofuran carbons].
References


1. 3, 4-benzotriazepines


