# Comprehensive IR and NMR research of a newly Synthesized derivative of Imidazole–1,3,4–Oxadiazole

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## Abstract

# Background

Due to their critical applications in several domains or diseases, the compounds imidazole and oxadiazole have attracted a lot of interest. Oxadiazole is an anti-tussive, anti-inflammatory, anaesthetic, vasodilator, anti-helmintic, anti-allergic, and anti-platelet drug. Imidazole is an antifungal, anti-protozoal, and antihypertensive drug. The purpose of this study is to synthesize and characterize the derivative by using FTIR and 1H-NMR. The derivatives synthesis was completed. Ethyl 2-(1H-imidazol-1-yl) acetate is made in the first stage, and 2-(1H-imidazol-1-yl) acet-hydrazide is made using this Ethyl 2-(1H-imidazol-1-yl) acetate. The subsequent addition of 3-methoxybenzaldehyde followed by the addition of acetic anhydride led to the formation of the desired compounds. Studies using FTIR were conducted. Studies using 1H-NMR were also carried out.

# Result

As a result, IR and 1H-NMR were used to characterise the synthesised material. A synthetic derivative's structure was established.

# Conclusions

In conclusion, imidazole serves as the starting ingredient for the synthesis. The IR and NMR investigation was appropriately conducted, and this technique yields satisfactory results.


## Background

Imidazole is a heterocyclic moiety with five members. Imidazole has three carbon atoms, two nitrogen atoms, four hydrogen atoms, and two double bonds. Imidazole is also known as 1,3-diazole. We define 1,3-diazole as amphoteric in nature, i.e., possessing both acidic and basic properties. It is an uncolored or white solid. It is extremely soluble in water and other polar solvents. The typical chemical formula for imidazole is $C_3H_4N_2$. Atoms of nitrogen are present in the first and third positions of the ring, which are not adjacent positions. Imidazole is made up of two nitrogen atoms, one of which is a hydrogen atom and the other is known as pyrrole type nitrogen[1].

In heterocyclic chemistry, imidazole and its derivatives occupy a specific position. The chemical properties of imidazole and its derivatives are very diverse. Histamine, vitamin B12, the DNA base structure, and other human components all have an imidazole nucleus as their main structural element. Imidazole is a component of several medicinal substances, both natural and synthetic. Imidazole was first discovered by Heinrich Debus in 1858[2].

German scientist Arthur Rudolf Hantzsch is credited with creating the name "imidazole" in 1887. Diazoles are a subclass of imidazoles. Non-adjacent nitrogen atoms exist in imidazole. It is a planar five-membered heterocyclic compound containing three carbons and two nitrogens in positions 1 and 3. Initially synthesised with glyoxal and ammonia, imidazole was formerly known as gluoxaline[3].

It is highly polar compound having dipole moment 3.61D[4]. IUPAC name of imidazole is 1*H*-imidazole. Molar weight of 68.08g/mol[5].

Various imidazole based derivatives which shows different activity are econazole shows anti-fungal activity[19,20], anti-sporulant activity[8], anti-mycotic activity[9]. Tinidazole shows anti-protozoal activity[23,24] , bactericidal activity[12]. Eberconazole and lanoconazole shows anti-fungal activity[26,**27]**. Fenticonazole shows antifungal activity[28,29], anti-bacterial activity[17]. Bifonazole shows antifungal activity[31,32]. Sulconazole shows anti microbial activity, antifungal activity[33,34]. Luliconazole shows antifungal activity[35,36].

There are several medical uses for the 1,3,4-oxadiazoles class of synthetic chemicals. This essay will concentrate on current advancements in the pharmacology of 1,3,4-oxadiazoles. The 1,3,4-oxadiazole ring system is a significant moiety that has been the subject of numerous recent review studies. On this page, a summary of the various biological activities associated with it is provided. The 1,3,4-oxadiazole ring does not have a cliché name like "azoxime" for 1,2,4-oxadiazole or "furazan" for 1,2,5-oxadiazole. Oxadiazoles are five-membered rings with one oxygen and two nitrogen atoms[24].

Oxadiazole is a five-membered heterocyclic molecule composed of two carbon atoms, one oxygen atom, two nitrogen atoms, two double bonds, and two nitrogen atoms. Oxadiazole comes from furan. In place of two methane groups (-CH=) in furan, two nitrogen atoms of the pyridine type (-N=) were utilised. Based on where the nitrogen atom is located in the ring, four distinct forms of oxadiazole isomers exist[25].

# Materials And Methods

### Material

IR spectrophotometer was used to determine the functional group of the compound

NMR spectrophotometer is use to determine the structure of compound (Derivative).

### Method

### Synthesis of 3-Methoxybenzaldehyde:

**m-Hydroxybenzaldehyde:** Sulfuric acid are cooled to 0° using a salt-ice bath in a three-necked flask that is furnished with a mechanical stirrer, a thermometer, and a dropping funnel.

m-aminobenzaldehyde dimethylacetal is added dropwise, the acid is agitated and kept at 0° or below. The mixture turns a dark orange or crimson.

Once the amino compound has been added completely, a solution of 97 percent sodium nitrite in water is gently added while the acid solution's temperature is kept at 5°. To finish the reaction, stir at 5° for another hour.

**3-Methoxybenzaldehyde**: Sodium hydroxide are used to dissolve the crude m-hydroxybenzaldehyde, three-necked flask that also has a mechanical stirrer, thermometer, and dropping funnel.

While adding methyl sulphate dropwise, the dark-colored solution is agitated while the temperature is held at 40-45°.

The mixture is agitated for 5 minutes once the addition is finished. Sodium hydroxide is added, followed by the addition of methyl sulphate, but this time the temperature is allowed to increase to 50°.

After cooling the mixture and continuing to stir at 50 degrees for 30 minutes, the organic layer is extracted using ether. The ether solution is filtered and concentrated by distillation after being dried over anhydrous sodium sulphate for eight hours. Under lower pressure, the residue is distilled[26].

**Steps for the preparation of derivatives:** Derivatve preparation involves a number of processes. Imidazole is the base ingredient utilised to create the derivative. In this reaction, imidazole is combined with dry acetone and ethyl chloroacetate to create crystals, which are subsequently combined with hydrazine hydrate and ethanol. In this combination, benzyldehyde is reacted. Then, acetyl chloride is used to react with this combination of A3. Various derivatives of this aromatic aldehyde are added as the last stage.

**Preparation of Ethyl 2-(1H-imidazol-1-yl) acetate (A1):**

Imidazole, ethyl chloroacetate, dry acetone, and potassium carbonate were combined and heated in a reflux for 6 hours at 80°C while being stirred. The solution is filtered after the solvent evaporates under pressure, and the separated result is ethanol that has been recrystallized to produce crystals.

**Preparation of 2–(1H–imidazol-1–yl) acet–hydrazide: (A2)**

A1 and Hydrazine Hydrate in Ethanol were refluxed for three hours, then the residual solution was concentrated and chilled. Crystals were produced by re-crystallizing the product from ethanol after it had been filtered and purified.

**Preparation of A3.**

3-Methoxybenzyldehyde and A2 combined in ethanol The solution was concentrated and cooled after being refluxed for four hours. Filtering was used to isolate the end product, which was then crystallised again from ethanol.

**Preparation of derivative:**

A3 and acetyl chloride were combined, and the combination was refluxed for six hours before distillation removed the solvent. The crushed ice was combined with the residue. Filtration separated the outcome[27]. This is shown in the fig 1.

# Results

### FTIR study of derivative:

For an alkane, the C-H group exhibits stretching vibration at wavelength 2929.30 $cm^{-1}$. At a wavelength of 2873.11 $cm^{-1}$, the C-H group exhibits stretching viberation for the methyl group. Wavelength 2320.32 $cm^{-1}$ exhibits stretching viberation in the N-H group. Stretching viberation in the C=O group is seen at 1741.28 $cm^{-1}$ in wavelength. Stretching vibration is visible in the C=C ring at wavelength 1503.15 $cm^{-1}$. The bending viberation in O-H is at 1382.37 $cm^{-1}$. At a wave length of 1219.40 $cm^{-1}$, the C-O-C group exhibits asymmetric stretching vibration. Wavelength 1163.78 $cm^{-1}$ exhibits stretching vibration in the C-O group. At wavelengths of 1031.78 $cm^{-1}$, 772.35 $cm^{-1}$, and 716.22 $cm^{-1}$, C-C stretching was observed. This is shown in the figure no.2 and table no1.

**Table 1: Table of IR result.**

| Sr.No. | Wave number in $cm^{-1}$ | Assignment | Mode of Viberation |
|---|---|---|---|
| 1 | 2929.30 | CH group (alkane) | Stretching |
| 2 | 2873.11 | CH group (methyl) | Stretching |
| 3 | 2320.32 | NH group | Stretching |
| 4 | 1741.28 | C=O group | Stretching |
| 5 | 1503.15 | C=C ring | Stretching |
| 6 | 1382.37 | O-H group | bending |
| 7 | 1219.40 | C-O-C group | stretching |
| 8 | 1163.78 | C-O group | stretching |
| 9 | 1031.78, 772.35 and 716.22 | C-C group | stretching |

### $^1$H-NMR study of derivative:

The structure derivative in this spectrum is identified by 1H-NMR. 1H-NMR (DMSO-d6, 600 MHz) (sep,3.430ppm, 3.424ppm, 3.415ppm, 3.409ppm, 3.397ppm, 3.517ppm, 3H). At 3.4 ppm, the O-CH3 peak is reached. (1.64 ppm,1.838 ppm, s) alkyl peak appears at 1.6 and 1.8 ppm. (d, 2.516 and 2.514 ppm, 1H),at 2.5 ppm, the carbonyl group peaks. The peak of oxadiazole is about 3.5 ppm. (d,7.277ppm, 7.275ppm, 1H). at 7.2 ppm, imidazole shows its peak. The interpretation of data was done by using a spectroscopic identification book (by Silversten)[28]. The NMR data is shown below in fig 3.

# Discussion

Synthesis of derivative was carried out. Studies on infrared spectroscopy, and nuclear magnetic resonance were conducted. In these research, graphs were drawn, and the structure and functional group were identified in accordance with the graphs and values. The interpretation is carried out using the book Spectroscopic Identification of Organic Compound (by silverstein).

# Conclusions

The conclusion of this study is that the imidazole-1,3,4-oxadiazole derivative were synthesized and its characterization study were performed. The characterization study such as FTIR and NMR were studied. In-lab characterisation investigations were conducted once the derivative was produced. Interpretation of IR and NMR is done. For future aspects various activities of this derivative can be checked.

# Abbreviations

| Abbreviation | Full Form |
|---|---|
| FTIR | Fourier Transform Infrared |
| NHR | Nuclear Magnetic Resonance |
| IUPAC | International Union of Pure and Applied Chemistry |
| DMSO | Dimethyl Sulphoxide |
| Ppm | Parts per million |
| cm | Centimetre |
| DNA | Deoxyribonucleic acid |
| g/mol | Gram per mole |
| MHz | Megahertz |
| D | Dipole moment |

# Declarations

**Ethics approval and consent to participate:** Not Applicable

**Consent for publication:** Not Applicable

**Availability of data and materials:** Not Applicable.

**Competing Interests**: The authors declare that thay have no competing interests.

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**Authours Contribution:** Ms. Palvi Sharma, Ms. Ravina Kumari and Mr. Vikrant Dalwal has synthesized the derivative. Dr. Kapil Kumar Verma and Ms. Shivalika interpreted the data.

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# Figures

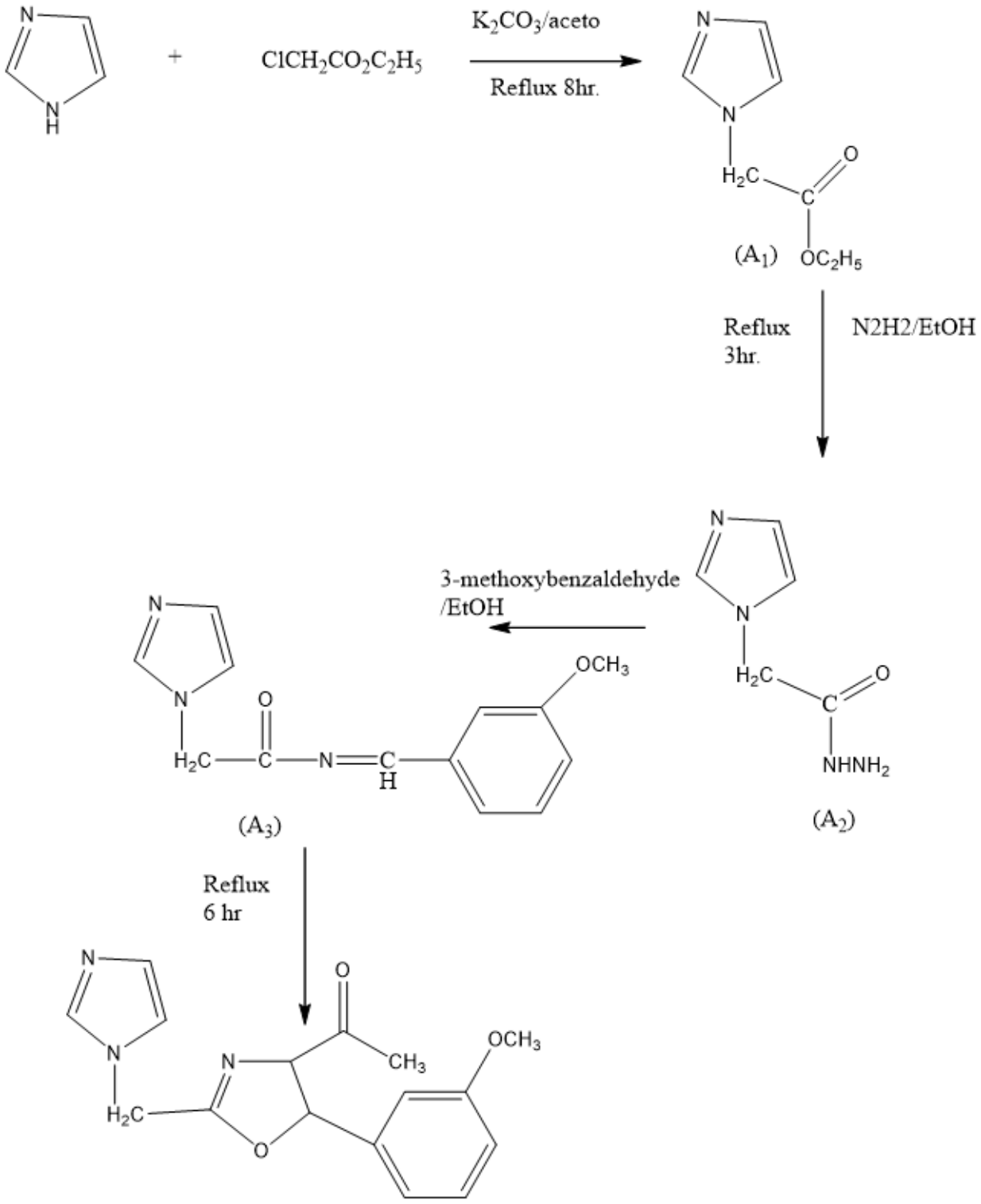



Figure 1

Synthesis of derivative.

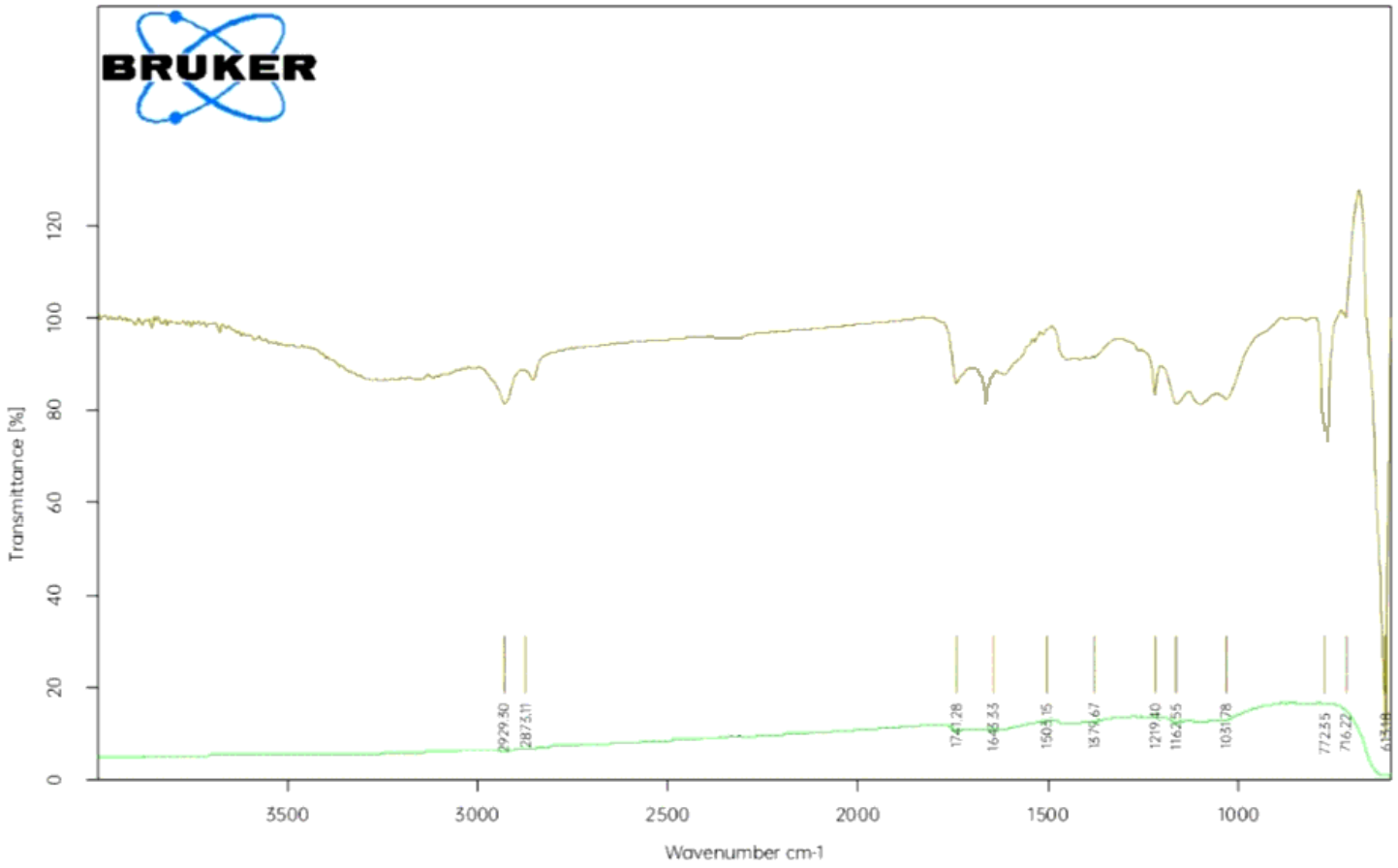
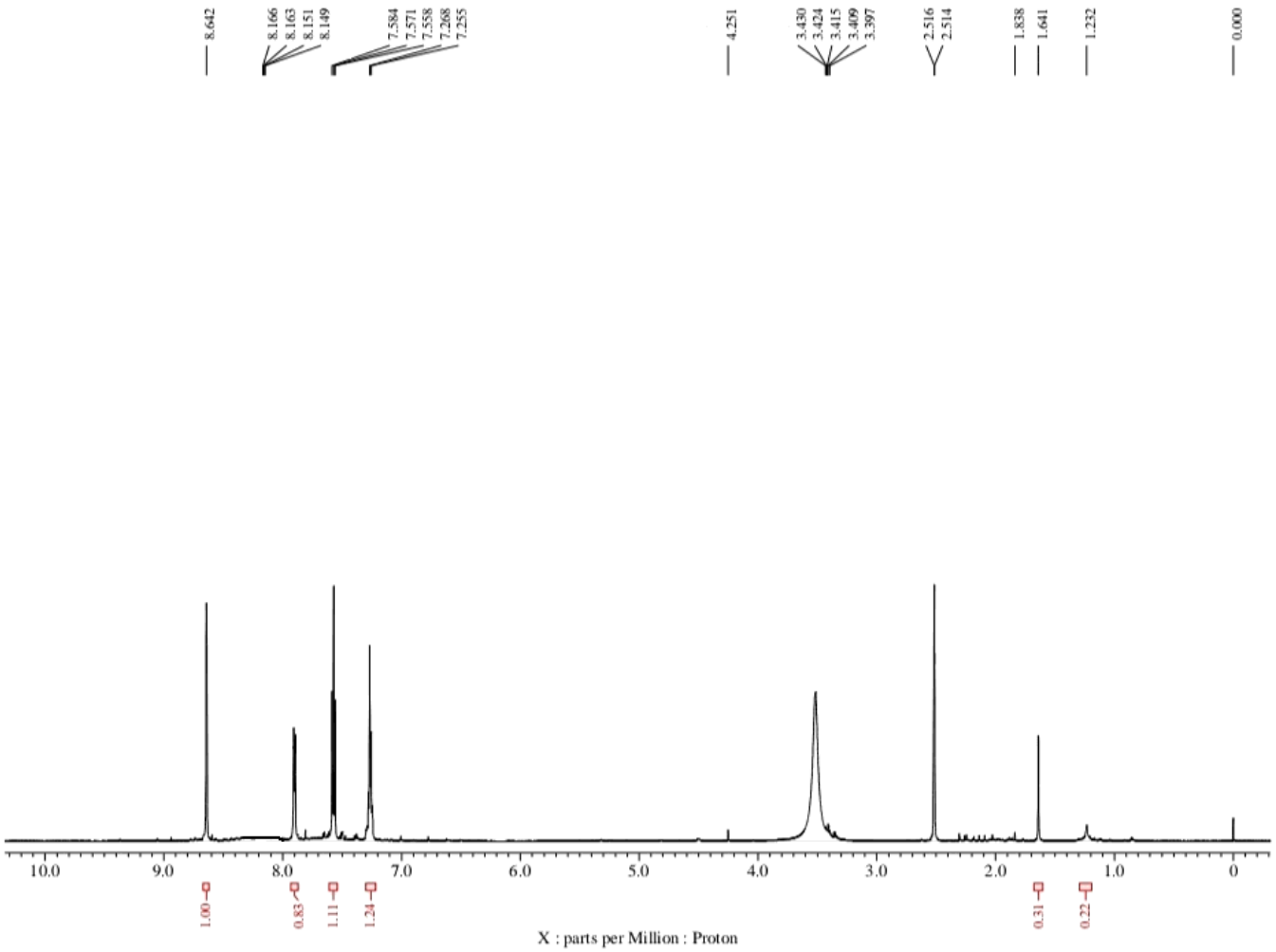



Figure 2

Figure of IR study.




## Figure 3

## $^{1}$H-NMR study of derivative.