Microwave assisted synthesis of naphtho[2,1-*b*]furan-1, 3, 4-benzotriazepines: a potent antimicrobial agent

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Abstract

Synthesis of 3-{naphtho[2,1-*b*]furan-2-ylcarbonyl}-3*H*-1,3,4-benzotriazepine 6 was reported. The conversion of 3 into various substituted derivatives of schiff bases by reacting with substituted 2-aminobenzaldehyde 4, which intern cyclise in presence of triethyl ortho formate to produce the title compounds. The structures of all the newly synthesized compounds have been established by ^{1}H NMR, IR, Mass spectra and elemental analysis. The selected compounds have been screened for antibacterial and antifungal activities.

Keywords: 2-Hydroxy-1-naphthaldehyde, 2-aminobenzaldehyde, schiff base, triethyl ortho formate, microwave, 1,3,4-benzotriazepine

Introduction

Synthetic potential and biological activity of benzodiazepines has been explored to the maximum extent and several heterocyclic systems containing 1,2-benzodiazepines have been reported in the literature.[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] Such a versatile biological activity of the benzodiazepine pharmacophore has prompted investigations into nitrogen homologues, the benzotrizepines,[9,10] in order to find new therapeutical leads. In this lead a great number of publications are come out on 1,3,5 benzotriazepines,[11-15] but little work has been carried on 1,3,4-benzotrizepines.[16,17] Moreover, naphthofuran heterocycles present in many natural products were reported to possess biological activities.[18-21] Recently, naphthofuran

heterocycles synthesized in our laboratory [22-26] have exhibited significant biological activities. The conventional procedures are not fully satisfactory with regard to operational simplicity, cost of the reagent and isolated yield. In recent years, microwave irradiation has been demonstrated not only to dramatically accelerate many organic reactions, but also to improve yields and selectivity [27-30]. Thus, the drive continues to find a better and improved methodology. Encouraged by their potential clinical applications and as part of our search to synthesis new active compounds by combining two active molecules by microwave irradiation, we report herein a successful annulation of naphthofuran with benzotriazepines by microwave method and screening them for antimicrobial activities.

Results and Discussion

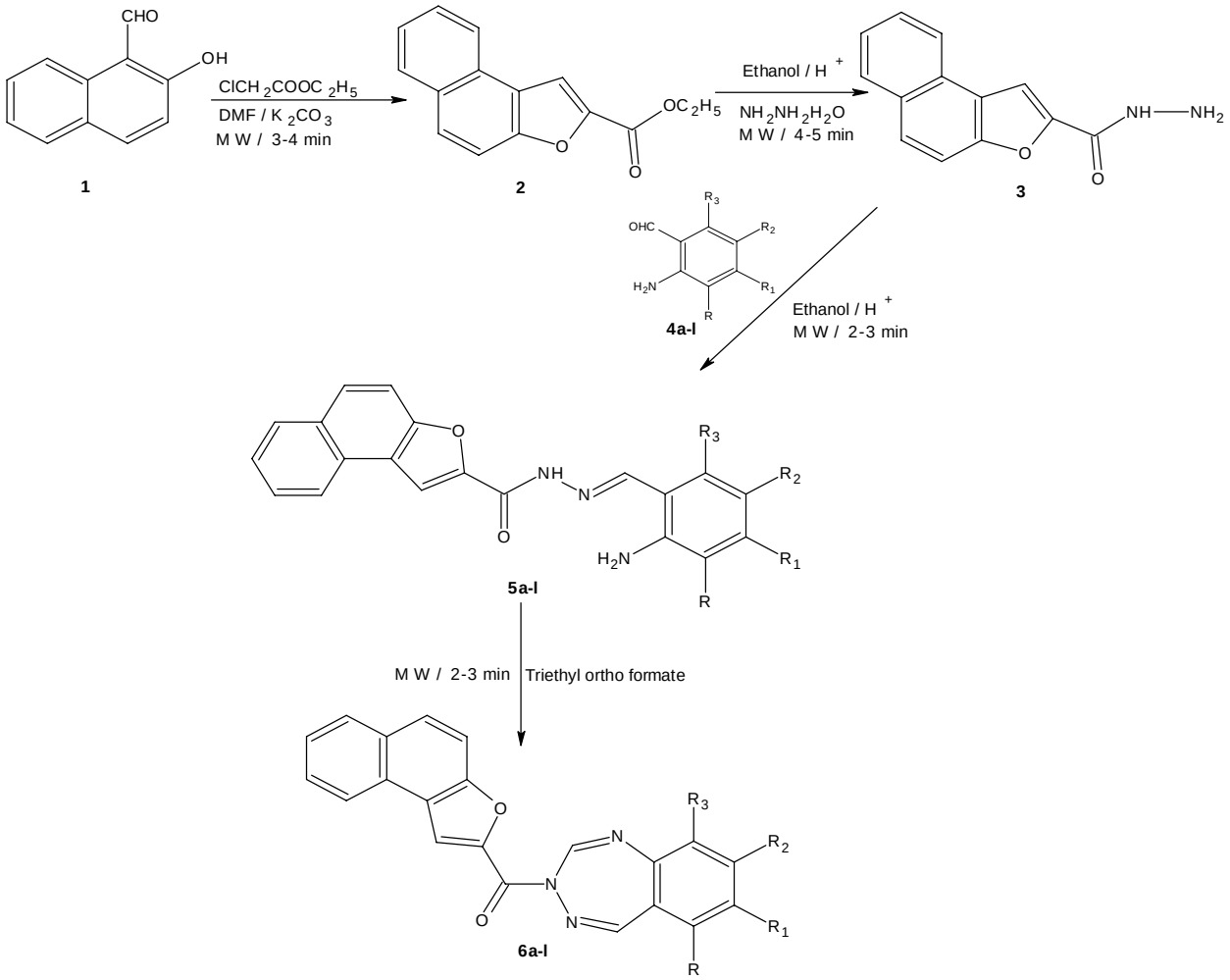
We initially prepared ethyl naphtho[2,1-*b*]furan-2-carboxylate **2** from 2-hydroxy-1-naphthaldehyde on reacting with ethyl chloro acetate in potassium carbonate and DMF by microwave irradiation. The identity of the product was determined by IR and ^{1}H NMR spectral studies. IR spectrum of compound **2** exhibited absorption frequency at 1732 cm^{-1} for carbonyl group. 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 δ 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-C & 6-C resonate as triplets at δ 7.60 ppm (J=7 Hz) and δ 7.70 ppm (J=7 Hz) respectively. 8-C and 9-C resonate as doublet at δ 7.90 ppm (J=9 Hz) & δ 8.45 ppm (J=8 Hz), 3-C resonate at δ 8.50 ppm as singlet and 4-C & 7-C at δ 8.05-8.15 ppm as a double doublet (J=8 Hz) confirms the structure of naphthofuran. Also, its Mass spectra revealed a molecular ion peak at m/z 240 (M^+) corresponding to the molecular formula $C_{15}H_{12}O_3$. The compound **2** was made to react with hydrazine hydrate at acidic condition in ethanol under microwave produce naphtho[2,1-*b*]furan-2-carbohydrazide **3**. The structure of **3** was confirmed by IR, ^{1}H NMR and Mass spectral technique. IR showed the absence of ester stretching frequency, instead it gave band at 1657 cm^{-1} for carbonyl group and showing two sharp bands in the region of 3300-3400 cm^{-1} due to -NH & –NH_2 groups. ^{1}H NMR spectrum of compound **3** exhibited no peak corresponds to ester instead it showed signals at δ 10.1 ppm and δ 4.6 ppm for -NH and -NH_2 (D_2O exchangeable) of hydrazide respectively. The structure was further confirmed by recording its Mass spectra. It gave the molecular ion peak at m/z 226 (M^+) corresponds to the molecular formula $C_{13}H_{10}N_2O_2$.

To prepare *N*-{-(2-aminophenyl)methylene}naphtho[2,1-*b*]furan-2-carbohydrazides **5a-l**, the compound **3** was treated with substituted 2-aminobenzaldehyde **4a-l** in presence of catalytic amount of acetic acid in ethanol under microwave irradiation. The structure of compound **5a** was elucidated by spectroscopic data. The IR spectrum of **5a** exhibit absorption band at 1602 cm^{-1} due to -C=N and amide stretching frequency remain at 1655 cm^{-1}. ^{1}H NMR of **5a** exhibits multiplets at δ 7.65-8.55 ppm for 11 aromatic protons. Where as -NH proton found to resonate

at δ 12.21 ppm (D_2O exchangeable) and $–NH_2$ protons (D_2O exchangeable) appeared at δ 9.52 ppm as a singlet.

In order to obtain the title compounds 3-(naphtho[2,1-*b*]furan-2-ylcarbonyl)-3*H*-1,3,4-benzotriazepine **6a-l**, the compounds **5a-l** was dissolved in excess of triethyl ortho formate and was irradiated in microwave oven with short interceptions of 30 Sec to avoid the excess evaporation of triethyl ortho formate. As a typical example, the structure of the resulting molecule **6a** was confirmed by its IR, NMR and Mass spectral studies. The IR spectra of the compound revealed two strong absorption bands at 1610 cm^{-1} and 1685 cm^{-1} for C=O & C=N group respectively. Further, ^1H NMR spectrum exhibited multiplets in the region 7.60-8.90 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 δ 8.42 & 8.53 ppm respectively. It gave molecular ion peak at m/z 339(M^+) confirms the assigned structure to the molecule (Scheme 1). 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 given in appropriate place and are in agreement with the assigned structures.

In conclusion, the present protocol describes a simple and efficient method for the synthesis 1,3,4 benzotrizepines by different schiff bases of naphtho[2,1-*b*]furan and 2-aminobenzaldehyde. It has been demonstrated that cyclocondensation of schiff bases with triethyl ortho formate proceeded with fairly high yields in a relatively short reaction time and easy work-up procedures. These conditions enable this method to be good protocol for the synthesis naphtho[2,1-*b*]furan based 1,3,4 benzotrizepines heterocycles.



	R	R_1	R_2	R_3					
a.	H	H	H	H	b.	H	H	CH_3	H
c.	H	CH_3	H	H	d.	CH_3	H	H	H
e.	H	H	OCH_3	H	f.	H	OCH_3	H	H
g.	OCH_3	H	H	H	h.	H	H	Br	H
i.	H	H	Cl	H	j.	H	Cl	H	H
k.	H	OCH_3	OCH_3	H	l.	H	OCH_3	OCH_3	OCH_3

Scheme 1. General synthetic procedure of naphtho[2,1-*b*]furan-1,3,4-benzotriazepines **6a-l**

Experimental Section

General Procedures. All the chemicals used were of analytical reagent grade. Melting points were determined in open capillary and uncorrected. Purity of the compounds was checked by TLC on silica gel and purified by column chromatography. ^{1}H NMR was obtained on a Bruker supercon FT NMR (400 MHz) spectrometer using DMSO-d_6 as solvent, TMS as internal

standard and chemical shifts are expressed in δ units. IR spectra are recorded on a Perkin Elmer 157 Infrared spectrophotometer. Mass spectra were performed on a Jeol JMS-D 300 Mass spectrometer operating at 70 eV. Thin layer chromatography was carried out on 5x20 cm plates coated with silica gel GF 254 type 60-mesh size 50-250. The microwave-assisted procedures were carried out in a Whirlpool Microwave oven operating at 1000 W.

Evaluation of antimicrobial activity. The *in vitro* antimicrobial activity was carried out against 24 hr old cultures of two bacteria and two fungi by cup-plate method.[31] Compounds **6a-l** (except 6b, 6d, 6f, 6g, and 6j) have been tested for their antibacterial activity against *Pseudomonas aerugenosa* and *Staphylococcus aureus* and antifungal activity against *Aspergillus niger* and *Candida albicans.* Nutrient agar and potato dextrose agars were used to culture the bacteria and fungus respectively. The compounds were tested at a concentration of 0.005 mol / ml in DMF solution. The solution of Chloramphenicol (2 mg/ ml) and Flucanazole (2 mg/ ml) were prepared in sterilized water and used as standards for comparison of antibacterial and antifungal activities respectively. The compounds were tested at varied concentration. The minimum inhibition concentration was found to be 0.001mol/ ml in DMF against all organisms. Inhibition was recorded by measuring the diameter of the inhibition zone at the end of 24 h for bacteria at 28^0C and 48 h for fungus at 35^0C. Each experiment was repeated thrice and the average of the three independent determinations was recorded. The protocols were summarized in (Table 1). The compounds 6h, 6k, and 6l were found to be more active against *P. aerugenosa* and the compounds 6k, 6l, 6e and 6h were found to exhibit more activity against *S. aureus*. The compounds 6i, 6h, 6k and 6e against *A. niger* and compounds 6l, 6i and 6e against *C. albicans* exhibited significant antifungal activity.

Table 1. Antimicrobial activity of the compounds **6a-l**

Compd.	Antibacterial activity Zone of inhibition in mm		Antifungal activity Zone of inhibition in mm	
	P.aerugenosa	*S. aureus*	*A. niger*	*C. albicans*
6a	14	14	13	14
6c	15	14	-	15
6e	-	15	15	16
6h	17	15	16	-
6i	15	-	17	16
6k	16	16	15	15
6l	15	16	-	16
Chloramphenicol	22	24	-	-
Flucanazole	-	-	25	26

Diameter of the well,
Control (DMF) (-) - No activity.
Highly active (inhibition zone > 12 mm);

Moderately active (inhibition zone 9-12 mm);
Slightly active (inhibition zone 6-9 mm);
Inactive - inhibition zone < 6 mm).

Ethyl naphtha[2,1-*b*]furan-2-carboxylate (2). A mixture of 2-hydroxy-1-naphthaldehyde **1** (1.72 g, 10 mmol), chloro ethyl acetate (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 gave **2** in 80-90% yields.

Naphtho[2,1-*b*]furan-2-carbohydrazide (3). An equimolar mixture of **2** (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 **3** in 80-85% yields.

***N*-{(2-Aminophenyl)methylene}naphtho[2,1-*b*]furan-2-carbohydrazide (5).** The compound **3** (2.2 g, 10 mmol) and 2-amino benzaldehyde (1.2 g, 10 mmol) **4a** 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 conclusion 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 give the desired compounds **5a** in 70-75% yields. Similarly, compounds **5b-l** was synthesized and characterization data of **5a-l** are given in appropriate place.

Synthesis of 3-(naphtho[2,1-*b*]furan-2-ylcarbonyl)-3*H*-1, 3,4-benzotriazepine (6a-l). General procedure. A dilute solution of compound **5a-l** (1.6 g, 5 mmol) in triethyl ortho formate was irradiated until completion (TLC monitoring, 5 min). After cooling, the reaction mixture on pouring into ice-cold water gave solid, which was recrystallized from ethanol to obtain crude compound. Thus crude product was purified by column chromatography on silica gel {eluent: ethyl acetate: petroleum-ether (bp 40 ^{o}C-60 ^{o}C)=1:9}.

3-(Naphtho[2,1-*b*]furan-2-ylcarbonyl)-3*H*-1, 3,4-benzotriazepine (6a). Brown solid, (65%), Mp 173-74 ^{o}C, MS: (M^{+}) 339; Anal.Calcd for $C_{21}H_{13}N_3O_2$: C 74.33, H 3.86, N 12.38. Found: C 74.43, H 3.76, N 12.45. IR (KBr, cm^{-1}): 1320 (C-N), 1595 (C=C), 1603 (C=O), 1689 (C=N). ^{1}H NMR (400 MHz, DMSO): δ 6.98-8.65 (m, 11H, Ar-H), 8.42 (s, 1H, N-CH=N), 8.51 (s, 1H, HC=N), ^{13}C 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 (6b). Brown solid, (67 %), Mp 177-179 ^{o}C, MS: (M^{+}) 353; Anal.Calcd for $C_{22}H_{15}N_3O_2$: C 74.78, H 4.28, N 11.89, Found: C 74.56, H 4.35, N 11.75. IR (KBr, cm^{-1}): 1322 (C-N), 1598 (C=C), 1605 (C=O), 1687 (C=N). ^{1}H NMR (400 MHz, DMSO): δ 1.15 (s, 3H, CH_3), 6.98-8.63 (m, 10H, Ar-H), 8.43 (s, 1H, N-CH=N), 8.51 (s, 1H, HC=N), ^{13}C NMR (DMSO) δ: 36.23 (CH_3), 137.15 (C-CH_3), 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)-3*H*-1,3,4-benzotriazepine (6c). Brown solid, (72 %), Mp 176-179 ^{o}C, MS: (M^{+}) 353; Anal.Calcd for $C_{22}H_{15}N_3O_2$: C 74.78, H 4.28, N 11.89, Found: C 74.65, H 4.32, N 11.79. IR (KBr, cm^{-1}): 1320 (C-N), 1596 (C=C), 1610 (C=O), 1685 (C=N). ^{1}H NMR (400 MHz, DMSO): δ 1.13 (s, 3H, CH_3), 8.41 (s, 1H, N-CH=N), 8.51 (s, 1H, HC=N), 6.98-8.63 (m, 10H, Ar-H), ^{13}C NMR (DMSO) δ: 36.16 (CH_3), 137.16 (C-CH_3), 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)-3*H*-1,3,4-benzotriazepine (6d). Brown solid, (75 %), Mp 175-178 ^{o}C, MS: (M^{+}) 353; Anal.Calcd for $C_{22}H_{15}N_3O_2$: C 74.78, H 4.28, N 11.89, Found: C 74.75, H 4.35, N 11.69. IR (KBr, cm^{-1}): 1321 (C-N), 1603 (C=C), 1602 (C=O), 1687 (C=N). ^{1}H NMR (400 MHz, DMSO): δ 1.12 (s, 3H, CH_3), 6.98-8.66 (m, 10H, Ar-H), 8.42 (s, 1H, N-CH=N), 8.53 (s, 1H, HC=N), ^{13}C NMR (DMSO) δ: 36.13 (CH_3), 137.13 (C-CH_3), 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)-3*H*-1,3,4-benzotriazepine (6e). Brown solid, (82 %), Mp 180-183 ^{o}C, MS: (M^{+}) 369; Anal.Calcd for $C_{22}H_{15}N_3O_3$: C 71.54, H 4.09, N 11.38, Found: C 71.65, H 4.05, N 11.45. IR (KBr, cm^{-1}): 1322 (C-N), 1601 (C=C), 1612 (C=O), 1686 (C=N). ^{1}H NMR (400 MHz, DMSO): 3.82 (s, 3H, OCH_3), 6.98-8.70 (m, 10H, Ar-H), 8.41 (s, 1H, N-CH=N), 8.54 (s, 1H, HC=N), ^{13}C NMR (DMSO) δ: 56.26 (OCH_3), 159.18 (C=N), 159.41 (C-OCH_3), 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)-3*H*-1,3,4-benzotriazepine (6f). Brown solid, (80 %), Mp 183-185 ^{o}C, MS: (M^{+}) 369; Anal.Calcd for $C_{22}H_{15}N_3O_3$: C 71.54, H 4.09, N 11.38, Found: C 71.62, H 4.08, N 11.43. IR (KBr, cm^{-1}): 1323 (C-N), 1605 (C=C), 1608 (C=O), 1685 (C=N). ^{1}H NMR (400 MHz, DMSO): 3.81 (s, 3H, OCH_3), 6.98-8.63 (m, 10H, Ar-H), 8.43 (s, 1H, N-CH=N), 8.52 (s, 1H, HC=N), ^{13}C NMR (DMSO) δ: 56.16 (OCH_3), 159.21 (C=N), 159.43 (C-OCH_3), 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].

6-Methoxy-3-(naphtho[2,1-*b*]furan-2-ylcarbonyl)-3*H*-1,3,4-benzotriazepine (6g). Brown solid, (83 %), Mp 180-182 ^{o}C, MS: (M^{+}) 369; Anal.Calcd for $C_{22}H_{15}N_3O_3$: C 71.54, H 4.09, N 11.38, Found: C 71.52, H 4.02, N 11.45. IR (KBr, cm^{-1}): 1320 (C-N), 1603 (C=C), 1608 (C=O), 1687 (C=N). ^{1}H NMR (400 MHz, DMSO): 3.84 (s, 3H, OCH_3), 6.98-8.63 (m, 10H, Ar-H), 8.41 (s, 1H, N-CH=N), 8.53 (s, 1H, HC=N), ^{13}C NMR (DMSO) δ: 56.28 (OCH_3), 159.15 (C=N), 159.41 (C-OCH_3), 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)-3*H*-1,3,4-benzotriazepine (6h). Brown solid, (85 %), Mp 186-188 ^{o}C, MS: (M^{+}) 418; Anal.Calcd for $C_{21}H_{12}N_3O_2Br$: C 60.31, H 2.89, N 10.05, Found: C 60.45, H 2.83, N 10.15. IR (KBr, cm^{-1}): 1323 (C-N), 1605 (C=C), 1605 (C=O), 1685 (C=N). ^{1}H NMR (400 MHz, DMSO): δ 6.98-8.63 (m, 10H, Ar-H), 8.43 (s, 1H, N-CH=N), 8.51 (s, 1H, HC=N), ^{13}C NMR (DMSO) δ: 123.51 (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)-3*H*-1,3,4-benzotriazepine (6i). Brown solid, (75 %), Mp 196-198 ^{o}C, MS: (M^{+}) 373; Anal.Calcd for $C_{21}H_{12}N_3O_2Cl$: C 67.48, H 3.24, N 11.24, Found: C 67.35, H 3.28, N 11.56. IR (KBr, cm^{-1}): 1321 (C-N), 1602 (C=C), 1603 (C=O), 1683 (C=N). ^{1}H NMR (400 MHz, DMSO): δ 6.95-8.63 (m, 10H, Ar-H), 8.43 (s, 1H, N-CH=N), 8.52 (s, 1H, HC=N), ^{13}C NMR (DMSO) δ: 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)-3*H*-1,3,4-benzotriazepine (6j). Brown solid, (78 %), Mp 194-196 ^{o}C, MS: (M^{+}) 373; Anal.Calcd for $C_{21}H_{12}N_3O_2Cl$: C 67.48, H 3.24, N 11.24, Found: C 67.45, H 3.38, N 11.46. IR (KBr, cm^{-1}): 1320 (C-N), 1603 (C=C), 1605 (C=O), 1685 (C=N). ^{1}H NMR (400 MHz, DMSO): 6.98-8.63 (m, 10H, Ar-H), 8.42 (s, 1H, N-CH=N), 8.53 (s, H, HC=N), ^{13}C NMR (DMSO) δ: 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)-3*H*-1,3,4-benzotriazepine (6k). Brown solid, (80 %), Mp 183-185 ^{o}C, MS: (M^{+}) 339; Anal.Calcd for $C_{23}H_{17}N_3O_4$: C 69.17, H 4.29, N 10.52, Found: C 69.23, H 4.38, N 10.57. IR (KBr, cm^{-1}): 1323 (C-N), 1605 (C=C), 1608 (C=O), 1685 (C=N). ^{1}H NMR (400 MHz, DMSO): 3.78 (s, 3H, OCH_3), 3.85 (s, 3H, OCH_3), 6.98-8.63 (m, 10H, Ar-H), 8.42 (s, 1H, N-CH=N), 8.52 (s, 1H, HC=N), ^{13}C NMR (DMSO) δ: 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)-3*H*-1,3,4-benzotriazepine (6l). Brown solid, (75 %), Mp 180-183 ^{o}C, MS: (M^{+}) 429; Anal.Calcd for $C_{24}H_{20}N_3O_5$: C 67.13, H 4.46, N 9.79, Found: C 67.34, H 4.35, N 9.86. IR (KBr, cm^{-1}): 1322 (C-N), 1601 (C=C), 1612 (C=O), 1686 (C=N). ^{1}H NMR (400 MHz, DMSO): 3.65 (s, 3H, OCH_3), 3.73 (s, 3H, OCH_3), 3.82 (s, 3H, OCH_3), 6.98-8.63 (m, 10H, Ar-H), 8.42 (s, 1H, N-CH=N), 8.52 (s, 1H, HC=N), ^{13}C NMR (DMSO) δ: 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].

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