Synthesis and characterization of 1-benzofuran-2-yl thiadiazoles, triazoles and oxadiazoles by conventional and non-conventional methods

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2.1. Introduction

Benzofuran compounds are associated with various physiological and biological properties and thus find important use in various therapeutic areas. In nature's collection of biologically active heterocycles, benzo[b]furan derivatives\(^1\)\(^-\)\(^3\) constitutes a major group. They are usually important constituents of plant extracts used in traditional medicine.\(^2\) Recently, a number of benzofuran analogues have been studied as potential inhibitors of 3-amyloid formation\(^4\) and HUVEC.\(^5\)

Thiadiazole derivatives are highly potent inhibitors of HIV-1\(^6\)\(^a\) and useful as anti-inflammatory\(^6\)\(^b\) and anti-arrhythmic agents.\(^6\)\(^c\) In addition, it is a common structural feature in many biologically active molecules which are used clinically in the treatment of some forms of epilepsy.\(^6\)\(^d\) The complexes of thiadiazole derivatives are showing antifungal,\(^7\)\(^a\) antibacterial\(^7\)\(^b\) and carbonic anhydrase inhibitory activities.\(^7\)\(^c\) In particular, 1,3,4-thiadiazole nucleus have been reported to possesses CNS stimulant,\(^8\)\(^a\) anticholinergic,\(^8\)\(^b\) hypoglycemia,\(^8\)\(^c\) anticonvulsant,\(^8\)\(^d\) spasmyloytic and anti-inflammatory activities.\(^8\)\(^e\)

Triazoles are an important class of heterocyclic compounds. The derivatives of triazoles are exhibit important biological properties such as, tranquilizer and sedative,\(^9\)\(^a\) pesticidal,\(^9\)\(^b\) antibacterial,\(^9\)\(^c\) anxiolytic,\(^9\)\(^d\) anticonvulsant,\(^9\)\(^e\) antidepressants\(^9\)\(^f\) and antifungal.\(^9\)\(^g\)

The substituted oxadiazoles are heterocyclic compounds, which serve both as biomimetic, reactive pharmacophores and many are key elements with potential biological activities such as CNS stimulant, anti-inflammatory, hypotensive\(^10\)\(^a\) insecticidal\(^10\)\(^b\) bactericidal,\(^10\)\(^c\) hypoglycemic,\(^11\)\(^a-b\) analgesic, anticonvulsive, antiemetic, and diuretic,\(^12\) muscle relaxant\(^13\) and fungicidal\(^14\) activities.

The science of green chemistry was developed to meet the increasing demand for environmentally benign chemical processes. Microwave\(^15\) and ultrasonic\(^16\) irradiation techniques have an importance in the search for green synthesis because of their use as an efficient alternative heating source for organic reactions. The main advantage of microwave and ultrasonic assisted organic synthesis is the shorter reaction time, simple experimental procedure, very high yields and clean reaction of many
microwave and ultrasonically induced transformations offers additional convenience in the field of organic synthesis.

Biological activities associated with 1-benzofuran, thiadiazoles, triazoles and oxadiazole moieties and advantages of microwave and ultrasound irradiation technique prompted us to synthesize some oxadiazole, thiadiazoles and triazoles with 1-benzofuran.

2.2 Literature Review

Whalley et al\textsuperscript{17} synthesized different substituted benzofuran ester in the presence of potassium carbonate in acetone at 50-60°C.

\begin{equation}
\text{Scheme-1}
\end{equation}

Same Benzofuran was synthesized in Glenmark Pharmaceuticals S.A\textsuperscript{18} by two steps as first is formation of ether with 2-methoxy-phenol and ethyl 2-chloro-3-oxobutanoate in Toluene at reflux temperature followed by Cyclization in PPA/Water at 80-90°C to get desired compound (Figure-2).

\begin{equation}
\text{Scheme-2}
\end{equation}

Glaxo Group Limited\textsuperscript{19} has synthesized hydrazine acid in Ethanol by reacting benzofuran ester with substituted hydrazine at 60-65°C (Figure-3).
Mitsubishi Pharma Corporation\textsuperscript{20} has reported synthesized 7-methoxybenzofuran-2-carbohydrazide from ethyl 7-methoxybenzofuran-2-carboxylate (Figure-4).

Scheme-3

Keshk, E. M et al\textsuperscript{21} synthesized benzofuran-2-carbohydrazide by reacting ester with hydrazine in ethanol with catalytic amount of acid (Figure-5).

Scheme-4

Saku Osamu et al\textsuperscript{22} synthesized benzofuran-2-carbohydrazide by reacting ester with hydrazine in presence of hydrazine in ethanol at 60-65°C (Figure-6)

Scheme-5

Scheme-6
Keshk, E. M. et al\textsuperscript{23} work on the synthesis of thiosemicarbazides from different substituted thioisocyanates at 50-60 °C in ethanol with 95% yield (Figure-7).

![Scheme-7](image)

Halli, Madappa B. et al\textsuperscript{24} synthesized thiosemicarbazides in ethanol at 50–60°C with 85% yield (Figure--8).

![Scheme-8](image)

Basavaraja, K. M and Dawood et al\textsuperscript{25 (a,b)} synthesis in benzene obtained 95% yield (Figure--9)

![Scheme-9](image)

Keshk, E. M. et al\textsuperscript{26} synthesized thiazolidinones 67% with trichlorophosphate at elevated temperature (10).

![Scheme-10](image)
Basavaraja, K. M et al\textsuperscript{27} isolates the Benzothiazolidinones 57% with Phosphoric acid at 110-120\textdegree C, within 0.5 hrs (Figure-11).

\begin{center}
\includegraphics{scheme11}
\end{center}

Scheme-11

Dawood, Kamal M et al\textsuperscript{28} obtained same result for the synthesis of Benzothiazolidinones (Figure-12).

\begin{center}
\includegraphics{scheme12}
\end{center}

Scheme-12

Basavaraja, K. M. and et al\textsuperscript{29} synthesis Benzothiadiazoles from thicarbazides in presence of sodium hydroxide gives 97% yield (Figure-13).

\begin{center}
\includegraphics{scheme13}
\end{center}

Scheme-13

Tondon et al\textsuperscript{30} have reported an efficient one pot synthesis of 1,3,4-oxadiazoles by the reaction of acid chloride with the hydrazine hydrate followed by the cyclization in acidic medium (Figure-14).
Sharma et al.\textsuperscript{31} developed the Zirconium (IV) chloride mediated cyclodehydration of 1,2-diacetylhydrazines for the convenient synthesis of 2,5-diaryl 1,3,4-oxadiazoles (Figure-15).

\begin{center}
\textbf{Scheme-14}
\end{center}

Rajapaske et al.\textsuperscript{32} observed an efficient one pot synthesis of 1,3,4-oxadiazoles from Carboxylic acids and acyl hydrazides (Figure-16).

\begin{center}
\textbf{Scheme-15}
\end{center}

Joshi et al.\textsuperscript{33} carried out the facile conversion of acyldithi Carbazinate salts to 1,3,4-oxadiazole derivatives under microwave irradiation (Figure-16).

\begin{center}
\textbf{Scheme-16}
\end{center}

\begin{center}
\textbf{2.3.1 Present Work}
\end{center}

In the present work, the commercially available benzofuran ester 1 was treated with hydrazine hydrate to give the acid hydrazide 2 in 94% yields. The synthesized acid hydrazide 2 was condensed with commercially available a series of aryl isothiocyanate 3a-i in ethanol under reflux condition to obtain the corresponding hydrazine carbothiamide (4a-i) in 62-85% yield. The formation of the products has been confirmed by physical and spectroscopic data. The same condensation has also been achieved under microwave and ultrasound irradiation in good yields. Under ultrasound...
irradiation, it requires minimum time as compared to conventional heating method and yields are also good. Under microwave irradiation, it requires minimum time (2 min.) for the completion of the reaction. It suggests that the reactions under microwave irradiation condition are better for the synthesis of the titled compounds (4a-i). The intramolecular cyclocondensation of hydrazine carbothiamide (4a-i) in the presence of Conc. H₂SO₄ at room temperature to form the corresponding thiadiazoles (5a-i) in 53-79% yields. The same products have been obtained under ultrasound irradiation in 20 min. and microwave irradiation in 2 min. with 71-85% and 64-87% yields respectively.

In this case, microwave irradiation method gives product formation in less time. The carbothiamides (4a-i) on cyclocondensation under basic condition by using NaOH gives the corresponding 1,2,4-triazoles (6) under conventional heating, ultrasound and microwave irradiation in good yields. All the synthesized triazoles (6a-f) were characterized by physical and spectroscopic data.

Again, the cyclocondensation of carbothiamide (4a-i) with I₂-KI and NaOH in ethanol give the corresponding 1,3,4-oxadiazoles (7a-h) in 1 h. with 64-77% yields.

But, this cyclocondensation was not observed under ultrasound and microwave irradiation.
2.3.2 Results and Discussion

In the present work, benzofuran ester \textbf{1} was treated with hydrazine hydrate to give the acid hydrazide \textbf{2} in 94% yields. The synthesized acid hydrazide \textbf{2} was condensed with a series of aryl isothiocyanate \textbf{3a-i} in ethanol under reflux condition to obtain the corresponding hydrazine carbothiamide (\textbf{4a-i}) in 62-85% yield. The formation of the products has been confirmed by physical and spectroscopic data. The same condensation has also been achieved under microwave and ultrasound irradiation in good yields. Under ultrasound irradiation, it requires minimum time as compared to conventional heating method and yields are also good. Under microwave irradiation, it requires minimum time (2 min.) for the completion of the reaction. It suggests that the
reactions under microwave irradiation condition are better for the synthesis of the titled compounds (4a-i). The intramolecular cyclocondensation of hydrazine carbothiamide (4a-i) in the presence of Conc. H₂SO₄ at room temperature to form the corresponding thiadiazoles (5a-i) in 53-79% yields. The same products have been obtained under ultrasound irradiation in 20 min. and microwave irradiation in 2 min. with 71-85% and 64-87% yields respectively. In this case, microwave irradiation method gives product formation in less time. The carbothiamides (4a-i) on cyclocondensation under basic condition by using NaOH gives the corresponding 1,2,4-triazoles (6) under conventional heating, ultrasound and microwave irradiation in good yields. All the synthesized triazoles (6a-f) were characterized by physical and spectroscopic data. The respective yields, times and physical data of synthesized compounds are summarized in (Table 1) and the formation of compounds was confirmed by spectroscopic analysis.
Table 1: Characterization data of the synthesized compounds

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*All compounds were characterized by spectral analysis. *Reaction not overcome.
2.3.2 Conclusion
We have synthesized a new series of 1,3,4-thiadiazoles, 1,3,4-triazoles and 1,3,4-oxadiazole incorporation benzofuran ring by conventional and non-conventional methods. All the compounds were obtained in excellent yields.

2.3.3 Experimental
Ultrasound irradiation was carried out in ultrasonic cleaner model EN-20U-S manufactured by Entertech Electronics Pvt. Ltd, Mumbai, India having maximum power output of 100W and 33 KHz operating frequency. Microwave irradiation was carried out in Cem Discover Microwave oven – Maximum power-300-700w and model no. 908010, Maximum current-6.3 A with 50/60 MHz frequency (CEM-Matthews.NC. made in USA). All the melting points determined in open capillary tubes. I.R. spectra were recorded on Perkin-Elmer FTIR spectrophotometer using KBr disc. $^1$H NMR spectra were recorded on Varian in DMSO at 300 MHz spectrophotometer and TMS as an internal standard. A mass spectrum was recorded on Finnigan mass spectrometer using electrospray Ionization technique. The elemental analysis was carried out on Flash EA-1112, 50/60 Hz, 1400-VA CHNS analyzer.

General procedure

Ethyl 7-methoxy-3-methylbenzofuran-2-carboxyacid hydrazide (2)
To the stirred mixture of ethyl 7-methoxy-3-methylbenzofuran-2-carboxylate (0.01 mole) and hydrazine hydrate (0.015 mole) in ethanol (50 mL) at 78°C. The progress of reaction was monitored on TLC. After completion of reaction (60 min.), reaction mass was poured over ice-water and solid compound was separated by filtration to obtain the product in 94% of yield. The crude solid product was crystallized from ethanol water (7:3 systems) to get the desired product.

Synthesis of-[{(7-Methoxy-3-methyl-1-benzofuran-2-yl)carbonyl]-N-(2-ethoxyphenyl) hydrazinecarbothioamide(4a-e).

Method (A) By conventional method. In RBF, mixture of equimolar amounts (0.01 mole) of acid hydrazide (2) and aryl isothiocyanates (3) (0.01 mole) with 15 mL ethanol
was heated up to reflux on oil bath at 78 °C. Progress of the reaction was monitored on TLC. After completion of reaction (45 min.), reaction mass was poured over ice-water and solid compound was separated by filtration. The solid product was crystallized from ethanol water. This typical experimental procedure was followed to prepare other analogs of this series. The synthesized compounds by above procedures are listed in Table 1 with their Physical data, Yields and Time duration

Method (B) By US method. In RBF, mixture of equimolar amount (0.01 mole) of acid hydrazide (2) and aryl isothiocyanates (3) (0.01 mole) with 15 mL ethanol was subjected for ultra sound irradiation for 20 minutes. Progress of reaction was monitored on TLC. After completion of reaction product obtained was poured over ice-water and separated by filtration. The solid product was crystallized from ethanol and dried at 50-60 °C for 4–5 h.. This typical experimental procedure was followed to prepare other analogs of this series. The synthesized compounds by above method are characterized by IR, NMR, Mass spectra.

Method (C) By MW method. A mixture of equimolar amount of acid hydrazide (2) (0.01 mole), and aryl isothiocyanates (3) (0.01 mole) in ethanol (25 mL) was irradiated in a borosilicate glass tube (50 mL) inside a microwave oven for 90-120 sec at an output of 300 watts power, with short interruption of 15 sec to avoid excessive evaporation of solvent. Progress of reaction was monitored on TLC. The reaction mixture was cooled and poured into ice water. Solid product was separated by filtration and crystallized with alcohol to afford the titled compound. The synthesized compounds by above method are characterized by IR, 1H NMR, and mass spectroscopy.

Synthesis of-(7-Methoxy-3-methyl-1-benzofuran-2-yl)-N-phenyl-1,3, 4-thiadiazol-2-amine (5a-e)

Method (A) By Conventional method. In 100 mL RBF, thiosemicarbazide (4a) (0.01 mole) was taken with 5 mL conc. H₂SO₄, the reaction mixture was well stirred at room temperature for 2 h. After completion of reaction, as monitored by TLC, poured the mixture into crushed ice. The solid obtained was separated by filtration and
crystallized from water: DMF (6:4) and dried under vacuum at 50-60°C to get desired compounds. The synthesized compounds by above method are characterized by IR, $^1$H NMR, and mass spectroscopy.

Method (B) By US method. The solution of thiosemicarbazide (4a-i) (0.01 moles) was taken in 100 mL RBF with 5 mL conc. H$_2$SO$_4$. And reaction mixture was subjected for ultrasound irradiation for 20 minutes. Progress of reaction was monitored on TLC. After completion of reaction contents was poured on crushed ice. Product obtained was separated by filtration, the product was crystallized from water:DMF (6:4) and dried under vacuum at 50-60°C to get desired pure compound. This typical experimental procedure was followed to prepare other analogs of this series. The synthesized compounds by above method are characterized by IR, $^1$H NMR, and mass spectroscopy.

Method (C) By MW method. A solution of Thiosemicarbazide (4) (0.01 mole) was taken in 50 mL borosilicate glass tube with 5 mL conc. H$_2$SO$_4$. Reaction mixture was irradiated inside a microwave oven for 2 min to 2.5 min at an output of 300 watts power, with short interruption of 15 second. Progress of the reaction was monitored by TLC. The reaction mixture was cooled and poured on crushed ice. Product was separated by filtration and crystallized from water: DMF (6:4) and dried under vacuum at 50-60°C to get desired compound. The synthesized compounds by above method are characterized by IR, $^1$H NMR, and mass spectroscopy.

5-(7-Methoxy-3-methyl-1-benzofuran-2-yl)-4-phenyl-$^4$H-1, 2, 4-triazole-3-thiol (6a-e).

Method (A) By conventional method. A solution of thiosemicarbazide (4a-i) (0.01 mole) and 10 mL of 2N NaOH was heated up to mild reflux for 1.5 h. Progress of reaction was monitored on TLC. After completion of reaction, mixture was poured on crushed ice and acidified with dilute acetic acid. Product was separated by filtration and crystallized crystallized from water:DMF (6:4) to get desired compound and dried under vacuum at 50-60°C. The synthesized compounds by above method are characterized by IR, $^1$H NMR, Mass spectroscopy.
Method (B) By US method. A Solution of thiosemicarbazide (4a-i) (0.01 moles) was taken in 100 mL RBF with 10 mL 2N NaOH solution. Reaction mixture was subjected for ultra sound irradiation for 30 minutes. Progress of reaction was monitored on TLC. After completion of reaction, mixture was poured on crushed ice and acidified with dilute acetic acid. Product was separated by filtration and crystallized from water:DMF (6:4) and dried under vacuum at 50-60°C to get desired compound. The Compounds synthesized by above method are characterized by IR, $^1$HNMR, Mass spectroscopy.

Method (C) By MW method. Thiosemicarbazide (4) (0.01mole) was taken in 50 mL borosilicate glass tube with 10 mL 2N NaOH solution. Reaction mixture was irradiated inside a microwave oven for 2 min to 2.5 min at an output of 300 watts power, with short interruption of 15 second. Progress of reaction was monitored on TLC. After compilation of reaction, mixture was poured on crushed ice and acidified with dilute acetic acid. Product was separated by filtration and crystallized from water: DMF (6:4) and dried under vacuum at 50-60°C to get desired compound. The synthesized compounds by above method are characterized by IR, $^1$HNMR, Mass spectroscopy.

5-(6-methoxy-3-methyl-1-benzofuran-2-yl)-N-(2-methoxyphenyl)-1, 3, 4-oxadiazol-2-amine (7a-e)

By conventional method. Thiosemicarbazide (4a-h) (0.01 mole) and 2 mL of 4N NaOH in ethanol was heated up to reflux temperature, than add a solution of Iodine (2.5 gm) and KI (3.2 gm) in 10 mL of ethanol at above temperature. The progress of reaction was monitored on TLC for 4 h at reflux temperature. Reaction mass was evaporated up to slurry and diluted with 10 mL of water and excess iodine was quenched with a 10% solution of sodium meta bisulphite. Solid product was filtered and crystallized from ethanol: water to and dried under vacuum at 50-60°C get a desired compound. The Synthesized compounds by above method are characterized by IR, $^1$H NMR, and Mass spectroscopy.
2.4. Spectral Analysis

Ethyl 7-methoxy-3-methylbenzofuran-2-carboxyacid hydrazide (Fig. 8, Comp. 2)

$^1$H NMR (300, MHz, DMSO-d$_6$, $\delta$ ppm): 2.94 (3H, s); 3.34 (3H, s); 6.57 (brs, 2H, NH$_2$); 6.88 (1H, m); 7.22 (t, 1H, $J = 1.2$, 6.3 Hz); 8.10 (1H, d, $J = 6.6$ Hz); 9.47 (1H, s, NH).

IR (KBr, cm$^{-1}$): 3460; 1680; 1610; 1202.

ES-MS: m/z (m+1): 221.2.

Elemental Analysis :- Calc.: C-59.99%, H-5.49%, N-12.72; Found: C, 59.85; H, 5.24; N, 12.33.

Fig. 1 $^1$H NMR of Ethyl 7-methoxy-3-methylbenzofuran-2-carboxyacid hydrazide (Comp. 2).
[(7-Methoxy-3-methyl-1-benzofuran-2-yl)carbonyl]-N-(2-ethoxyphenyl) hydrazinecarbothioamide (4a)

$^1$H NMR (300 MHz, DMSO-$d_6$, δ ppm): 2.54 (3H, s); 3.73 (3H, s); 3.97 (3H, s); 6.88 (2H, d, $J = 8.7$ Hz); 7.10 (1H, d, $J = 7.5$ Hz); 7.28 (4H, m); 9.60 (1H, s); 9.69 (1H, dd); 10.52 (1H, s).

IR (KBr, cm$^{-1}$): 3421, 3138, 1678, 1513, 1252.

ES-MS: m/z (m+1): 385.9.

Elemental Analysis :- Calc.: C-61.77%, H-5.18%, N-11.37%, S-8.68%; Found: C-61.42%, H-4.71%, N-11.11%, S-8.27%.
Fig-2 $^1$H NMR of 2-[(7-Methoxy-3-methyl-1-benzofuran-2-yl)carbonyl]-N-(2-methoxyphenyl) hydrazinecarbothioamide(4a).
Fig-3 I.R of 2-[(7-Methoxy-3-methyl-1-benzofuran-2-yl)carbonyl]-N-(2-methoxyphenyl) hydrazinecarbothioamide (Table 1, Comp. 4a).
Fig. 4 Mass spectra of 2-[(7-Methoxy-3-methyl-1-benzofuran-2-yl)carbonyl]-N-(2-methoxyphenyl) hydrazinecarbothioamide (Table 1, Comp. 4a).
(7-Methoxy-3-methyl-1-benzofuran-2-yl)-N-phenyl-1,3, 4-thiadiazol-2-amine (Table 1, Comp. 5a).

$^1$H NMR (300, MHz, DMSO-d$_6$, δ ppm): 2.55 (3H, s); 3.75 (3H, s); 3.96 (3H, s); 6.9-7.02 (2H, m); 7.26-7.52 (2H, m); 7.72 (1H, m); 7.90 (1H, dd); 10.52 (1H, s).

IR (KBr, cm$^{-1}$): 3433; 2910; 2777; 1631; 1609; 1580; 1493; 1233; 1182; 1028; 731; 587.

ES-MS: m/z (m+1): 385.9.

Elemental Analysis: C-64.94%, H-4.88%, N-11.96%, S-9.12%; Found: C-64.68%, H-4.53%, N-11.61%, S-8.65%.
Fig-5 $^1$H NMR Spectra of (Table 1, Comp. 5a).
Fig-6 I.R spectra of 5-(7-Methoxy-3-methyl -1-benzofuran-2-yl)-N-phenyl-1,3, 4-thiadiazol-2-amine (Table 1, Comp. 5a).
5-(7-Methoxy-3-methyl-1-benzofuran-2-yl)-4-phenyl-4H-1, 2, 4-triazole-3-thiol  
(Table 1, Comp. 6a).

$^1$H NMR (300, MHz, DMSO-$d_6$, δ ppm): 2.27 (3H, s); 3.70 (3H, s); 3.78(3H, s); 6.98  
(1H, d, $J = 9.0$ Hz); 7.20 (3H, m); 7.32 (1H, d, $J = 9$ Hz); 7.40-7.70 (2H, m); 14.45  
(1H, s).

IR (KBr, cm$^{-1}$): 3098; 2939; 1514; 1248; 1172; 1036; 827; 731; 565.

ES-MS: m/z (m+1): 367.42.

Elemental Analysis :- Calc.: C-64.94%, H-4.88%, N-11.96%, S-9.12%; Found: C-  
64.66%, H-4.54%, N-11.68%, S-8.71%.
Fig-7 $^1$H NMR 5-(7-Methoxy-3-methyl-1-benzofuran-2-yl)-4-phenyl-4H-1, 2, 4-triazole-3-thiol (Table 1, Comp. 6a).
Fig-8 $^1$H NMR 5-(7-Methoxy-3-methyl-1-benzofuran-2-yl)-4-phenyl-$4H$-1, 2, 4-triazole-3-thiol (Expansion) (Table 1, Comp. 6a).
Fig-9 I.R spectrum of 5-(7-Methoxy-3-methyl-1-benzofuran-2-yl)-4-phenyl-4H-1, 2, 4-triazole-3-thiol (Table 1, Comp. 6a).
Fig-10 Mass Spectra of 5-(7-Methoxy-3-methyl -1-benzofuran-2-yl)-4-phenyl-4H-1, 2, 4-triazole-3-thiol (Table 1, Comp. 6a).
5-(7-methoxy-3-methylbenzofuran-2-yl)-N-(3-methoxyphenyl)-1,3,4-oxadiazol-2-amine (Table 1, Comp. 7a).

$^1$H NMR (300 MHz, DMSO-$d_6$, $\delta$ ppm): 2.51 (3H, s); 3.73 (3H, s); 3.97 (3H, s); 6.89-7.31 (5H, m); 7.55 (1H, d); 14.22 (1H, s).

IR (KBr, cm$^{-1}$): 3430; 3058; 2911; 1633; 1611; 1578; 1495; 1247; 1133; 1028; 722; 587.

ES-MS: $m/z$ (m+1): 351.35.

Elemental Analysis :- Calc.: C-68.05%, H-5.11%, N-12.53%; Found: C-67.83%, H-4.92%, N-12.19%. 

Part II
Fig. 11 $^1$HNMR of 5-(7-methoxy-3-methylbenzofuran-2-yl)-N-(3-methoxyphenyl)-1,3,4-oxadiazol-2-amine (Table 1, Comp. 7a).
Fig-12 I.R of 5-(7-methoxy-3-methylbenzofuran-2-yl)-N-(3-methoxyphenyl)-1,3,4-oxadiazol-2-amine (Table 1, Comp. 7a).
2.5 References


