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Article

Green and Selective Synthesis of *N*-Substituted Amides using Water Soluble Porphyrazinato Copper(II) Catalyst

Sara S. E. Ghodsinia,[a] Batool Akhlaghinia,[,a] Elham Safaei[b] and Hossein Eshghi[a]*

[a]*Department of Chemistry, Faculty of Sciences, Ferdowsi University of Mashhad, 9177948974 Mashhad, Islamic Republic of Iran*

[b]*Department of Chemistry, Institute for Advanced Studies in Basic Sciences (IASBS), 45137-66731 Zanjan, Islamic Republic of Iran*

N,N',N'',N'''-Tetrametil tetra(2,3-piridil)porfirazinato metil sulfato de cobre(II) ([Cu(2,3-tmtppa)]$(MeSO_4)_4$) catalisou com sucesso a conversão direta de nitrilas a amidas *N*-substituídas. A síntese seletiva do tipo *one pot* de amidas *N*-substituídas a partir de nitrilas e aminas primárias foi realizada em refluxo de água. O catalisador foi recuperado e reusado no mínimo 4 vezes, mantendo a sua eficiência.

N,N',N'',N'''-Tetramethyl tetra-2,3-pyridinoporphyrazinato copper(II) methyl sulfate ([Cu(2,3-tmtppa)]$(MeSO_4)_4$) efficiently catalyzed the direct conversion of nitriles to *N*-substituted amides. The one pot selective synthesis of the *N*-substituted amides from nitriles and primary amines was performed in refluxing H_2O. The catalyst was recovered and reused at least four times, maintaining its efficiency.

Keywords: [Cu(2,3-tmtppa)]$(MeSO_4)_4$, *N*-substituted amide, nitrile, amine

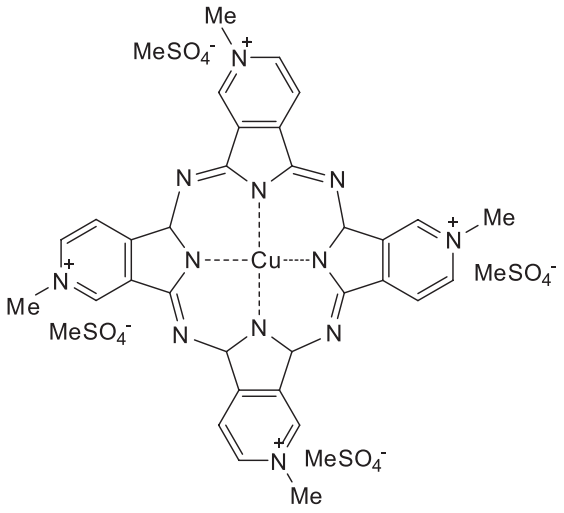
Introduction

Amide bond formation is a fundamental reaction of great interest in organic and bioorganic chemistry, peptides and proteins include these bonds. Synthesis of *N*-alkyl amides has been of great interest because they are versatile synthetic intermediates used in the manufacture of several pharmacological products, polymers, detergents, lubricants and drug stabilizers, as well as key structural motifs present in numerous natural products.[1-5] Current popular synthesis strategies of amides are the reaction of amines with carboxylic acids, transamidation of amides with amines, or with the reaction of carboxylic acid derivatives such as acyl halides, anhydrides, esters and other activated species usually in the presence of coupling reagents.[6-27] Reactions promoted by coupling reagents are fundamental in organic synthesis. The majority of amide bond syntheses is merely stoichiometric, making these methods generally expensive and wasteful procedures.[28] As the society needs forward-looking environmentally acceptable technology, the development of catalytic reactions that use transition-metal complex catalysts under neutral and mild reaction conditions is particularly important. These criteria include atom efficiency, formation of little inorganic waste, and selective synthesis of desired products, encouraging an effort towards using environmentally friendly catalytic processes that will not produce such waste. The conversion of aldehydes,[29-36] oxime[34,37-46] and nitriles[47-54] constitute effective methods to access amides.[31,55-61]

A little-known reaction which yields amides is the hydrolytic amidation of nitriles with amines. A platinum and an iron catalysts were found to perform the coupling.[53,54] Nitriles can also be coupled with alcohols to form amides in the Ritter reaction. As an alternative to sulfuric acid, the Ritter reaction can be catalyzed by metal complexes such as bismuth triflate[62] and iron complexes.[63]

Our group recently reported that [Cu(2,3-tmtppa)]$(MeSO_4)_4$ (*N,N',N'',N'''*-tetramethyl tetra-2,3-pyridinoporphyrazinato copper(II) methyl sulfate) could be used as catalyst for protection of hydroxyl and carbonyl groups.[64-66] In the course of our present study, our interesting is in using [Cu(2,3-tmtppa)]$(MeSO_4)_4$ (Scheme 1) as a safe, environmentally benign and efficient acid catalyst in the preparation of *N*-substituted amides.

*e-mail: akhlaghinia@um.ac.ir



Scheme 1. The structure of $[Cu(2,3\text{-tmtppa})](MeSO_4)_4$.

Experimental

General

The products were purified by column chromatography. The purity determinations of the products were accomplished by thin layer chromatography (TLC) on silica gel polygram STL G/UV 254 plates. The melting points of the products were determined with an Electrothermal type 9100 melting point apparatus. The Fourier transform infrared (FTIR) spectra were recorded on an Avatar 370 FTIR Therma Nicolet spectrometer. The nuclear magnetic resonance (NMR) spectra were provided on Brucker Avance 100 and 400 MHz instruments in $CDCl_3$. Elemental analyses were performed using an Elementar Vario EL V5.19.1121 and Thermofinnigan Flash EA 1112 Series instruments. Mass spectra (MS) were recorded with a Shimadzu GC-MS-QP5050 and CH7A Varianmat Bremem instruments at 70 eV. The known products were characterized by FTIR and ^{1}H NMR spectra and comparisons of their melting points (or those of the derivatives) were done with authentic samples. The catalyst was prepared and purified by the method described in the literature.[67-69]

Results and Discussion

The optimization of the reaction conditions was carried out for the reaction of phenylacetonitrile with benzylamine in the presence of $[Cu(2,3\text{-tmtppa})](MeSO_4)_4$ under various reaction parameters in order to achieve the maximum chemical yield at the lowest reaction time and lowest reaction temperature. The general reaction is outlined in Scheme 2 and the representative results are shown in Table 1.

In the absence of any catalyst, there was no conversion to *N*-benzyl-2-phenylacetamide (Table 1, entries 1, 20 and 21). In solvent free condition and applying different molar ratios of phenylacetonitrile, benzylamine, $[Cu(2,3\text{-tmtppa})]^{4+}$ was identified as a catalyst for *N*-benzyl-2-phenylacetamide formation but in prolonged reaction time and low yield (Table 1, entries 2-5). In an effort to develop better reaction conditions, different solvents were screened for the preparation of *N*-benzyl-2-phenylacetamide from the reaction of phenylacetonitrile with benzylamine in the presence of 0.5 mol% of $[Cu(2,3\text{-tmtppa})](MeSO_4)_4$. No product was obtained when the reaction was performed in dimethyl sulfoxide (DMSO), dimethylformamide (DMF), CH_2Cl_2 and Et_2O (Table 1, entries 6-9). The catalytic effect of $[Cu(2,3\text{-tmtppa})](MeSO_4)_4$ was efficiently decreased in aprotic polar solvents such as DMSO and DMF because of the strong coordination of solvent with Cu^{II}. As shown in Table 1, when the reaction was performed in refluxing 1,4-dioxane and H_2O, *N*-benzyl-2-phenylacetamide was obtained in good to excellent yields. To improve amide formation, the effect of different molar ratios of phenylacetonitrile, benzylamine was examined in 1,4-dioxane and H_2O (Table 1, entries 10-19). Also, the effect of temperature was studied in 1,4-dioxane and H_2O. No conversion was observed when the reaction was carried out at room temperature (Table 1, entries 22-23). It seems that the temperature is an important factor in the preparation of *N*-benzyl-2-phenylacetamide. The best results were obtained in 1,4-dioxane, H_2O, toluene and tetrahydrofuran (THF) (Table 1, entries 10-19,25-26). Because of safety, economic and handling considerations, H_2O was chosen for further experiments. Maximum yield was observed in refluxing H_2O with a 1:2 molar ratio of phenylacetonitrile:benzylamine (Table 1, entry 18). To investigate the effect of catalyst loading, the formation of *N*-benzyl-2-phenylacetamide was carried out in refluxing H_2O in the presence of 1 mol% of catalyst. According to this study, increasing the catalyst loading did not lead to higher conversion (Table 1, entry 24). It is noteworthy that no evidence for reaction of phenylacetonitrile with water was observed in the absence of benzylamine and any tendency between phenylacetonitrile and H_2O can be prohibited (Table 1, entry 27).

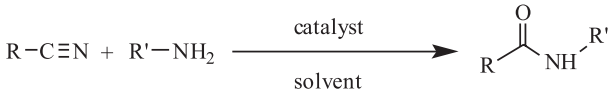
To explore the generality and scope of the *N*-substituted amides formation catalyzed by $[Cu(2,3\text{-tmtppa})](MeSO_4)_4$, the optimized reaction conditions (1:2 molar ratio of nitrile:amine, 0.5 mol% catalyst, refluxing H_2O) were used for the synthesis of a series of amide derivatives (Table 2).

According to the results obtained (Table 2), *N*-substituted amides were prepared from the reaction of aromatic and aliphatic nitriles with primary aliphatic amines in the

Table 1. Synthesis of *N*-benzyl-2-phenylacetamide in the presence of 0.5 mol% of [Cu(2,3-tmtppa)]$(MeSO_4)_4$ in various solvents, different molar ratios and different temperatures

entry	Molar ratio (phenylacetonitrile:benzylamine)	Solvent	Temperature / ºC	time / h	Isolated yield / %
1[a]	1/1	none	90	30	0
2	1/1	none	90	32	60
3	1/1.5	none	90	30	65
4	1/1.7	none	90	27	68
5	1/2	none	90	24	68
6	1/1	DMSO	90	24	0
7	1/1	DMF	90	24	0
8	1/1	CH_2Cl_2	reflux	24	0
9	1/1	Et_2O	reflux	24	0
10	1/1	1,4-dioxane	reflux	30	80
11	1/1.5	1,4-dioxane	reflux	25	85
12	1/1.7	1,4-dioxane	reflux	22	90
13	1/2	1,4-dioxane	reflux	20	95
14	1/2.2	1,4-dioxane	reflux	20	98
15	1/1	H_2O	reflux	23	85
16	1/1.5	H_2O	reflux	23	90
17	1/1.7	H_2O	reflux	22	95
18	1/2	H_2O	reflux	19	98
19	1/2.2	H_2O	reflux	19	97
20[a]	1/2	1,4-dioxane	reflux	20	0
21[a]	1/2	H_2O	reflux	20	0
22	1/2	1,4-dioxane	rt	20	0
23	1/2	H_2O	rt	20	0
24[b]	1/2	H_2O	reflux	19	98
25	1/2	toluene	reflux	19	98
26	1/2	THF	reflux	23	90
27	1/0	H_2O	reflux	20	0

[a]The reaction was performed in the absence of catalyst; [b]the reaction was performed in the presence of 1 mol% of catalyst.



	R		R'
1a	$C_6H_5CH_2$	**1b**	$C_6H_5CH_2$
2a	4-Cl-$C_6H_5CH_2$	**2b**	2-OMe-$C_6H_5CH_2$
3a	C_6H_5	**3b**	2-Cl-$C_6H_5CH_2$
4a	2-Pyridine	**4b**	$CH_3(CH_2)_3$
5a	3-Pyridine	**5b**	$CH_3CH_2O(CH_2)_3$
6a	4-Pyridine	**6b**	2-Furan-CH
7a	2-Thiophene	**7b**	$CH(CH_2)_5$
8a	$(CH_3)CHCH_2$		
9a	CH_3CH		

Scheme 2. Synthesis of *N*-substituted amides.

presence of [Cu(2,3-tmtppa)]$(MeSO_4)_4$ in high isolated yields. The mechanism of this transformation is unclear. On the basis of proposed mechanism in Scheme 3, the catalytic activity of [Cu(2,3-tmtppa)]$(MeSO_4)_4$ could well be attributed to the Lewis acidity of the complex. The catalytic reaction of alkyl and aryl nitriles with primary amines was achieved by refluxing aqueous solution of the corresponding nitriles, in the presence of 0.5 mol% [Cu(2,3-tmtppa)]$(MeSO_4)_4$, which initially generates the nitrile bound copper species I. This idea is supported by performing the reaction in the absence of catalyst. Without any catalyst, the reaction is not completed even after long period of time (Table 1, entries 1, 20 and 21). Nucleophilic attack of primary amines to I affords intermediate II, which upon reaction with H_2O, produces hydrolyzed product III. The formation of II and III was confirmed by the fact that nucleophilic attack of amine can be catalyzed by [Cu(2,3-tmtppa)]$(MeSO_4)_4$, according to the result obtained from Table 1, entry 27 (any tendency between nitrile compound and H_2O can be prohibited). Copper complex III produces *N*-substituted amide with concomitant loss of an ammonia molecule. Finally, the regeneration of catalyst initiates a second catalytic cycle. Nevertheless, at this time, there is no experimental evidence for I, II and III formation and action in this manner. However, further

Table 2. Synthesis of different structurally *N*-substituted amides in the presence of [Cu(2,3-tmtppa)]$(MeSO_4)_4$

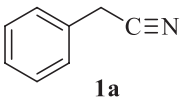
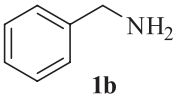
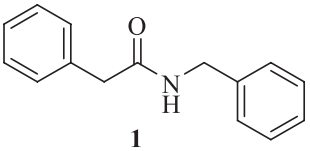
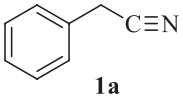
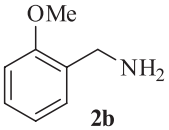
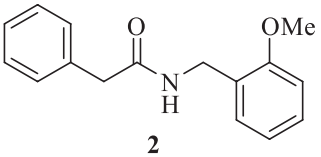
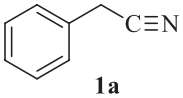
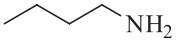
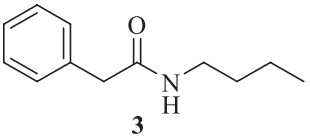
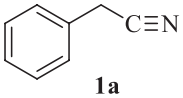
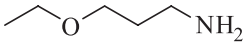
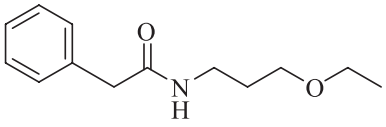
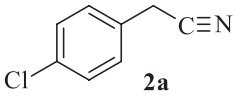
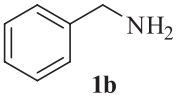
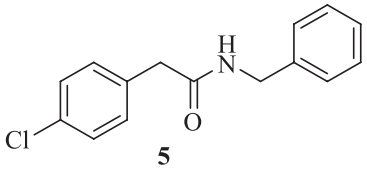
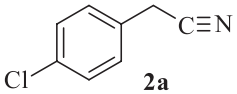
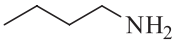
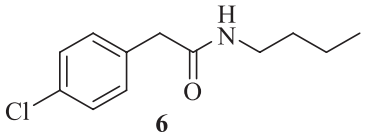
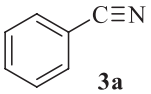
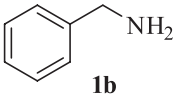
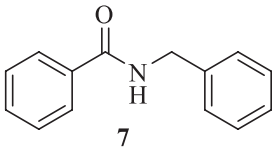
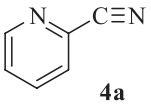
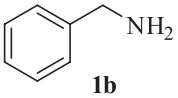
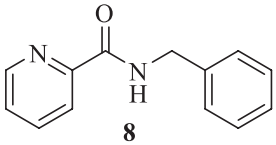
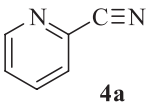
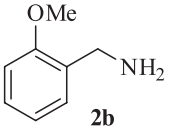
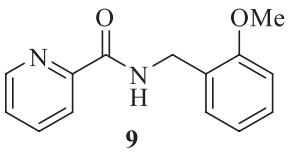
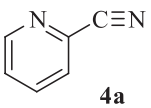
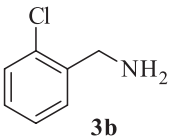
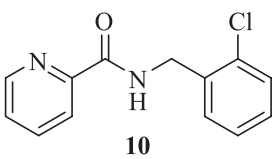
entry	Nitrile	Amine	Product	time / h	Yield / %
1	 **1a**	 **1b**	 **1**	19	98
2	 **1a**	 **2b**	 **2**	24	92
3	 **1a**	 **4b**	 **3**	15	95
4	 **1a**	 **5b**	 **4**	22	83
5	 **2a**	 **1b**	 **5**	17	90
6	 **2a**	 **4b**	 **6**	14	85
7	 **3a**	 **1b**	 **7**	24	98
8	 **4a**	 **1b**	 **8**	11	98
9	 **4a**	 **2b**	 **9**	13	92
10	 **4a**	 **3b**	 **10**	15	94

Table 2. continuation

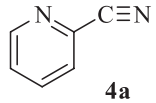
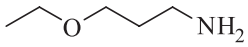
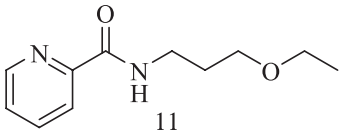
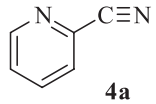
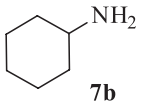
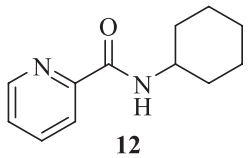
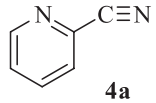
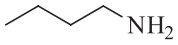
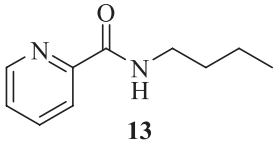
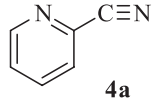
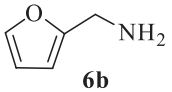
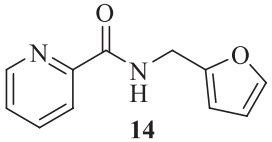
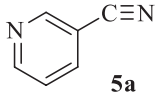
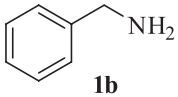
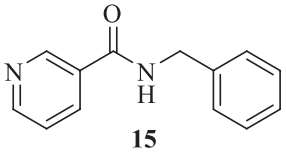
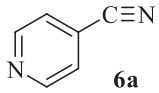
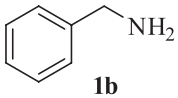
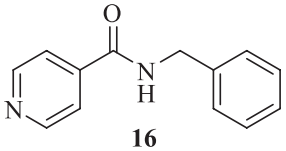
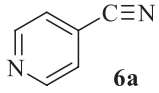
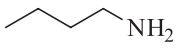
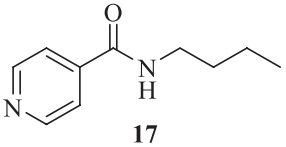
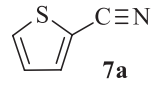
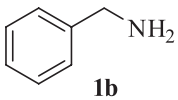
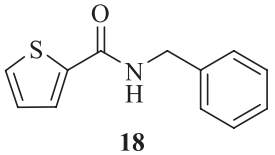
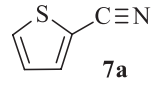
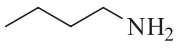
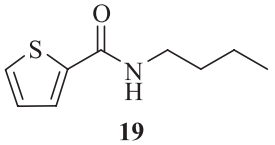
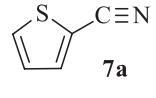
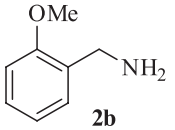
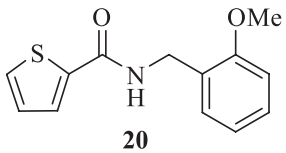
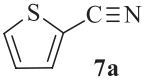
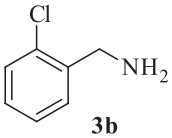
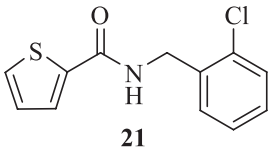
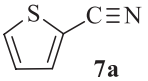
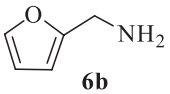
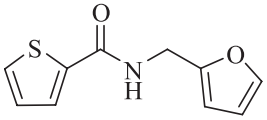
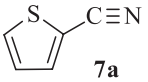
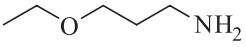
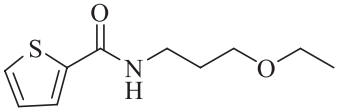
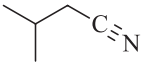
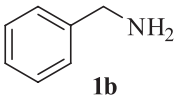
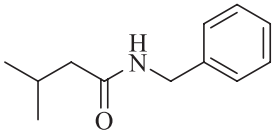
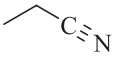
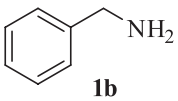
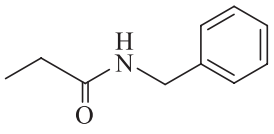
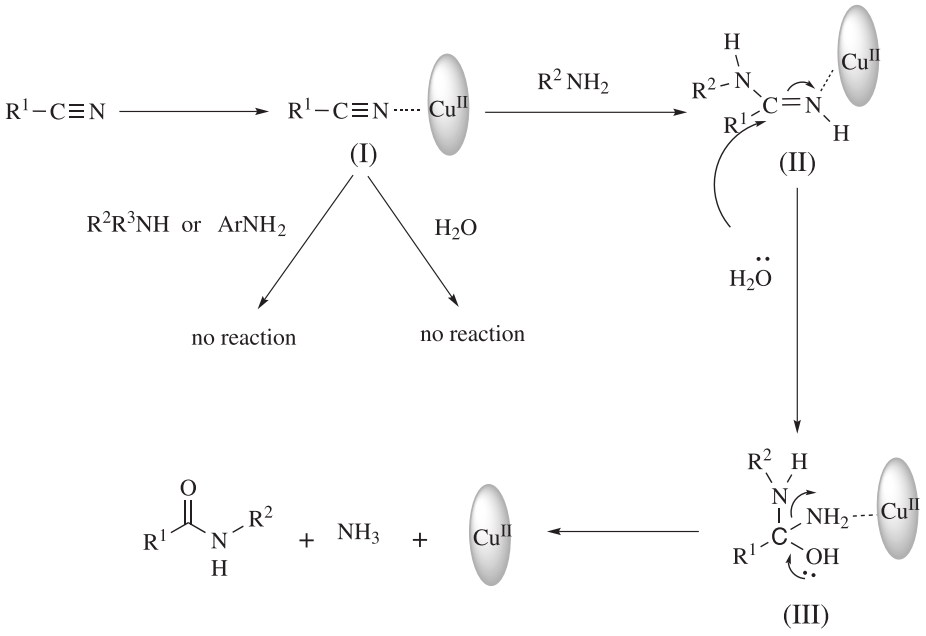
entry	Nitrile	Amine	Product	time / h	Yield / %
11	 **4a**	 **5b**	 11	16	90
12	 **4a**	 **7b**	 **12**	19	90
13	 **4a**	 **4b**	 **13**	14	92
14	 **4a**	 **6b**	 **14**	17	91
15	 **5a**	 **1b**	 **15**	16	92
16	 **6a**	 **1b**	 **16**	15	90
17	 **6a**	 **4b**	 **17**	18	96
18	 **7a**	 **1b**	 **18**	10	97
19	 **7a**	 **4b**	 **19**	15	98
20	 **7a**	 **2b**	 **20**	12	97

Table 2. continuation

entry	Nitrile	Amine	Product	time / h	Yield / %
21	 **7a**	 **3b**	 **21**	13	95
22	 **7a**	 **6b**	 **22**	15	93
23	 **7a**	 **5b**	 **23**	17	95
24	 **8a**	 **1b**	 **24**	24	73
25	 **9a**	 **1b**	 **25**	23	78



Scheme 3. A proposed mechanism for the formation of *N*-substituted amides.

mechanistic studies are required to confirm this mechanism. The catalytic activity of $[Cu(2,3\text{-tmtppa})](MeSO_4)_4$ was examined for the reaction of alkyl and aryl nitriles with secondary amines and aryl amines. Surprisingly, even after long period of time, secondary amines and aryl amines remain intact in the reaction medium.

[Cu(2,3-tmtppa)]$(MeSO_4)_4$ acts as a recyclable catalyst for one pot amide formation from various nitriles and primary amines in refluxing H_2O, which provides a new and green catalytic system for *N*-substituted amide synthesis. The catalyst can be easily recovered from the reaction mixture by extraction of organic compounds (3 × 5 mL CH_2Cl_2). The aqueous layer was evaporated and the catalyst was washed with CH_2Cl_2 three times to remove the products followed by drying in air at room temperature. Using this treatment, the recyclabilty of the catalsyt was evaluated for the reaction of phenylacetonitrile with benzyl amine (Table 3). The recovered catalyst was reused at least four times without any decrease in the yield of the *N*-benzyl-2-phenylacetamide. The 5th run gave 95% conversion after 19 h, but complete conversion and similar yield was obtained after 25 h.

Table 3. Reaction of phenylacetonitrile with benzylamine in the presence of reused catalyst

entry	time / h	Conversion / %	Isolated yield / %
1	19	100	98
2	19	100	98
3	19	100	95
4	19	100	97
5[a]	25/19	100/95	95
6[a]	25/19	100/95	96

[a]The second numbers in the third column correspond to yields after 19 h.

The results obtained (Table 2) clearly demonstrate that this method is inapplicable to synthesis of primary and *N,N*-disubstituted amides. The catalytic activity of [Cu(2,3-tmtppa)]$(MeSO_4)_4$ in this reaction is selective.

In our experiments, the completion of the reaction was confirmed by the disappearance of the nitrile on TLC followed by the disappearance of CN stretching frequency at 2230 cm^{-1} in the FTIR spectra. Also, absorption bands at 1677-1612 and 3396-3284 cm^{-1} due to carbonyl and NH group of *N*-substituted amide in FTIR spectra confirmed the amide formation. In the ^{1}H NMR spectrum, the NH proton of *N*-substituted amide showed a downfield shift as compared to the NH_2 protons of amine. In the ^{13}C NMR spectrum, a signal at 173-161 ppm is assigned to the quaternary carbonyl carbon. The structure of all products was further confirmed by mass spectroscopy and CHN analysis.

Conclusions

In this study, our group not only investigated another catalytic activity of [Cu(2,3-tmtppa)]$(MeSO_4)_4$ in organic synthesis, but also introduced an efficient, clean, convenient, practical and selective synthesis of *N*-substituted amides from the reaction of alkyl and aryl nitriles with amines in green solvent.

This process is attractive in comparison with the conventional methods because this method offers several advantages: (*i*) the reaction proceeds smoothly and selectively with a wide range of amides (aliphatic and aromatic *N*-substituted); (*ii*) the catalyst is stable and reusable that offers easy handling and simple work-up; (*iii*) this method has satisfactory yields of a variety of amides;[49] (*iv*) in contrast to the previously reported catalytic systems, which proceeded by hydration of nitrile to the primary amide and subsequent transamidation with amine, in the present method, amides are produced by direct reaction of nitriles with amines; (*v*) in comparison with the previous methods, nitriles are storage-stable and less corrosive substrates.

Supplementary Information

Supplementary data and spectra of the synthesized compounds are available free of charge at http://jbcs.sbq.org.br as PDF file.

Acknowledgment

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Supplementary Information

Green and Selective Synthesis of *N*-Substituted Amides using Water Soluble Porphyrazinato Copper(II) Catalyst

Sara S. E. Ghodsinia,[a] Batool Akhlaghinia,*[,a] Elham Safaei,[b] and Hossein Eshghi[a]

[a]*Department of Chemistry, Faculty of Sciences, Ferdowsi University of Mashhad, 9177948974 Mashhad, Islamic Republic of Iran*

[b]*Department of Chemistry, Institute for Advanced Studies in Basic Sciences (IASBS), 45137-66731 Zanjan, Islamic Republic of Iran*

Experimental

General

The products were purified by column chromatography. The purity determinations of the products were accomplished by thin layer chromatography (TLC) on silica gel polygram STL G/UV 254 plates. The melting points of products were determined with an Electrothermal Type 9100 melting point apparatus. The Fourier transform infrared (FTIR) spectra were recorded on an Avatar 370 FTIR Therma Nicolet spectrometer. The nuclear magnetic resonance (NMR) spectra were provided on Brucker Avance 100 and 400 MHz instruments in $CDCl_3$. Elemental analyses were performed using an Elementar, Vario EL V5.19.1121 and Thermofinnigan Flash EA 1112 Series instruments. Mass spectra (MS) were recorded with a Shimadzu GC-MS-QP5050 and CH7AV arianmat Bremem instruments at 70 eV.

Preparation of *N*-benzyl-2-phenylacetamide from phenyl acetonitrile and benzylamine (**1**)

To a solution of phenylacetonitrile (0.1171 g, 1 mmol) in H_2O (1 mL), $[Cu(2,3\text{-tmtppa})](MeSO_4)_4$ (0.0054 g, 0.5 mol%) was added at room temperature with continuous stirring. Benzylamine (0.2143 g, 2 mmol) was added with stirring at room temperature. The temperature was raised up to 100 °C. The progress of the reaction was followed by TLC. Upon completion of the reaction, the reaction mixture was extracted with 3 × 5 mL CH_2Cl_2. The organic layer was dried with anhydrous Na_2SO_4 and concentrated under reduced pressure. The resultant crude viscous product was recrystallized from *n*-hexane:dichloromethane (4:1) obtaining 0.2207 g of pale yellow crystals (98% yield).

*e-mail: akhlaghinia@um.ac.ir

Characterization data of spectra for representative compounds

N-Benzyl-2-phenylacetamide (**1**)

mp 118-120 °C (lit. 118-120 °C);[1] FTIR (KBr) ν_{max}/cm^{-1} 3289 (N–H), 3080, 3062, 3030, 2917, 1638 (C=O), 1551, 1493, 1453, 1028, 771, 694; ^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm 7.34-7.24 (m, 9H, ArH), 7.17 (d, 1H, *J* 4.76 Hz, ArH), 6.06 (br, 1H, NH), 4.42 (d, 2H, *J* 5.6 Hz, $\underline{CH_2}NH$), 3.61 (s, 2H, $\underline{CH_2}CO$); ^{13}C NMR (100 MHz, $CDCl_3$) δ/ppm 170.6, 137.5, 135.0, 129.6, 129.6, 128.9, 128.8, 127.3, 126.7, 43.9, 42.9.

N-(2-Methoxybenzyl)-2-phenylacetamide (**2**)

mp 88-90 °C; FTIR (KBr) ν_{max}/cm^{-1} 3281(N–H), 3076, 3027, 2917, 1645 (C=O), 1603, 1550, 1491, 1455, 1242, 1028, 753, 699; ^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm 7.35-7.21 (m, 7H, ArH), 6.91 (t, 1H, *J* 7.6 Hz, ArH), 6.83 (d, 1H, *J* 8.4 Hz, ArH), 6.05 (br, 1H, NH), 4.42 (d, 2H, *J* 5.6 Hz, $\underline{CH_2}NH$), 3.69 (s, 3H, $O\underline{CH_3}$), 3.61 (s, 2H, $\underline{CH_2}CO$); ^{13}C NMR (100 MHz, $CDCl_3$) δ/ppm 170.6, 157.5, 135.0, 129.6, 129.6, 128.9, 128.8, 127.3, 126.0, 120.7, 110.2, 55.1 , 43.9, 39.9; MS (EI) *m/z* (%) 255 [M^+], 254 (100) [$M^+ - H$], 253 (100) [$M^+ - 2H$], 136 [$M^+ - C_7H_8O$], 121 (100) [$M^+ - C_8H_8NO$], 91 [$C_7H_7^+$]; CHN ($C_{16}H_{17}NO_2$) calc. (%) C (75.27), H (6.71), N (5.49); found (%) C (74.99), H (6.78), N (5.52).

N-Butyl-2-phenylacetamide (**3**)

mp 35-37 °C (Lit. 37-38 °C);[2] FTIR (Neat) ν_{max}/cm^{-1} 3354 (N–H), 3178, 3080, 3064, 3027, 2802, 1638 (C=O), 1491, 1416, 1286, 1180, 747, 698; ^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm 7.40-7.29 (m, 5H, ArH), 5.61 (br, 1H, NH), 3.56 (s, 2H, $\underline{CH_2}CO$), 3.18 (q, 2H, *J* 6.8 Hz, $NH\underline{CH_2}CH_2$), 1.38 (qn, 2H, *J* 6.8 Hz, $CH_2\underline{CH_2}Et$), 1.23 (sx, 2H, *J* 7.2 Hz, $CH_2\underline{CH_2}CH_3$), 0.85 (t, 3H, *J* 7.2 Hz, CH_2CH_3); ^{13}C NMR

(100 MHz, $CDCl_3$) δ/ppm 173.5, 134.9, 129.5, 129.1, 127.5, 43.6, 39.5, 31.2, 19.7, 13.4.

N-(3-Ethoxypropyl)-2-phenylacetamide (**4**)

mp 136-138 °C; FTIR (KBr) ν_{max}/cm^{-1} 3352 (N–H), 3180, 3062, 3028, 2974, 2867, 1647 (C=O), 1550, 1496, 1453, 1416, 1289, 1114, 747, 700; ^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm 7.41-7.29 (m, 5H, ArH),5.85 (br, 1H, NH), 3.81 (s, 2H, CH_2CO), 3.64-3.59 (m, 4H, NH$\underline{CH_2}CH_2\underline{CH_2}O$), 3.542 (q, 2H, *J* 7.2 Hz, OCH_2CH_3), 1.95 (qn, 2H, *J* 6.4 Hz, $CH_2\underline{CH_2}CH_2O$), 1.29 (t, 3H, *J* 7.2 Hz, $CH_2\underline{CH_3}$); ^{13}C NMR (100 MHz, $CDCl_3$) δ/ppm 171.1, 135.1, 129.5, 129.1, 127.5, 69.4, 66.3, 41.8, 38.5, 29, 15.1; MS (EI) *m/z* (%) 221 [M^+], 219 [$M^+ - 2H$], 191 [$M^+ - C_2H_5$], 134 (100) [$M^+ - C_5H_{11}O$], 91 [$C_7H_7^+$]; CHN ($C_{13}H_{19}NO_2$) calc. (%) C (70.56), H (8.65), N (6.33); found (%) C (69.94), H (8.26), N (6.24).

N-Benzyl-2-(4-chlorophenyl)acetamide (**5**)

mp 150-151 °C (Lit. 151-153 °C);[3] FTIR (KBr) ν_{max}/cm^{-1} 3279 (N–H), 3056, 3027, 2913, 2872, 1644 (C=O), 1594, 1542, 1492, 1453, 1417, 1086, 1013, 800, 742, 692: ^{1}H NMR (100 MHz, $CDCl_3$) δ/ppm 7.52–6.97 (m, 9H, ArH), 5.74 (br, 1H, NH), 4.44 (d, 2H, *J* 6 Hz, $\underline{CH_2}NH$), 3.56 (s, 2H, $\underline{CH_2}CO$).

N-Butyl-2-(4-chlorophenyl)acetamide (**6**)

mp 80-81 °C; FTIR (KBr) ν_{max}/cm^{-1} 3301 (N–H), 3066, 2959, 2931, 2872, 1649 (C=O), 1595, 1543, 1492, 1417, 1089, 804, 740; ^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm 7.36 (d, 2H, *J* 8 Hz, ArH), 7.21(d, 2H, *J* 8.4 Hz, ArH), 5.47 (br, 1H, NH), 3.53 (s, 2H, *J* 6 Hz, $\underline{CH_2}CO$), 3.22 (q, 2H, *J* 6.8 Hz, NH$\underline{CH_2}CH_2$), 1.43 (qn, 2H, *J* 6.8 Hz, $CH_2\underline{CH_2}Et$), 1.29 (sx, 2H, *J* 7.2 Hz, $CH_2\underline{CH_2}CH_3$), 0.90 (t, 3H, *J* 7.2 Hz, $CH_2\underline{CH_3}$); ^{13}C NMR (100 MHz, $CDCl_3$) δ/ppm 170.3, 133.5, 133.3, 130.8, 129.1, 43.1, 39.5, 31.6, 20.0, 13.7; MS (EI) *m/z* (%) 227 [$M^+ + 2$], 225 [M^+], 190 [$M^+ - Cl$], 125 [$M^+ - C_5H_{10}NO$], 100 [$M^+ - C_7H_6Cl$], 57 (100) [$C_4H_9^+$]; CHN ($C_{12}H_{16}ClNO$) calc. (%) C (63.85), H (7.14), N (6.21); found (%) C (64.32), H (7.49), N (6.63).

N-Benzylbenzamide (**7**)

mp 89-90 °C (Lit. 90-91 °C);[4] FTIR (KBr) ν_{max}/cm^{-1} 3342(N–H), 3088, 3063, 3029, 2861,1643(C=O), 1603, 1540, 1494, 1453,1361, 1207, 1071, 1027, 736, 697; ^{1}H NMR (100 MHz, $CDCl_3$) δ/ppm 7.92-7.18 (m, 10H, ArH), 6.46 (br, 1H, NH), 4.68 (d, 2H, *J* 5.56 Hz, $\underline{CH_2}NH$).

N-Benzylpicolinamide (**8**)

mp 84-85 °C (Lit. 85 °C);[5] FTIR (KBr) ν_{max}/cm^{-1} 3305 (N–H), 3080, 3031, 2920, 1660(C=O), 1527, 1457, 1433, 1355, 1251, 1081, 999, 744, 702, 689; ^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm 8.55 (d, 1H, Pyr), 8.42 (br, 1H, NH), 8.26 (d, 1H, Pyr), 7.88 (td, 1H, J_1 7.6 Hz, J_2 1.2 Hz, Pyr), 7.46-7.43 (m, 1H, Pyr), 7.41-7.29 (m, 5 H, ArH) 4.70 (d, 2H, *J* 6.0 Hz, $\underline{CH_2}NH$); ^{13}C NMR (100 MHz, $CDCl_3$) δ/ppm 164.3, 149.8, 148.1, 138.2, 137.4, 128.7, 127.9, 127.5, 126.3, 122.4, 43.5; CHN ($C_{13}H_{12}N_2O$) calc. (%) C (73.56), H (5.7), N (13.2); found (%) C (73.15), H (5.7), N (3.16).

N-(2-Methoxybenzyl)picolinamide (**9**)

mp 89-91°C; FTIR (KBr) ν_{max}/cm^{-1} 3396 (N–H), 3072, 2966, 2835, 1665 (C=O), 1593, 1524, 1493,1462, 1437,1247, 1119, 997, 816, 755, 616; ^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm 8.56 (d, 1H, *J* 4.4 Hz, Pyr), 8.49 (br, 1H, NH), 8.24 (d, 1H, *J* 8 Hz, Pyr), 7.82 (td, 1H, J_1 7.6 Hz, J_2 1.6 Hz, Pyr), 7.44-7.41 (m, 1H, Pyr), 7.39-7.27 (m, 2H, ArH), 6.97-6.91 (m, 2H, ArH), 4.70 (d, 2H, *J* 6 Hz, $\underline{CH_2}NH$), 3.92 (s, 3H,CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) δ/ppm 164.1, 157.7, 150.2, 148.1, 137.3, 129.6, 128.8, 126.3, 126.0, 122.4, 120.6, 110.3, 55.4, 39.1.

N-(2-Chlorobenzyl)picolinamide (**10**)

mp 84-85 °C (Lit. 84-85 °C);[6] FTIR (KBr) ν_{max}/cm^{-1} 3321 (N–H), 3076, 3056, 2913, 1663(C=O), 1593, 1564, 1528, 1464, 1444, 1432, 1286, 1041, 1004, 745, 686; ^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm 8.56 (d, *J* 4.4 Hz, 1H, Pyr), 8.53 (br, 1H, NH), 8.23 (d, 1H, *J* 7.6 Hz, Pyr), 7.86 (td, 1H, J_1 7.6 Hz, J_2 1.2 Hz, Pyr), 7.48-7.24 (m, 5H, Pyr, ArH), 4.78 (d, 2H, *J* 6 Hz, $\underline{CH_2}NH$); ^{13}C NMR (100 MHz, $CDCl_3$) δ/ppm 164.4, 149.7, 148.2, 137.4, 135.7, 133.7, 130.0, 129.6, 128.9, 127.1, 126.3, 122.4, 41.4; CHN ($C_{13}H_{11}ClN_2O$) calc. (%) C (63.29), H (4.49), N (11.36); found (%). C (62.86), H (4.22), N (10.93).

N-(3-Ethoxypropyl)picolinamide (**11**)

Oil; FTIR (neat) ν_{max}/cm^{-1} 3350 (N–H), 3060, 2974, 2930, 2867, 2798, 1675 (C=O), 1569, 1527, 1464, 1434, 1377, 1282, 1112, 997, 824, 751, 691; ^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm 8.56 (*d*, 1H, *J* 4 Hz, Pyr), 8.50 (br, 1H, NH), 8.21 (d, 1H, *J* 8 Hz, Pyr), 7.86 (td, 1H, J_1 7.6 Hz, J_2 1.6 Hz, Pyr), 7.44 -7.41 (m, 1H, Pyr), 3.64-3.59 (m, 2H, $CH_2\underline{CH_2}OEt$, 2H, $O\underline{CH_2}CH_3$), 3.54 (q, 2H, *J* 7.2 Hz, NH$\underline{CH_2}CH_2$), 1.93 (qn, 2H, *J* 6.4 Hz, $CH_2\underline{CH_2}CH_2$), 1.28 (t, 3H, *J* 6.8 Hz, $OCH_2\underline{CH_3}$); ^{13}C NMR (100 MHz, $CDCl_3$) δ/ppm 164.3, 150.9, 148.1, 137.3, 126.00, 122.1, 69.3, 66.5, 37.8, 29.3, 15.2; MS (EI) *m/z* (%) 208 [M^+], 179 [$M^+ - C_2H_5$], 163 [$M^+ - C_2H_5O$], 149 [$M^+ - C_3H_7O$], 135 [$M^+ - C_4H_9O$], 106 [$C_6H_4NO^+$], 78 [$C_5H_4N^+$]; CHN ($C_{11}H_{16}N_2O_2$) calc. (%) C (63.44), H (7.74), N (13.45). found (%) C (63.04), H (7.65), N (13.67).

N-Cyclohexylpicolinamide (**12**)

mp 50-51 °C; FTIR (KBr) ν_{max}/cm^{-1} 3345 (N–H), 3064, 2931, 2850, 2965, 1677 (C=O), 1568, 1525, 1462, 1425, 1323, 1278, 1164, 1084, 996, 976, 891, 821, 753, 651, 619; ^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm 8.56 (d, 1H, *J* 4.4 Hz, Pyr), 8.22 (d, 1H, *J* 7.6 Hz, Pyr), 7.98 (br, 1H, NH), 7.85 (td, 1H, J_1 7.8 Hz, J_2 2 Hz, Pyr), 7.44-7.42 (m, 1H, Pyr), 4.04-3.94 (m, 1H, CHNH), 2.05-2.01 (m, 2H, CH_2CH_2CH), 1.82-1.76 (m, 2H, CH_2CH_2CH), 1.70-1.20 (m, 6H, $CH_2CH_2CH_2$); ^{13}C NMR (100 MHz, $CDCl_3$) δ/ppm 163.3, 150.3, 147.9, 137.3, 126.0, 122.2, 48.2, 33.1, 30.4, 25.6, 24.9, 23.0.

N-Butylpicolinamide (**13**)

Oil; FTIR (Neat) ν_{max}/cm^{-1} 3391 (N–H), 3056, 2958, 2930, 2871, 1670 (C=O), 1590, 1568, 1527, 1464, 1434, 1275, 1261, 997, 765, 749, 691; ^{1}H NMR (100 MHz, $CDCl_3$) δ/ppm 8.54-8.43 (d, 1H, *J* 3.5 Hz, Pyr), 8.25-8.15 (d, 1H, *J* 7.5 z, Pyr), 8.05 (br, 1H, NH), 7.93-7.7 (t, 1H, *J* 7.6 Hz, Pyr), 7.5-7.3 (m, 1H, Pyr), 3.49 (q, 2H, $NHCH_2CH_2$), 1.84-1.19 (m, 4H, $CH_2CH_2CH_2CH_3$), 1.12-0.79 (t, 3H, *J* 7.3 Hz, CH_2CH_3).

N-(Furan-2-ylmethyl)picolinamide (**14**)

mp 100-102 °C; FTIR (KBr) ν_{max}/cm^{-1} 3344 (N–H), 3133, 3105, 3047, 2925, 1661 (C=O), 1525, 1464, 1352, 1306, 1212, 1148, 1014, 927, 745, 664, 600; ^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm 8.56 (d, 1H, *J* 3.6 Hz, Pyr), 8.37 (br, 1H, NH), 8.24 (d, 1H, *J* 7.6 Hz, Pyr), 7.87 (td, 1H, J_1 7.6 Hz, J_2 1.2 Hz, Pyr), 7.40 (t, 1H, *J* 6.4 Hz, Pyr), 6.52 (d, 1H, *J* 0.8 Hz, furan), 6.36-6.31 (m, 2H, furan), 4.68 (d, 2H, *J* 6 Hz, CH_2NH); ^{13}C NMR (100 MHz, $CDCl_3$) δ/ppm 164.2, 151.3, 149.7, 148.1, 142.3, 137.4, 126.3, 122.4, 110.4, 107.5, 36.5; MS (EI) *m/z* (%) 202 [M$^+$], 106 [M$^+$ – C_5H_6NO], 96 (100) [M$^+$ – C_6H_4NO], 81 [M$^+$ – $C_6H_5N_2O$]; CHN ($C_{11}H_{10}N_2O_2$) calc. (%) C (65.34), H (4.98), N (13.85); found (%) C (66.09), H (4.93), N (13.91).

N-Benzylnicotinamide (**15**)

mp 72-74 °C (Lit. 73-74 °C);[7] FTIR (KBr) ν_{max}/cm^{-1} 3295, 3088, 3055, 3038, 2930, 1634, 1592, 1547, 1482, 1457, 1453, 1420, 1306, 1233, 1157, 1081, 1024, 750, 704 , 670; ^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm 9.01 (s, 1H, Pyr), 8.75 (d, 1H, *J* 4 Hz, Pyr), 8.17 (d, 1H, *J* 8 Hz, Pyr), 7.44-7.29 (m, 5H, ArH ,1H, Pyr); 6.50 (br, 1H, NH); 4.70 (d, 2H, *J* 5.6 Hz, CH_2NH); ^{13}C NMR (100 MHz, $CDCl_3$) δ/ppm 165.55, 152.23, 147.9, 137.78, 135.32, 130.13, 128.87, 127.99, 127.80, 123.57, 44.21; CHN ($C_{13}H_{12}N_2O$) calc. (%) C (73.56), H (5.7), N (13.2); found (%) C (73.08), H (5.64), N (13.52).

N-Benzylisonicotinamide (**16**)

mp 81-83 °C (Lit. 83-85 °C);[7] FTIR (KBr) ν_{max}/cm^{-1} 3313 (N–H), 3060, 3027, 2880, 2843, 1646 (C=O), 1599, 1543, 1494, 1452, 1413, 1300, 845, 735, 697; ^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm 8.91 (d, 2H, *J* 4.4 Hz, Pyr), 7.77 (d, 2H, *J* 4.8 Hz, Pyr), 7.45-7.29 (m, 5H, ArH), 6.95 (br, 1H, NH), 4.64 (d, 2H, *J* 5.2 Hz, CH_2NH); ^{13}C NMR (100 MHz, $CDCl_3$) δ/ppm 165.6, 150.4, 141.3, 137.5, 128.9, 128.0, 127.7, 122.0, 44.3.

N-Butylisonicotinamide (**17**)

mp 41-42 °C (Lit. 41-42 °C);[4] FTIR (KBr) ν_{max}/cm^{-1} 3312 (N–H), 2958, 2931, 2872, 1650 (C=O), 1600, 1552, 1491, 1409, 1308, 1218, 1066, 998, 847, 758, 670; ^{1}H NMR (100 MHz, $CDCl_3$) δ/ppm 8.67 (d, 2H, *J* 4.7 Hz, Pyr), 7.63 (d, 2H, *J* 3.09 Hz, Pyr), 6.95 (br, 1H, NH), 3.43 (q, 2H, *J* 4 Hz, CH_2CH_2NH), 1.85-1.17 (m, 4H, $CH_2CH_2CH_2CH_3$), 0.91 (t, 3H, *J* 4.5 Hz, CH_2CH_3).

N-Benzylthiophene-2-carboxamide (**18**)

mp 116-118 °C (Lit. 119.5-120.5 °C);[8] FTIR (KBr) ν_{max}/cm^{-1} 3351 (N–H), 3109, 3088, 3064, 3031, 2929, 1622 (C=O), 1545, 1511, 1422, 1303, 1246, 861, 772, 718, 696; ^{1}H NMR (100 MHz, $CDCl_3$) δ/ppm 7.62-7.45 (m, 2H, thiophene), 7.4-7.2 (m, 1H, thiophene, 4H, ArH), 7.04 (t, 1H, *J* 4 Hz, ArH), 6.36 (br, 1H, NH), 4.61 (d, 2H, *J* 6 Hz, CH_2NH); CHN ($C_{12}H_{11}NOS$) calc. (%) C (66.33), H (5.10), N (6.45), S (14.76); found (%) C (66.8), H (5.33), N (6.95), S (13.99).

N-Butylthiophene-2-carboxamide (**19**)

mp 64-66 °C (Lit. 67-68 °C);[9] FTIR (KBr) ν_{max}/cm^{-1} 3280 (N–H), 3105, 3084, 2953, 2924, 2876, 1612 (C=O), 1557, 1421, 1356, 1307, 1247, 1220, 1139, 980, 869, 772, 735; ^{1}H NMR (100 MHz, $CDCl_3$) δ/ppm 7.65-7.38 (m, 2H, thiophene), 7.05 (t, 1H, *J* 3.8 Hz, thiophene), 6.11(br, 1H, NH), 3.4 (q, 2H, *J* 4.8 Hz, $NHCH_2CH_2$), 1.75-1.13 (m, 4H, $CH_2CH_2CH_2CH_3$), 0.94 (t, 3H, *J* 6 Hz, CH_2CH_3); CHN ($C_9H_{13}NOS$) calc. (%) C (58.98), H (7.15), N (7.64), S (17.50); found (%) C (59.02), H (7.38), N (7.66), S (17.28).

N-(2-Methoxybenzyl)thiophene-2-carboxamide (**20**)

mp 154-156 °C (Lit. 157-159 °C);[9] FTIR (KBr) ν_{max}/cm^{-1} 3311 (N–H), 3084, 3015, 2831, 1618 (C=O), 1553, 1461, 1295, 1247, 1106, 1026, 771, 732; ^{1}H NMR (100 MHz, $CDCl_3$) δ/ppm 7.58-7.12 (m, 3H, thiophene, 1H, ArH), 7.12-6.85 (m, 3H, ArH), 6.69 (br, 1H, NH), 4.6 (d, 2H, *J* 4.5 Hz, CH_2NH), 3.83 (s, 3H, OCH_3); CHN ($C_{13}H_{13}NO_2S$) calc. (%) C (63.13), H (5.3), N (5.66), S (12.9); found (%) C (62.93), H (5.57), N (6.19), S (12.7).

N-(2-Chlorobenzyl)thiophene-2-carboxamide (**21**)

mp 116-118 °C; FTIR (KBr) ν_{max}/cm^{-1} 3306 (N–H), 3080, 2958, 2908, 2851, 1620 (C=O), 1553, 1442, 1417, 1301, 1246, 1147, 1037, 755, 724, 681; ^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm 7.55 (dd, 1H, J_1 3.8 Hz, J_2 2.8 Hz, thiophene); 7.51-7.47 (m, 2H, thiophene), 7.42-7.37 (m, 1H, ArH), 7.32-7.23 (m, 2H, ArH), 7.09 (dd, 1H, J_1 5 Hz, J_2 1.2 Hz, ArH), 6.56 (br, 1H, NH), 4.72 (d, 2H, J 6.4 Hz, $\underline{CH_2}NH$); ^{13}C NMR ($CDCl_3$, 100 MHz) δ/ppm 162.1, 138.7, 135.5, 133.5, 130.3, 129.5, 129.0, 128.4, 127.7, 127.4, 127.1, 41.8; MS (EI) *m/z* (%) 253 [M$^+$+2], 251 [M$^+$], 216 [M$^+$ – Cl], 139 [M$^+$ – C_5H_4OS], 126 [$C_7H_6C^+$l], 111 [M$^+$ – C_7H_7ClN], 57 [$C_2H_3NO^{2+}$]; CHN ($C_{12}H_{10}ClNOS$) calc. (%) C (57.25), H (4.00), N (5.56), S (12.74); found (%) C (57.41), H (4.25), N (5.75), S (12.55).

N-(Furan-2-ylmethyl)thiophene-2-carboxamide (**22**)

mp 97-100 °C (Lit. 100-102 °C);[10] FTIR (KBr) ν_{max}/cm^{-1} 3284 (N–H), 3076, 2933, 2835, 1620 (C=O), 1550, 1515, 1413, 1308, 1200, 1148, 1003, 859, 711, 668; ^{1}H NMR (100 MHz, $CDCl_3$) δ/ppm 7.67-7.22 (m, 3H, thiophene), 7.02 (t, 1H, J 3.2 Hz, furan), 6.65 (br, 1H, NH), 6.42-6.18 (m, 2H, furan), 4.6 (d, 2H, J 5.5 Hz, $\underline{CH_2}NH$); CHN ($C_{10}H_9NO_2S$) calc. (%) C (57.95), H (4.38), N (6.76), S (15.47); found (%) C (8.35), H (4.63), N (7.04), S (15.43).

N-(3-Ethoxypropyl)thiophene-2-carboxamide (**23**)

mp 56-58 °C; FTIR (KBr) ν_{max}/cm^{-1} 3309 (N–H), 3084, 2979, 2872, 2796, 1615 (C=O), 1555, 1515, 1354, 1221, 1105, 1053, 953, 861, 812, 719; ^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm 7.48 (dd, 1H, J_1 3.6 Hz, J_2 1.2 Hz, thiophene), 7.46 (dd, 1H, J_1 4.8 Hz, J_2 1.2 Hz, thiophene), 7.08 (t, 1H, J 2.4 Hz, thiophene), 6.21 (br, 1H, NH), 3.63 (t, 2H, J 5.6 Hz, $CH_2\underline{CH_2}OEt$), 3.60-3.51 (m, 4H, $\underline{CH_2}CH_3$,$\underline{CH_2}NH$), 1.89 (qn, 2H, J 5.6 Hz, $CH_2\underline{CH_2}CH_2$), 1.27 (t, 3H, J 7.2 Hz, $CH_2\underline{CH_3}$); ^{13}C NMR ($CDCl_3$, 100 MHz) δ/ppm 161.8, 139.5, 129.5, 127.7, 127.5, 70.3, 66.6, 39.2, 28.9, 15.4; MS (EI) *m/z* (%) 213 [M$^+$], 183 [M$^+$ – C_2H_6], 168 [M$^+$ – C_2H_5O], 140 [M$^+$ – C_4H_9O], 111 (100) [$C_5H_3OS^+$]; CHN ($C_{10}H_{15}NO_2S$) calc. (%) C (56.31), H (7.09), N (6.57), S (15.03); found (%) C (56.86), H (7.64), N (6.88), S (14.79).

N-Benzyl-3-methylbutanamide (**24**)

mp 56-58 °C (Lit. 58-59 °C);[11] FTIR (KBr) ν_{max}/cm^{-1} 3275 (N–H), 3062, 3028, 2960, 2949, 2873, 1643 (C=O), 1578, 1495, 1425, 1336, 737, 695.

N-Benzylpropionamide (**25**)

mp 40-42 °C (Lit. 42-43 °C);[12] FTIR (KBr) ν_{max}/cm^{-1} 3266 (N–H), 3130, 3063, 3032, 2975, 2937, 1658 (C=O), 1463, 1278, 1172, 1075, 997, 813, 700.

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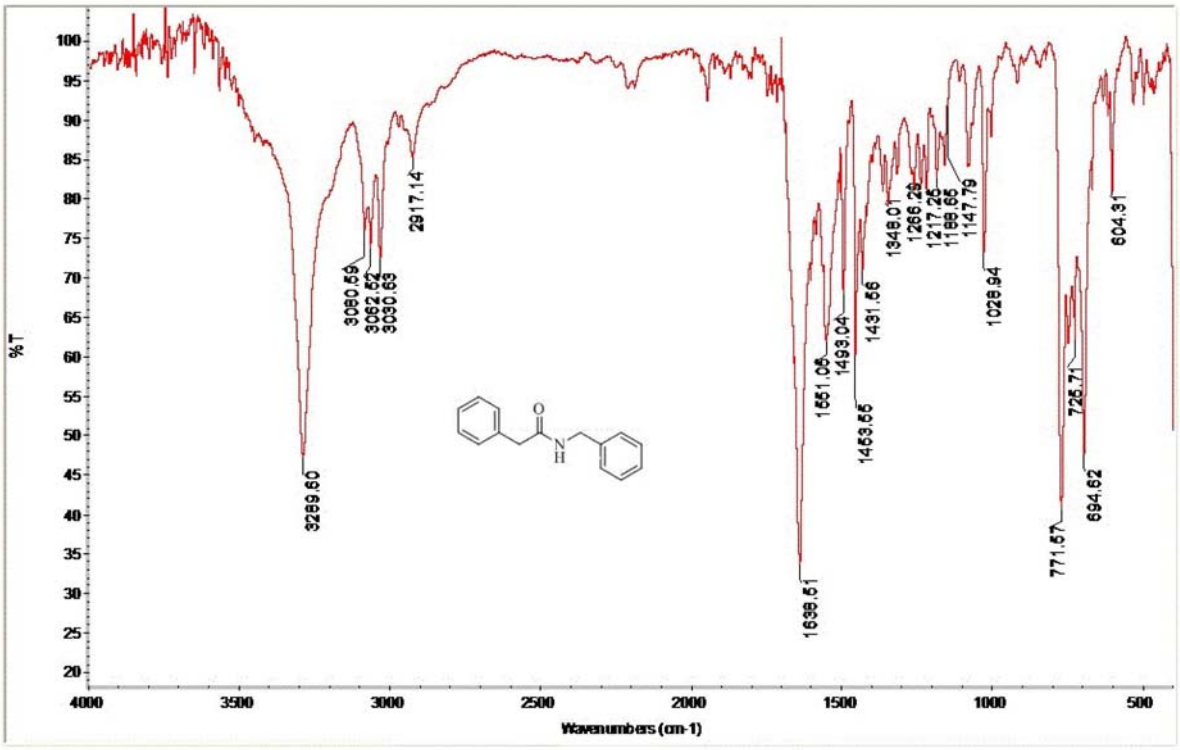

Figure S1. FTIR spectrum of *N*-benzyl-2-phenylacetamide (**1**).

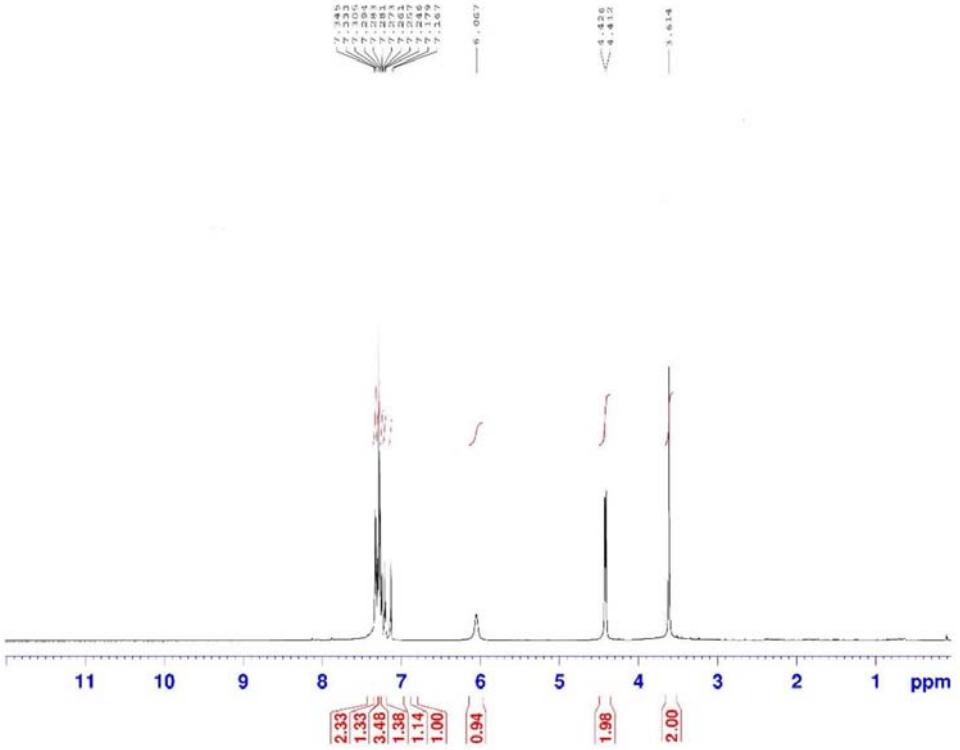

Figure S2. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-benzyl-2-phenylacetamide (**1**).

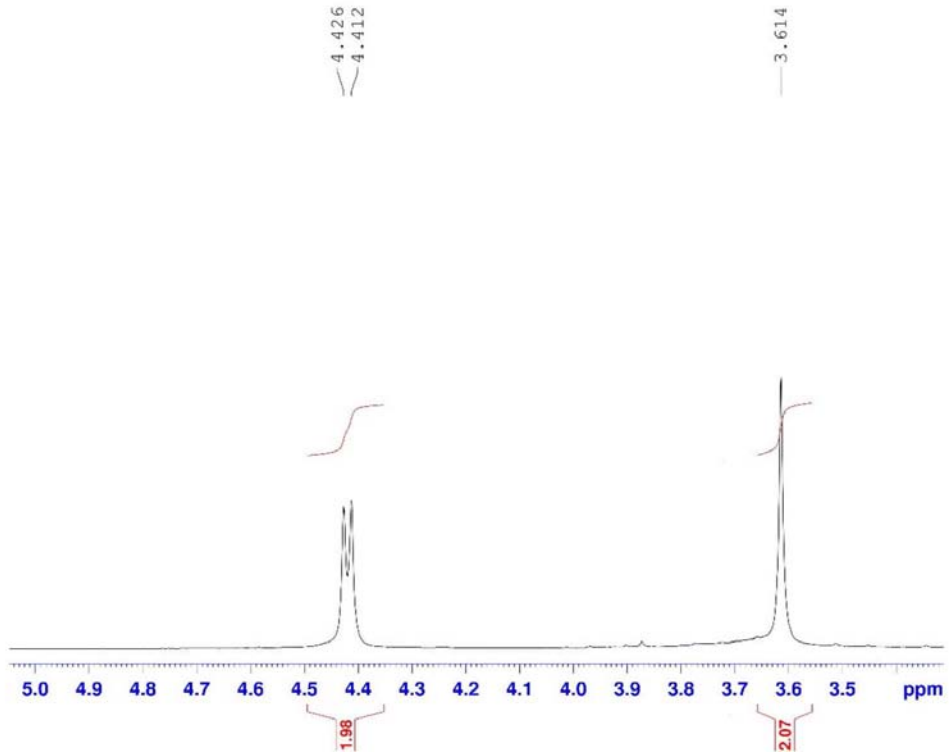

Figure S3. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-benzyl-2-phenylacetamide (**1**) expanded.

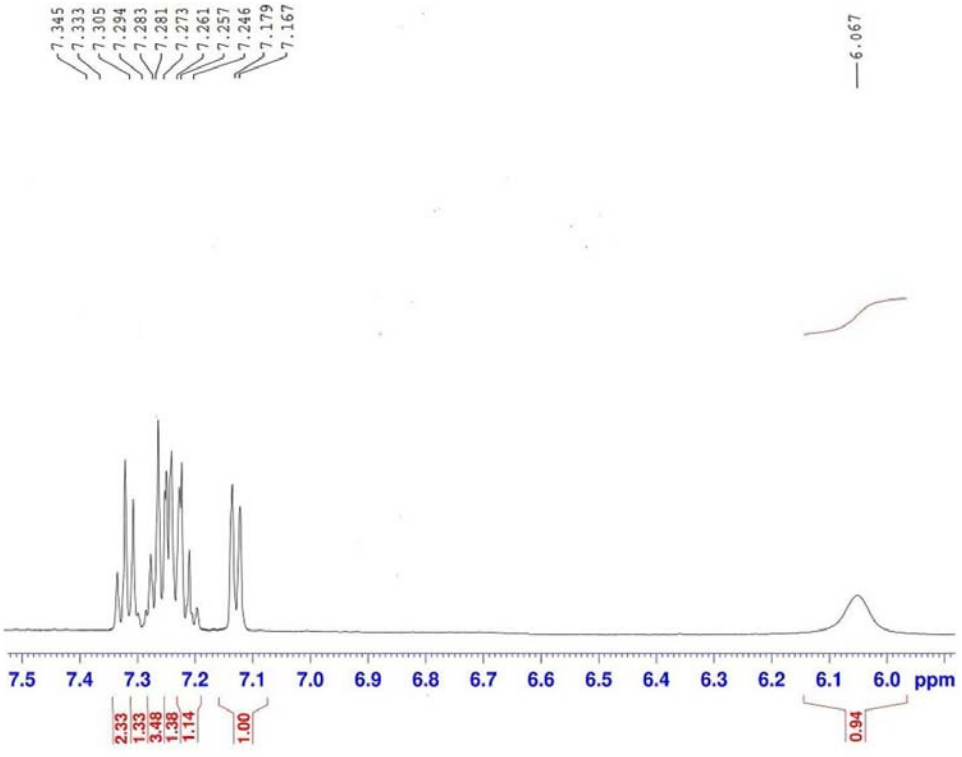

Figure S4. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-benzyl-2-phenylacetamide (**1**) expanded.

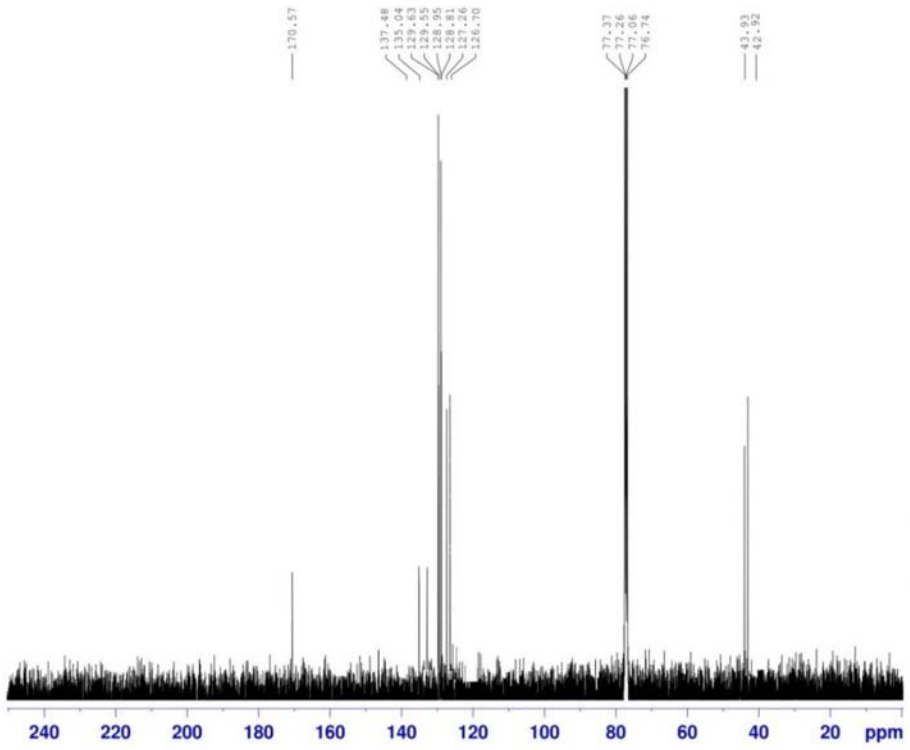

Figure S5. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-benzyl-2-phenylacetamide (**1**).

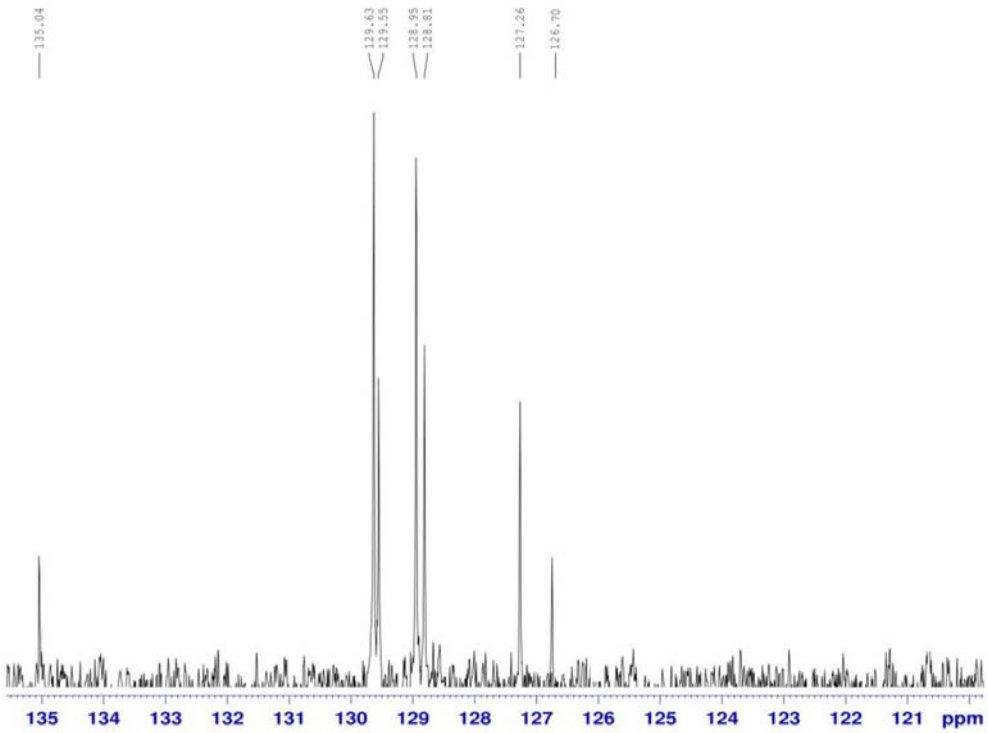

Figure S6. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-benzyl-2-phenylacetamide (**1**) expanded.

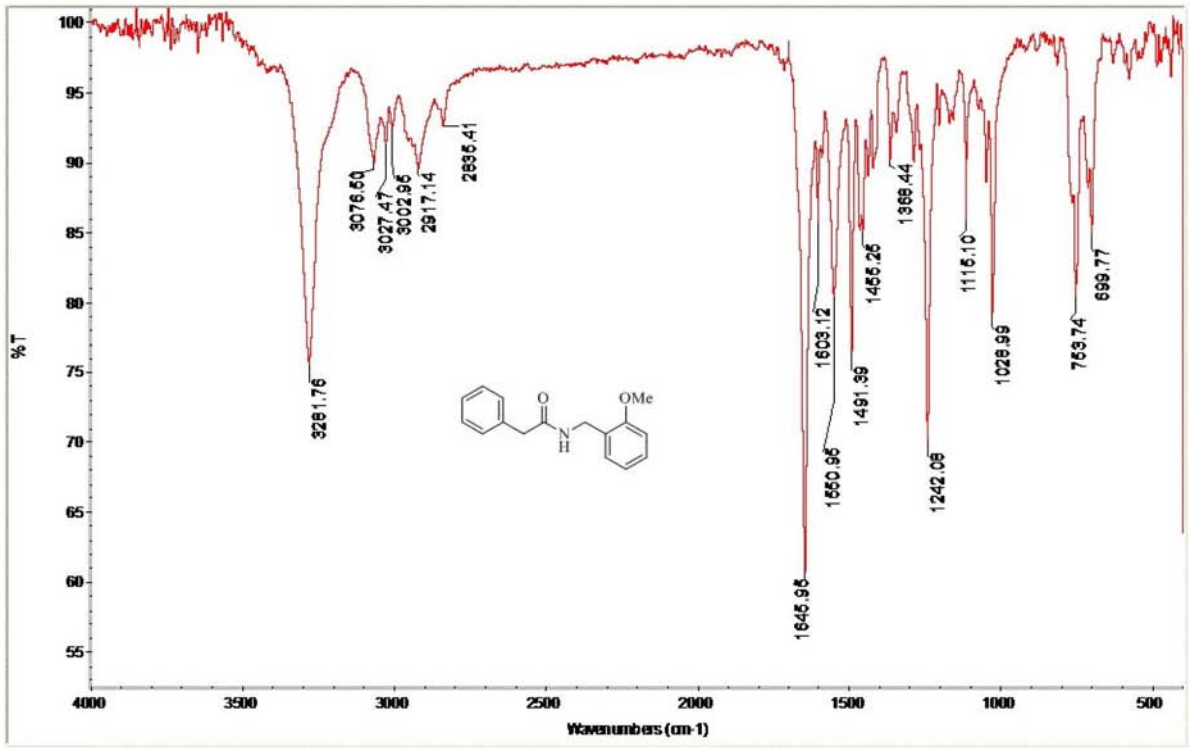

Figure S7. FTIR spectrum of *N*-(2-methoxybenzyl)-2-phenylacetamide (**2**).

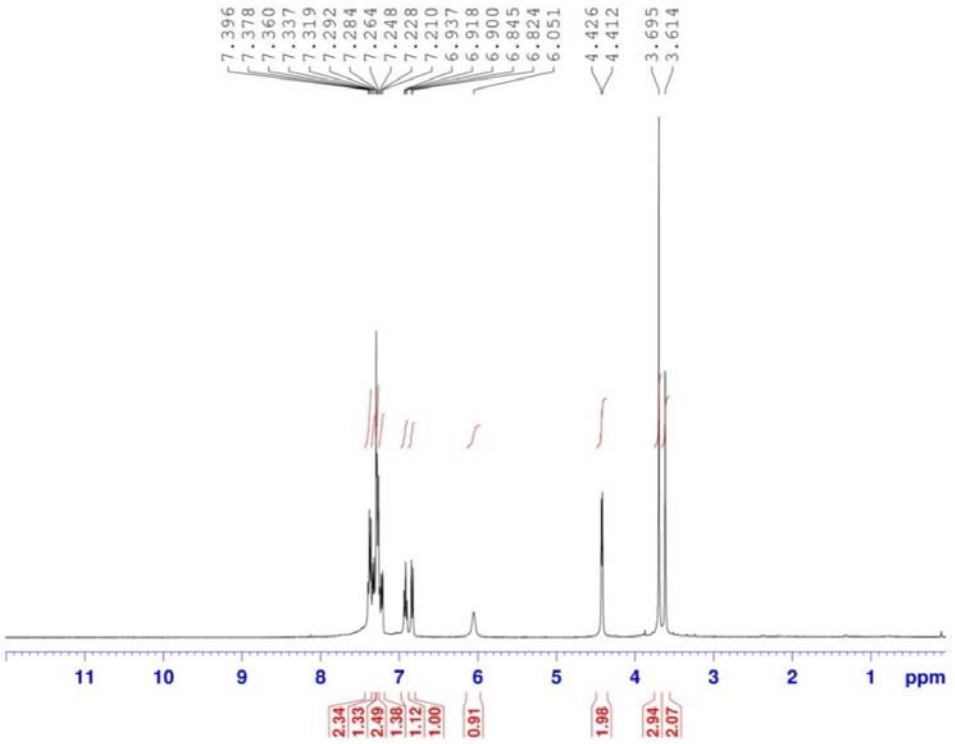

Figure S8. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-(2-methoxybenzyl)-2-phenylacetamide (**2**).

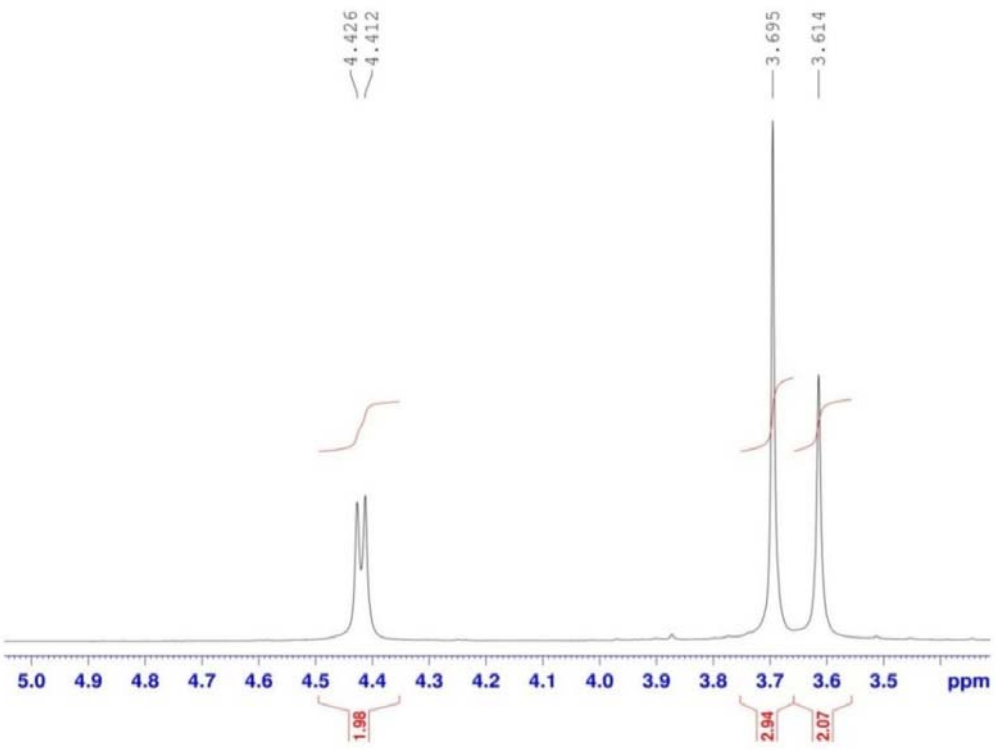

Figure S9. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-(2-methoxybenzyl)-2-phenylacetamide (**2**) expanded.

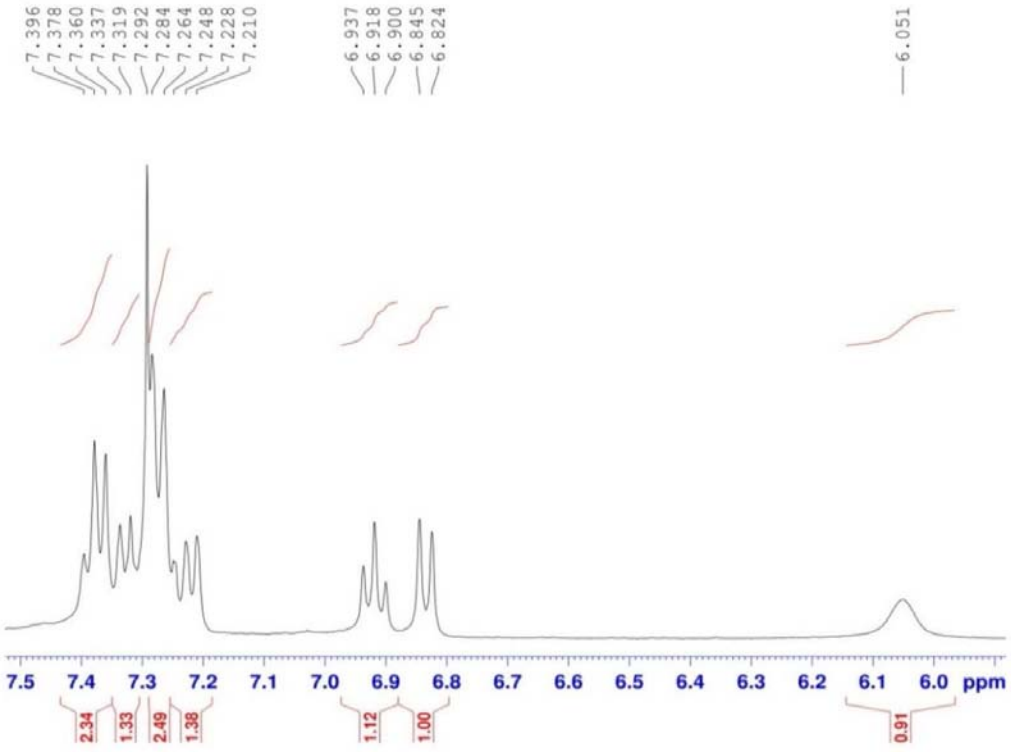

Figure S10. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-(2-methoxybenzyl)-2-phenylacetamide (**2**) expanded.

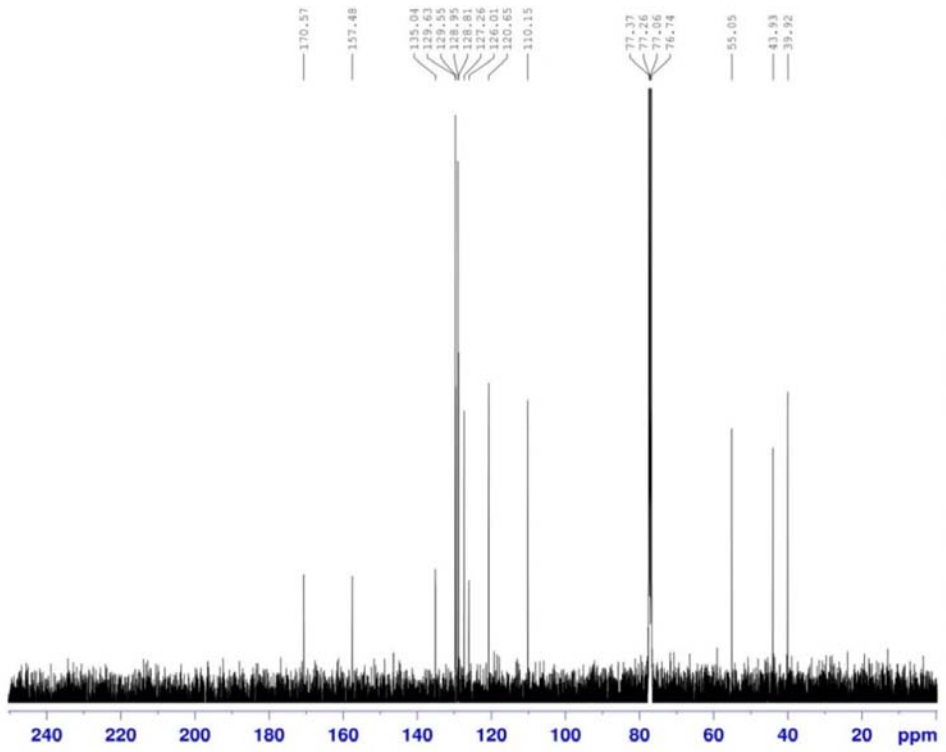

Figure S11. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-(2-methoxybenzyl)-2-phenylacetamide (**2**).

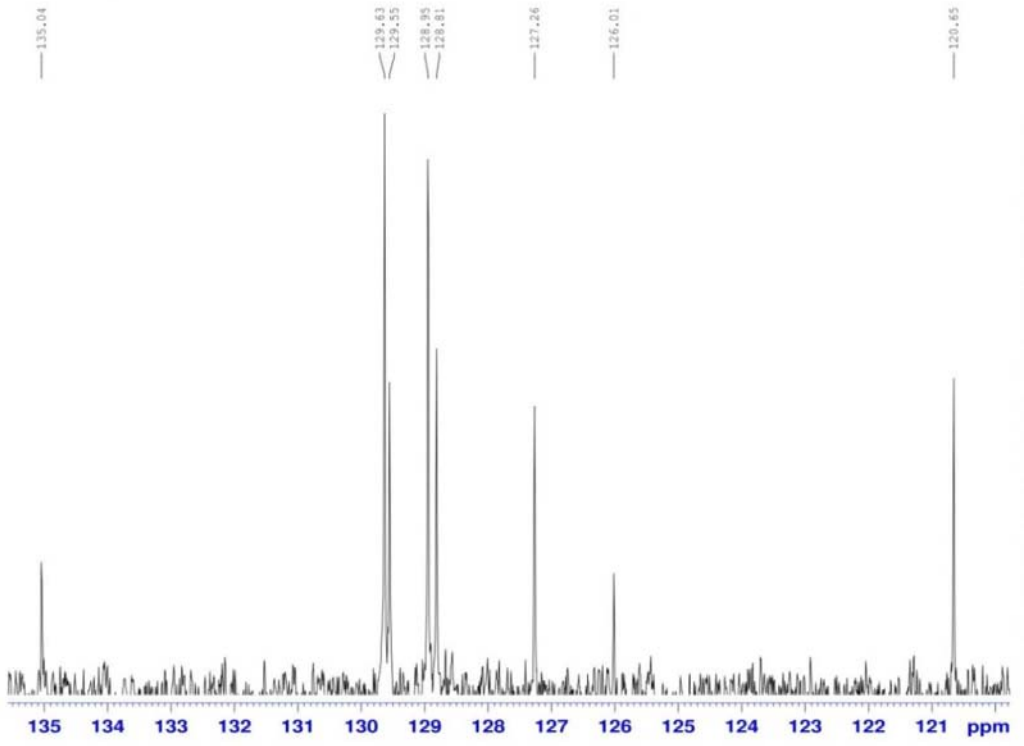

Figure S12. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-(2-methoxybenzyl)-2-phenylacetamide (**2**) expanded.

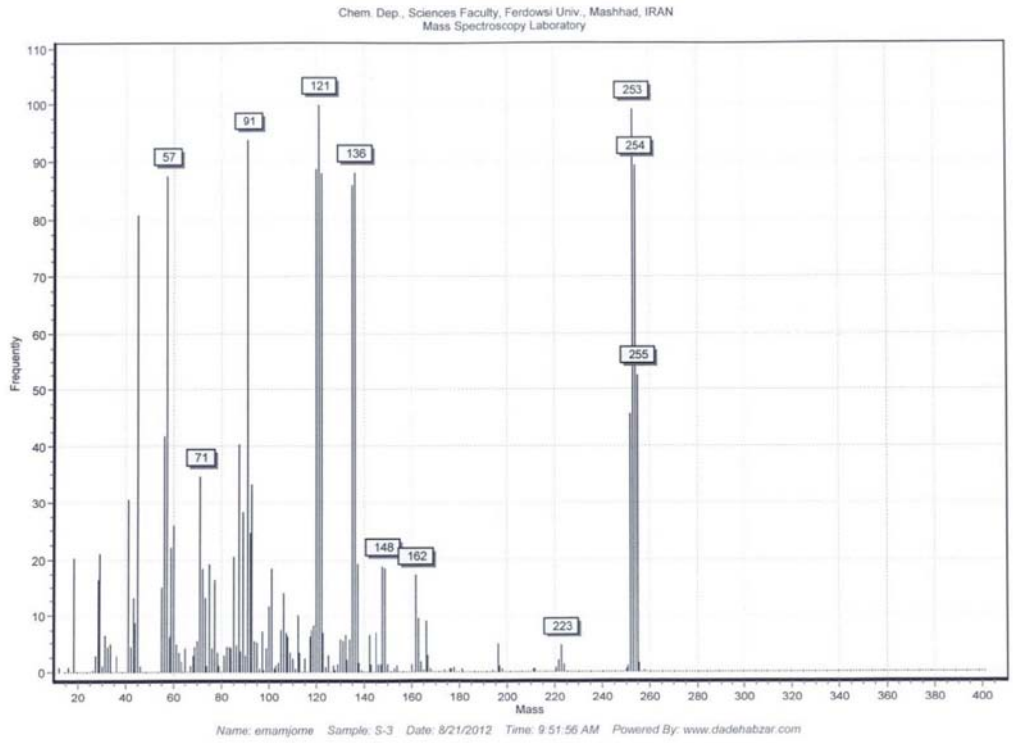

Figure S13. MS spectrum (EI, 70 eV) of *N*-(2-methoxybenzyl)-2-phenylacetamide (**2**).

Eager 300 Summarize Results

Date : 23/05/2012 at 11:12:17
Method Name : NCHS
Method Filename : Copy of Copy of N C H S-bkp .mth

Filename	AS Method	Vial
emamjomeh-130		

#	Group	Sample Name	Type	Weig.	Pro.F	---	---
130	1	S3	UNK	1.027	6.25	---	

Component name	Element %
Nitrogen%	5.52717638
Carbon%	74.99708557
Hydrogen%	6.786919594
Sulphur%	0

Calcd for $C_{16}H_{17}NO_2$

Nitrogen%	5.49
Carbon%	75.27
Hydrogen%	6.71
Suphur%	0

1 Sample(s) in Group No : 1

Component Name	Average
Nitrogen%	5.52717638
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Sulphur%	0

Figure S14. Elemental analysis data of *N*-(2-methoxybenzyl)-2-phenylacetamide (**2**).

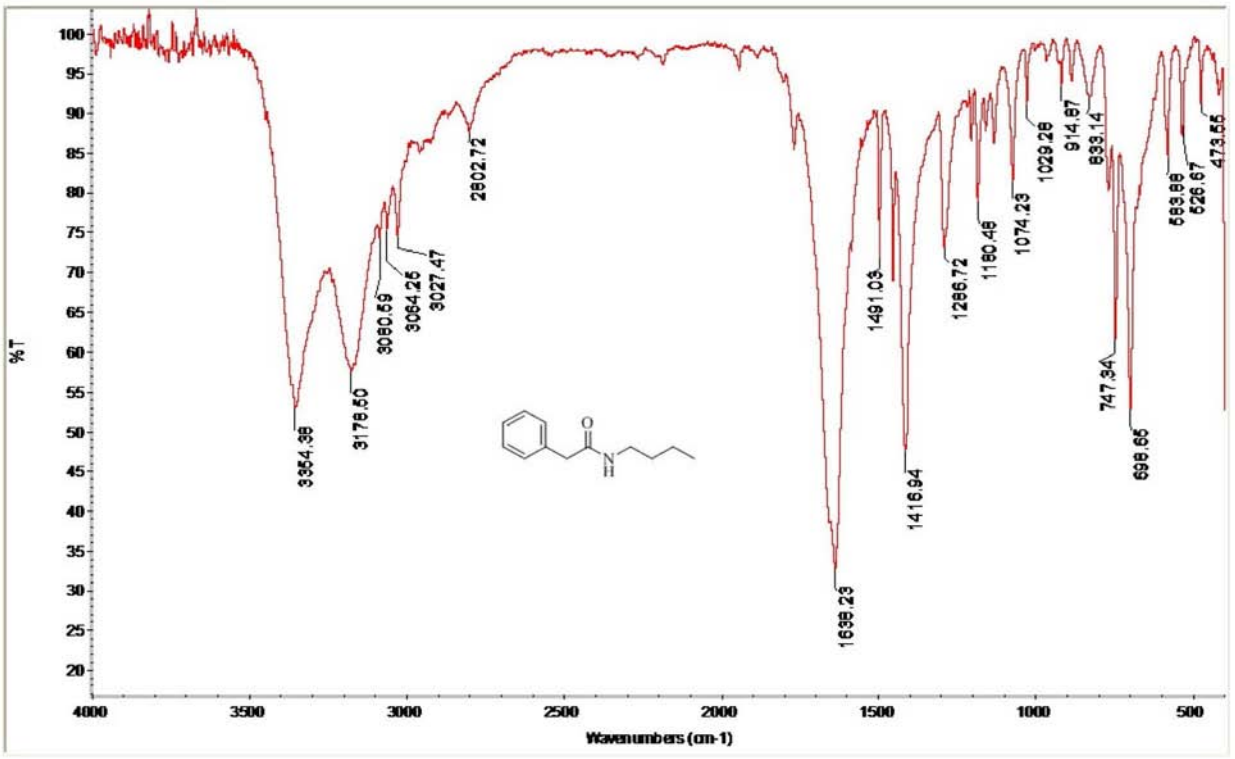

Figure S15. FTIR spectrum of *N*-butyl-2-phenylacetamide (**3**).

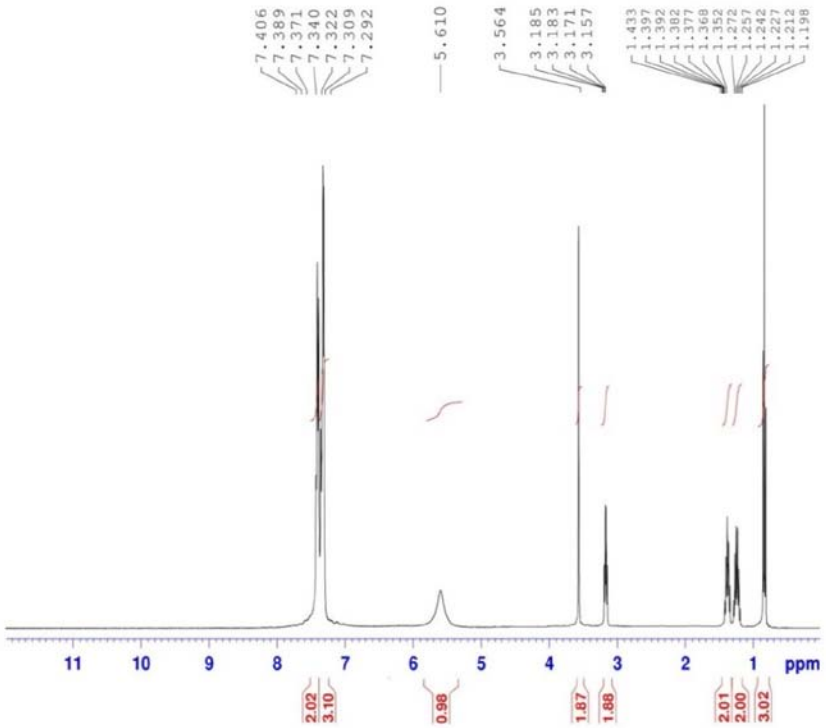

Figure S16. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-butyl-2-phenylacetamide (**3**).

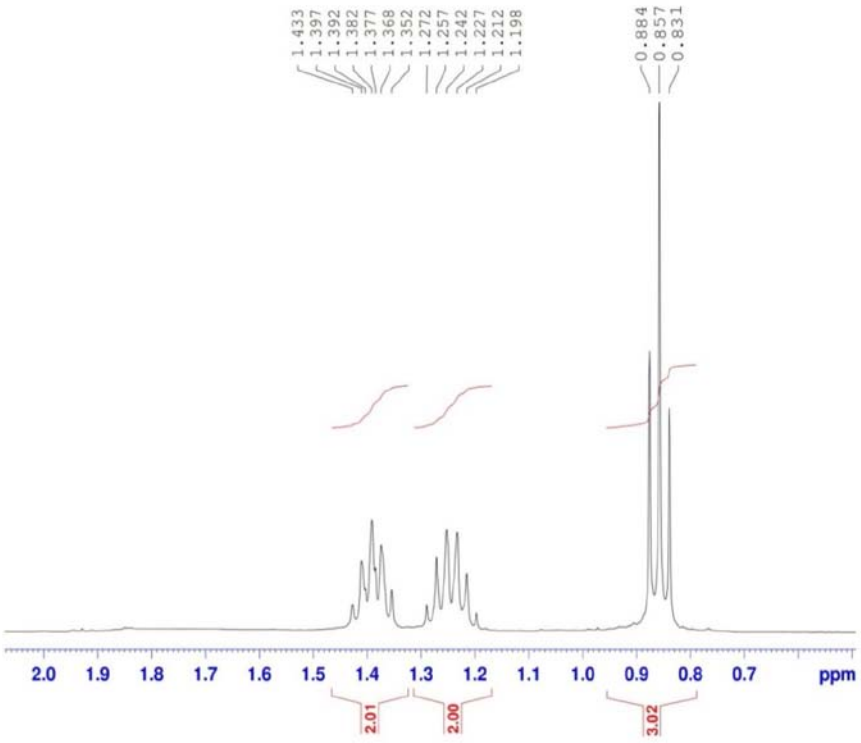

Figure S17. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-butyl-2-phenylacetamide (**3**) expanded.

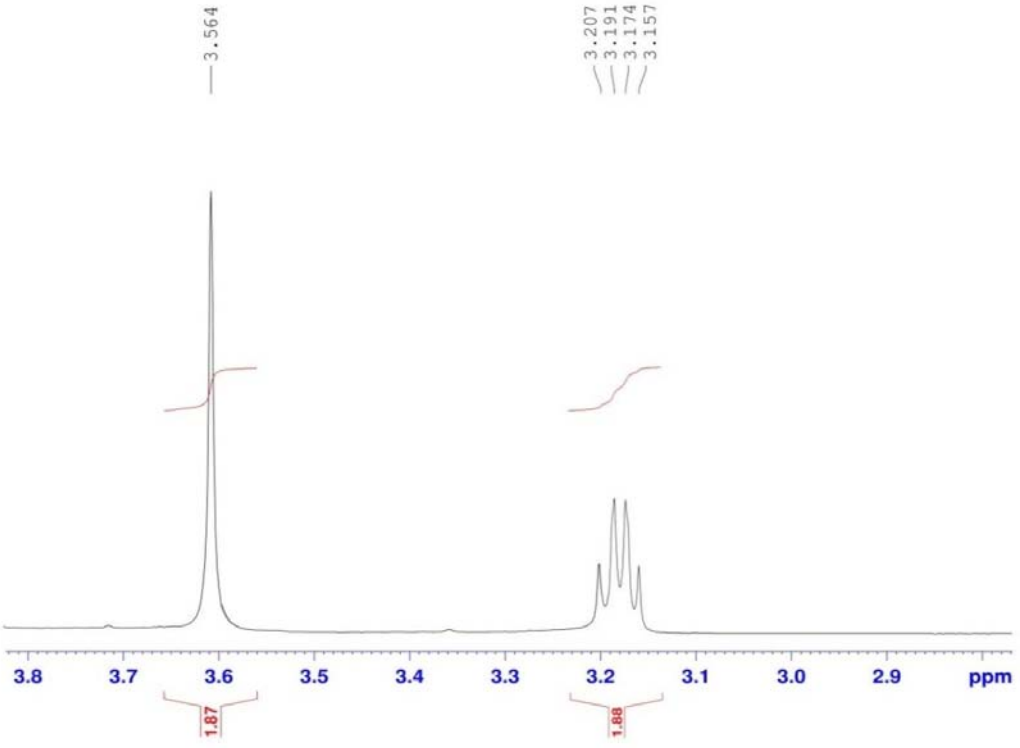

Figure S18. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-butyl-2-phenylacetamide (**3**) expanded.

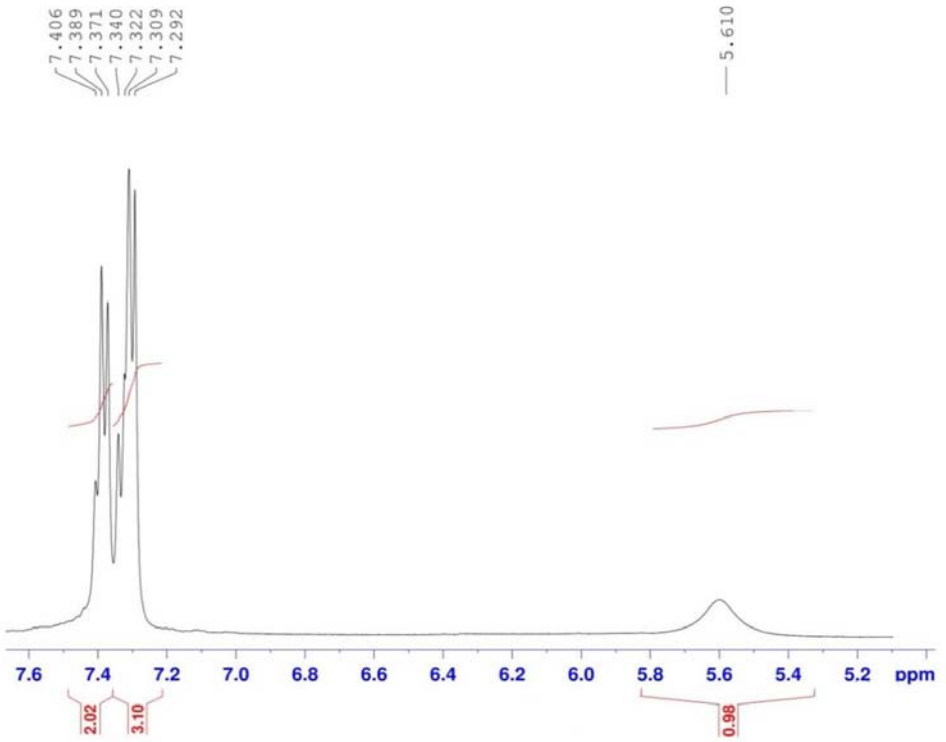

Figure S19. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-butyl-2-phenylacetamide (**3**) expanded.

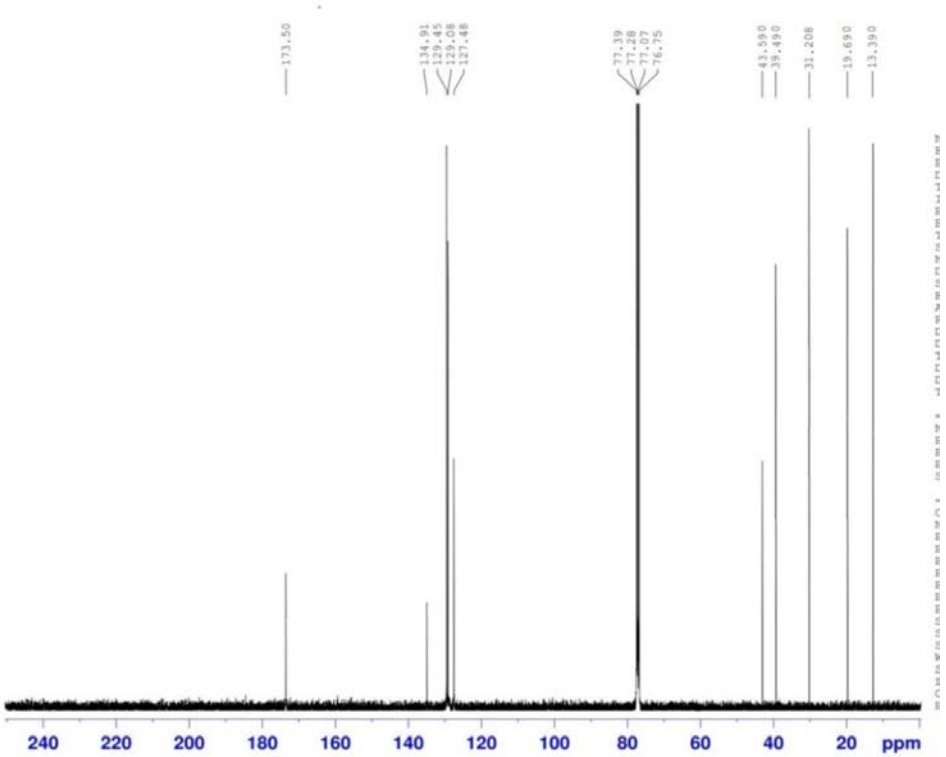

Figure S20. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-butyl-2-phenylacetamide (**3**).

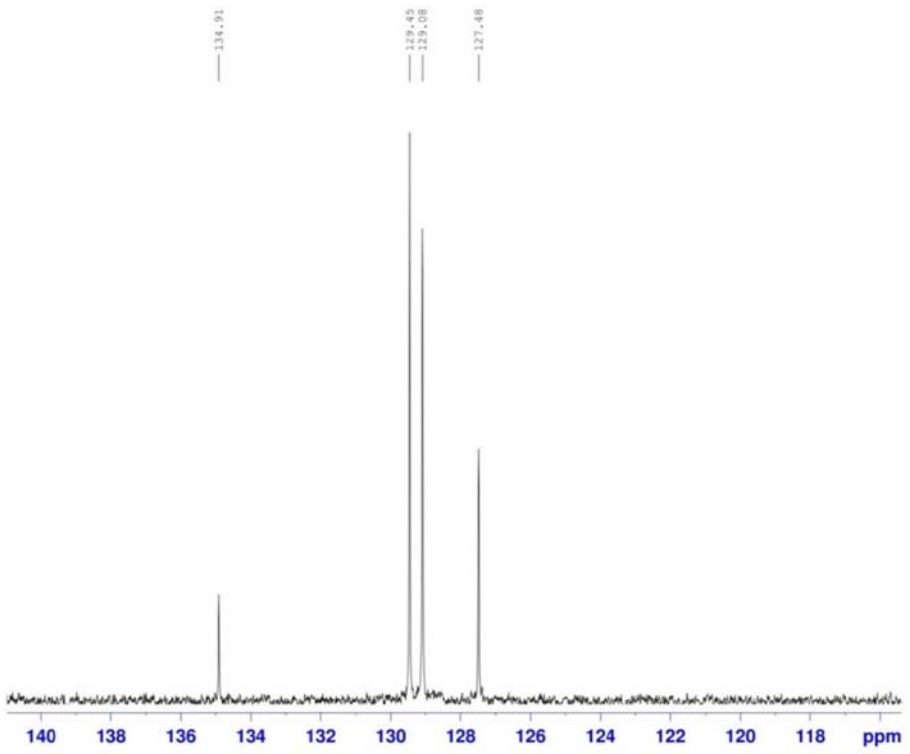

Figure S21. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-butyl-2-phenylacetamide (**3**) expanded.

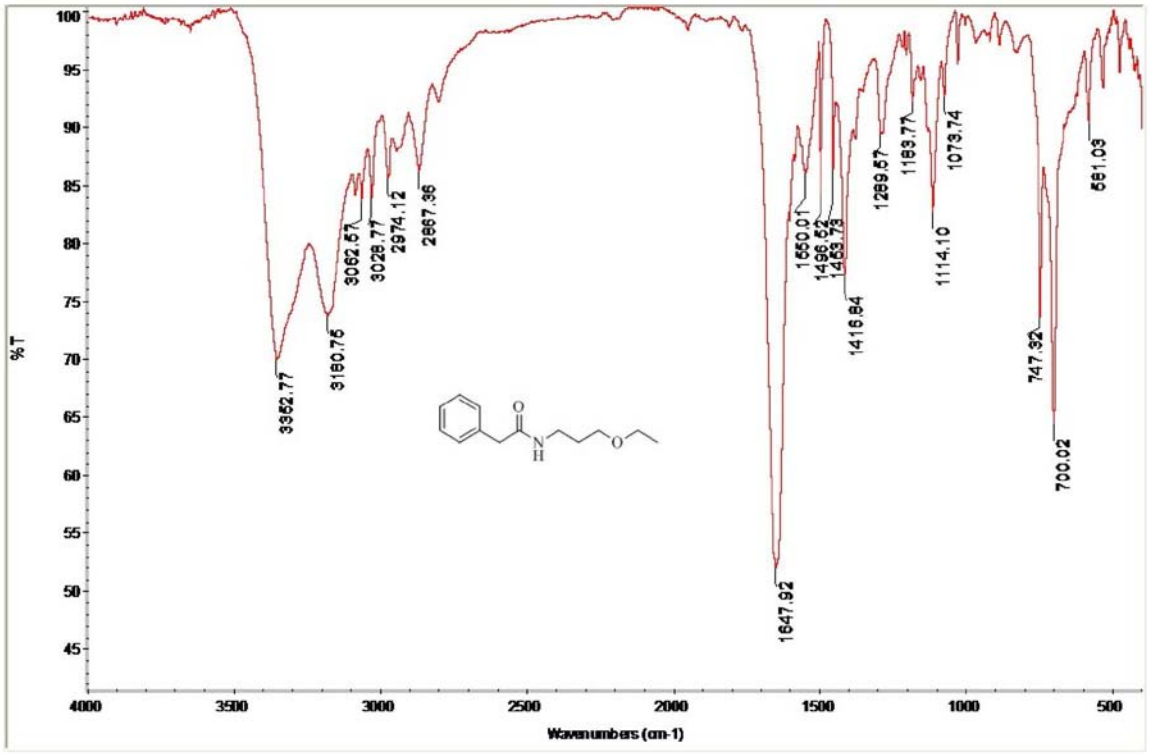

Figure S22. FTIR spectrum of *N*-(3-ethoxypropyl)-2-phenylacetamide (**4**).

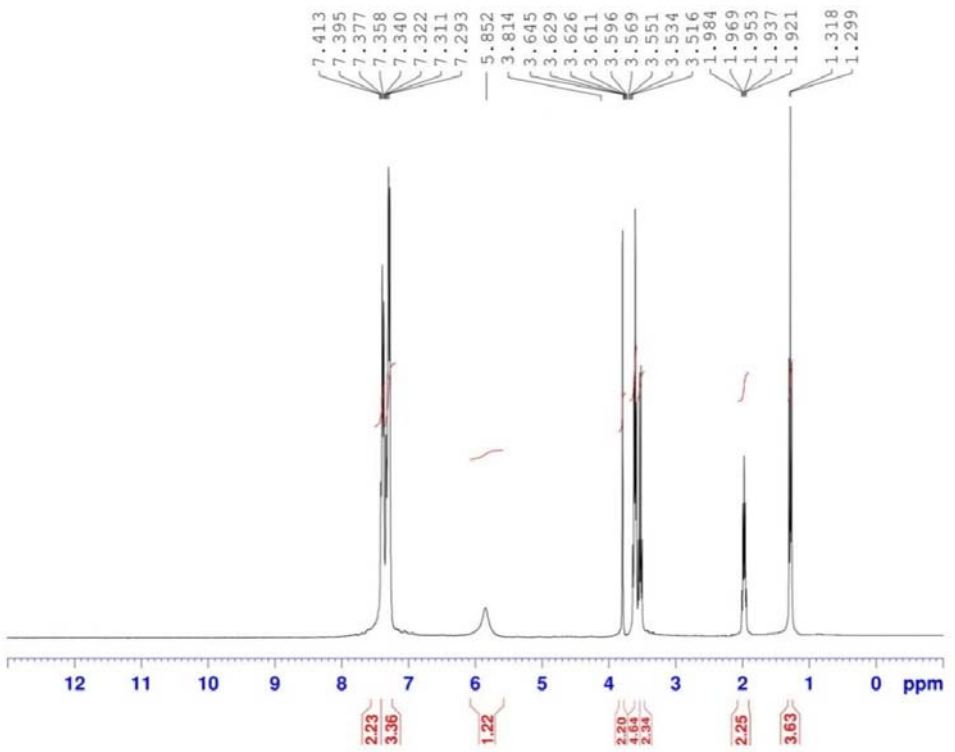

Figure S23. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-(3-ethoxypropyl)-2-phenylacetamide (**4**).

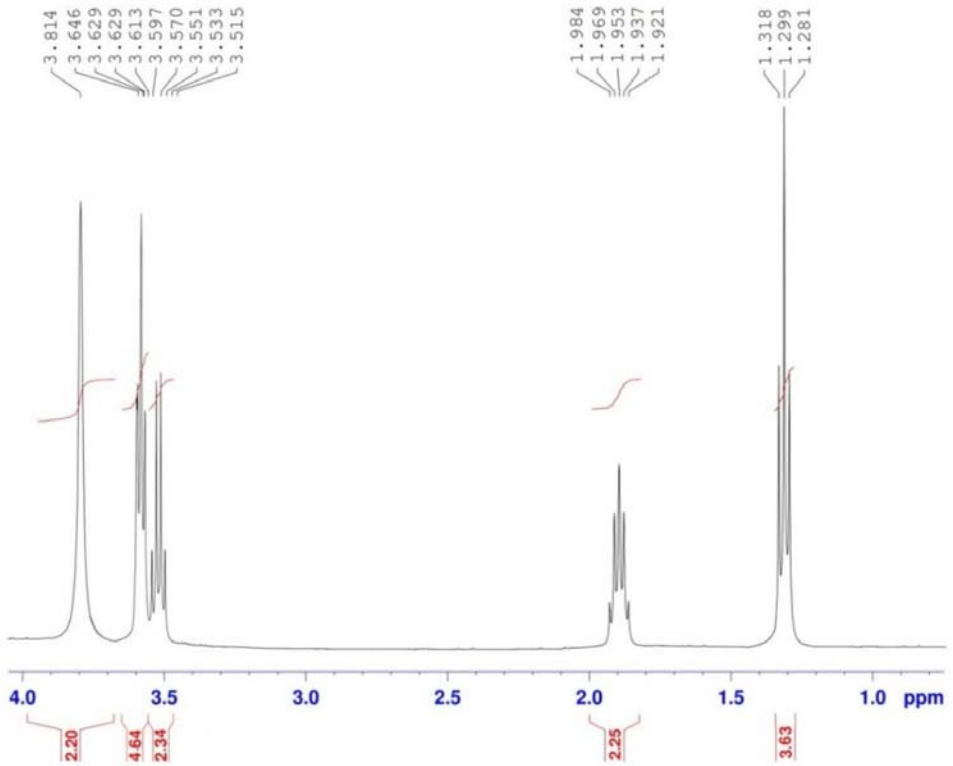

Figure S24. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-(3-ethoxypropyl)-2-phenylacetamide (**4**) expanded.

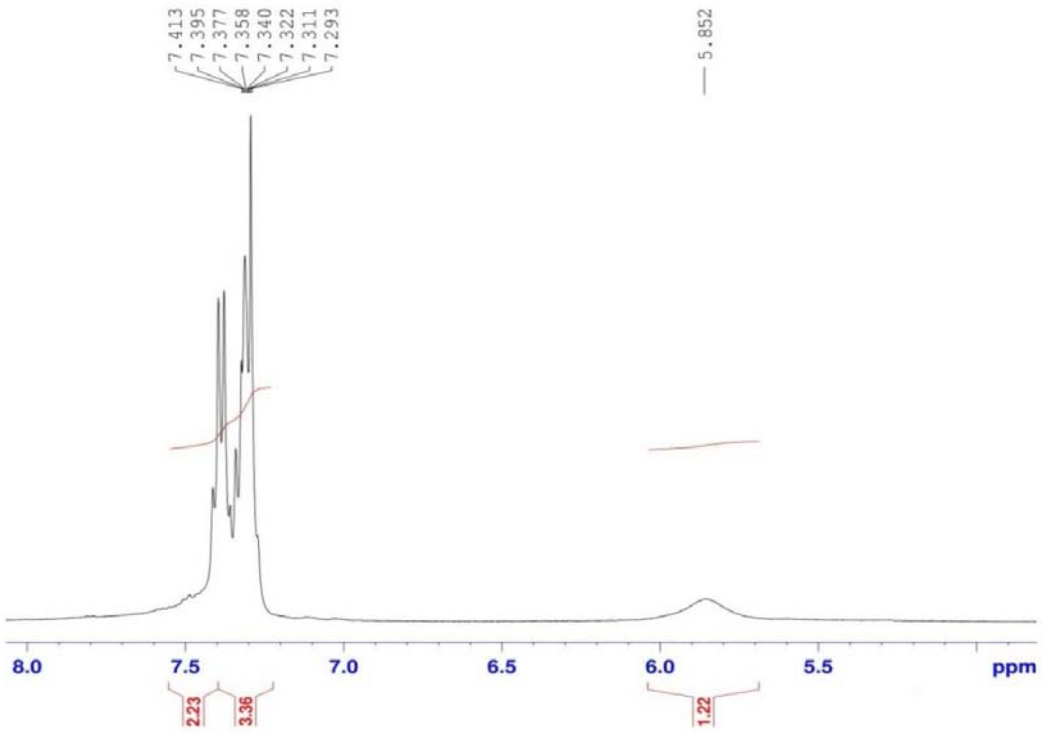

Figure S25. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-(3-ethoxypropyl)-2-phenylacetamide (**4**) expanded.

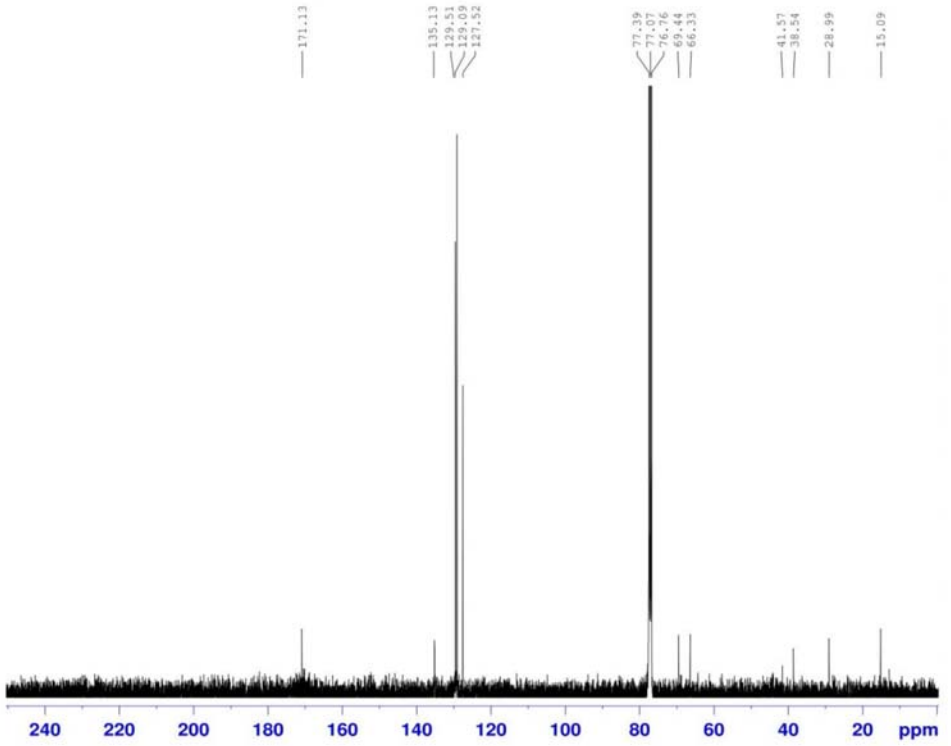

Figure S26. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-(3-ethoxypropyl)-2-phenylacetamide (**4**).

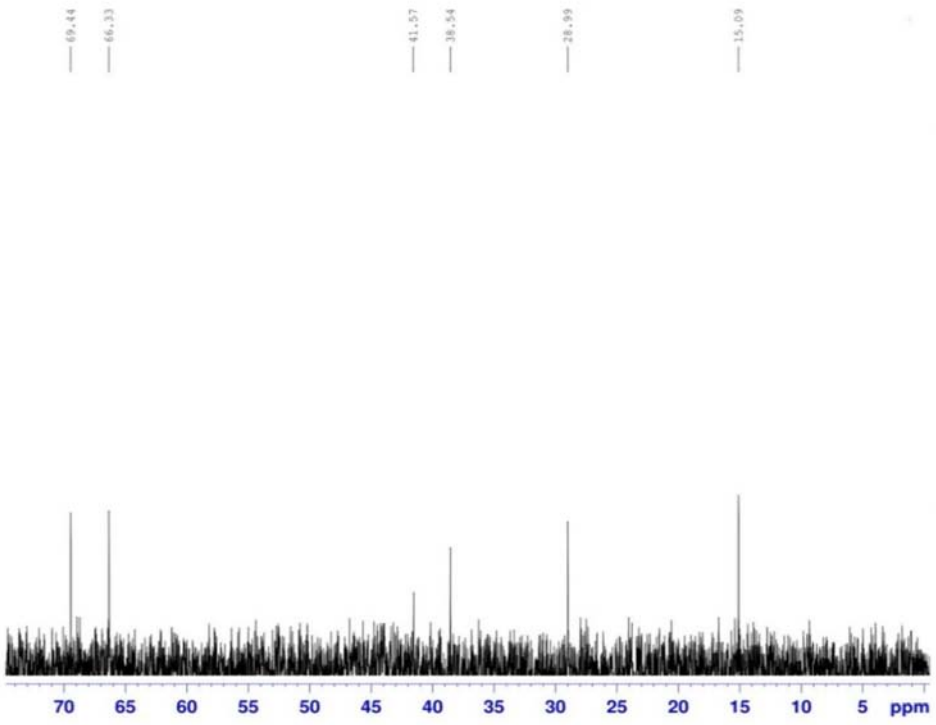

Figure S27. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-(3-ethoxypropyl)-2-phenylacetamide (**4**) expanded.

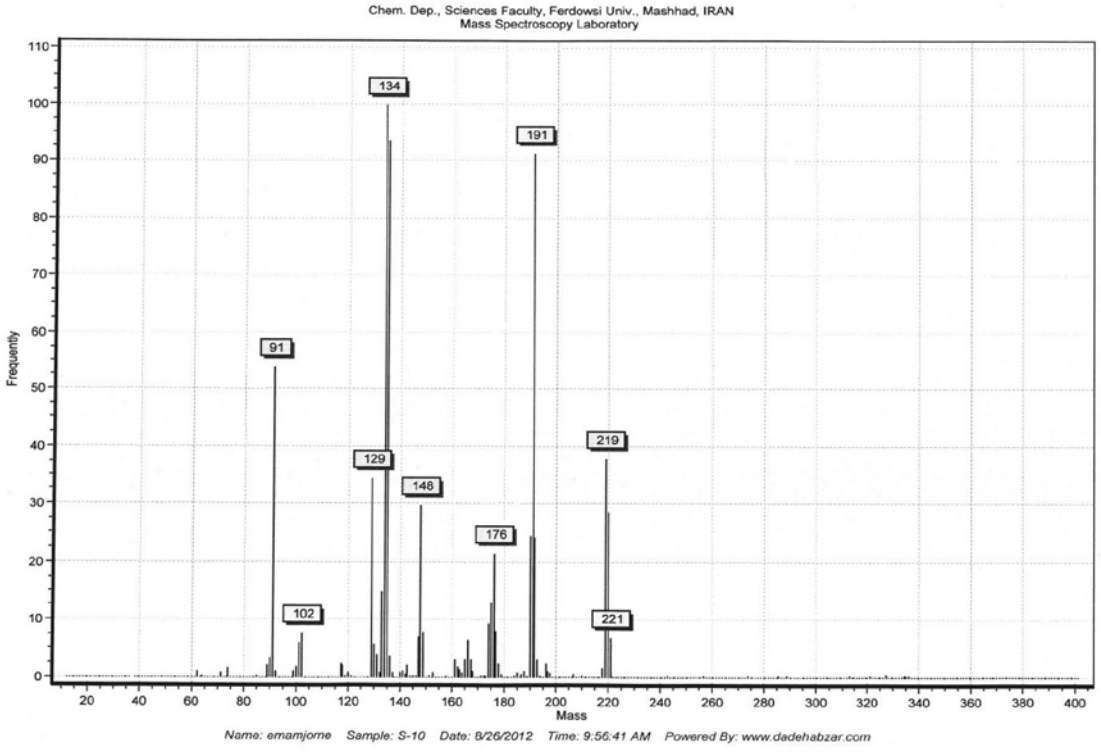

Figure S28. MS spectrum (EI, 70 eV) of *N*-(3-ethoxypropyl)-2-phenylacetamide (**4**).

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Component Name  Average
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Carbon%         69.9406662
Hydrogen%       8.260183811
Sulphur%        0
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Calcd for $C_{13}H_{19}NO_2$

Nitrogen%	6.33
Carbon%	70.56
Hydrogen%	8.65
Suphur%	0

Figure S29. Elemental analysis data of *N*-(3-ethoxypropyl)-2-phenylacetamide (**4**).

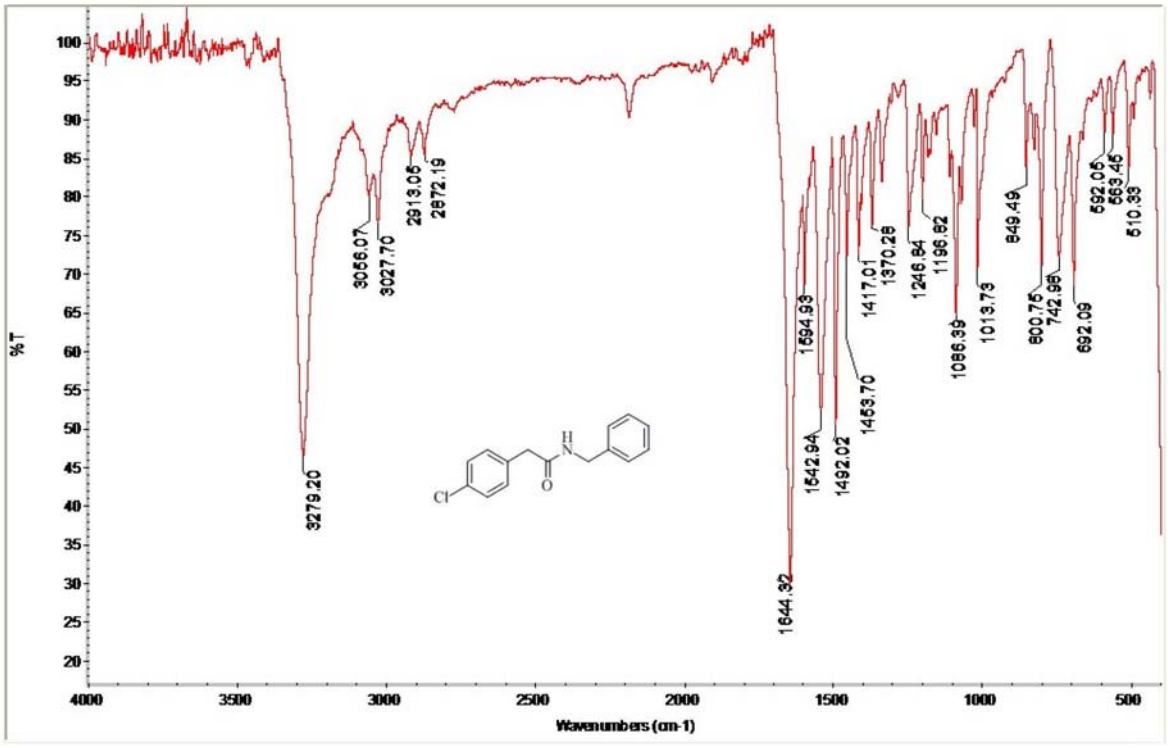

Figure S30. FTIR spectrum of *N*-benzyl-2-(4-chlorophenyl)acetamide (**5**).

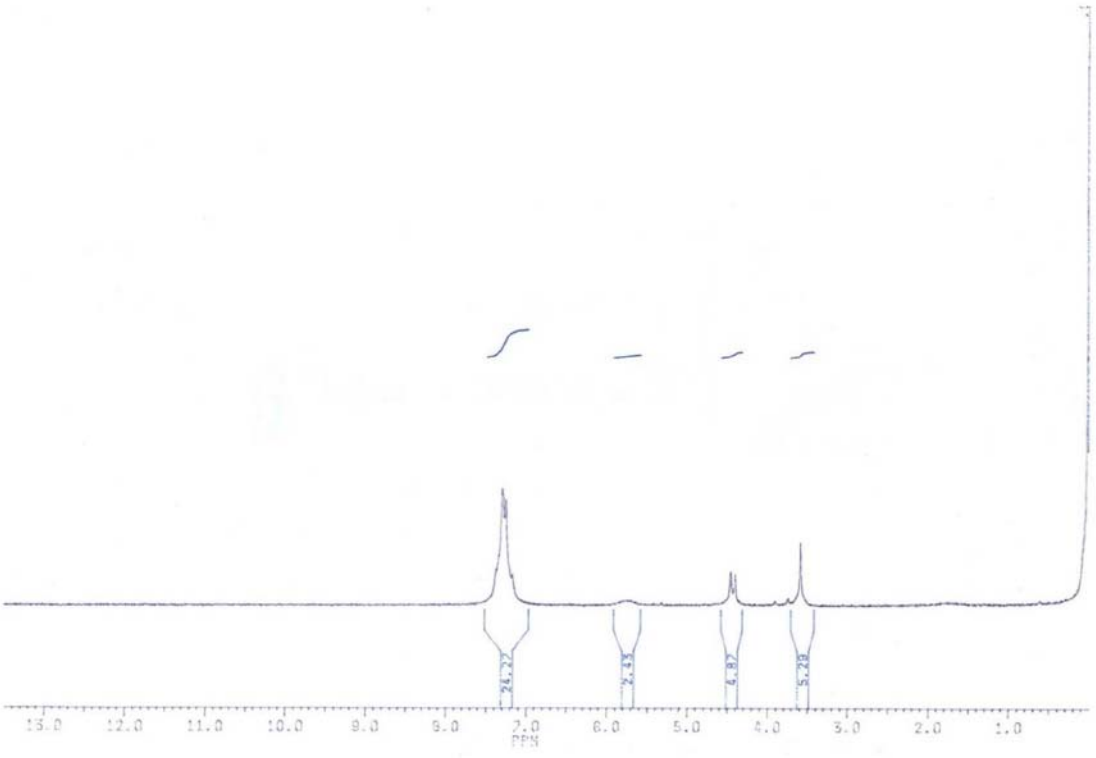

Figure S31. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-benzyl-2-(4-chlorophenyl)acetamide (**5**).

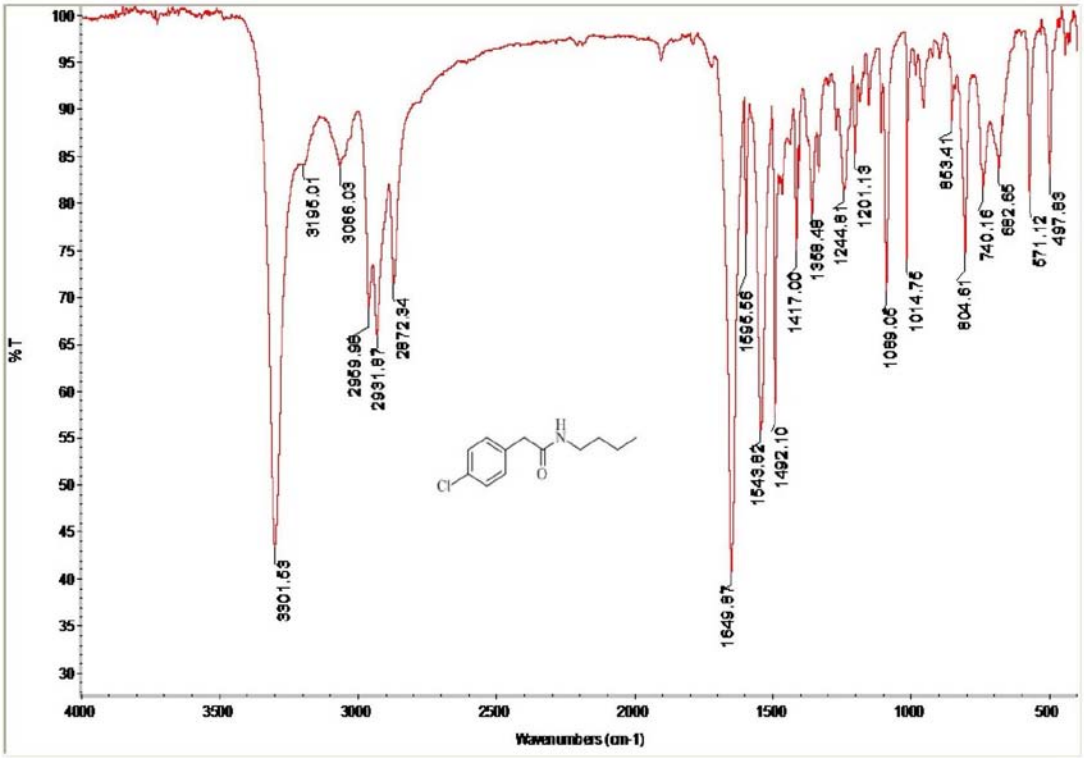

Figure S32. FTIR spectrum of *N*-butyl-2-(4-chlorophenyl)acetamide (**6**).

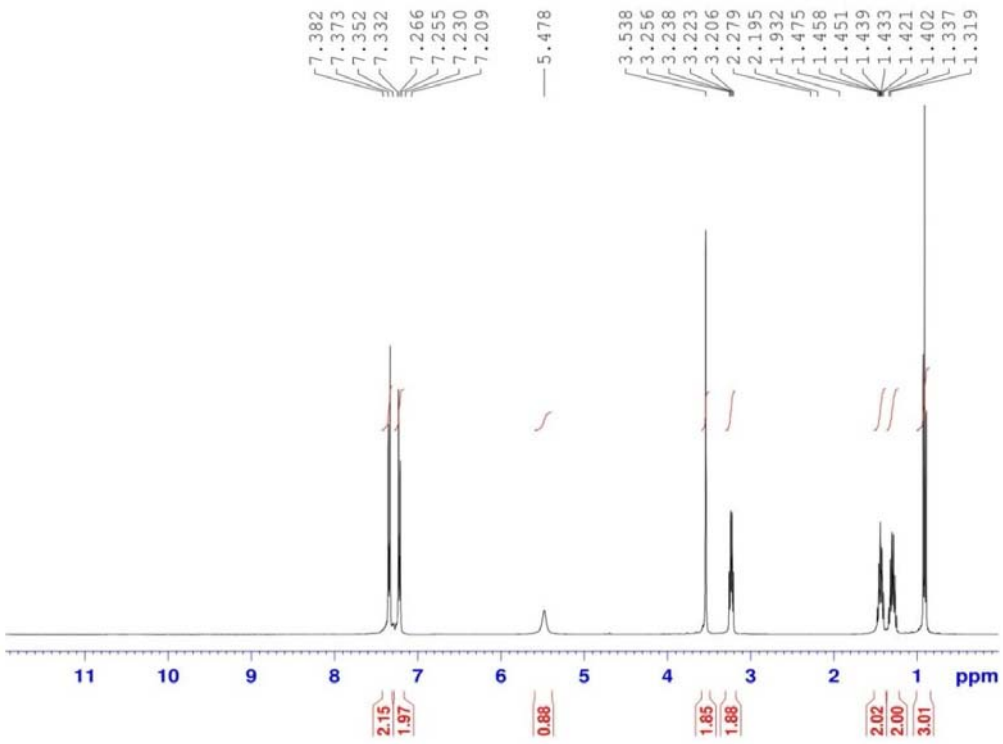

Figure S33. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-butyl-2-(4-chlorophenyl)acetamide (**6**).

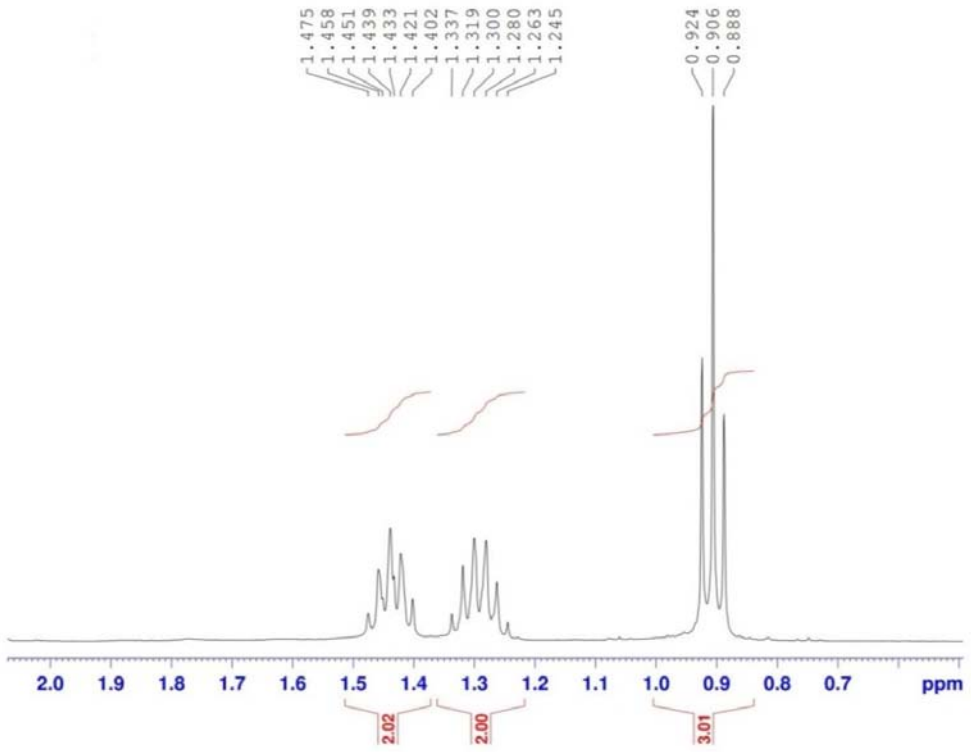

Figure S34. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-butyl-2-(4-chlorophenyl)acetamide (**6**) expanded.

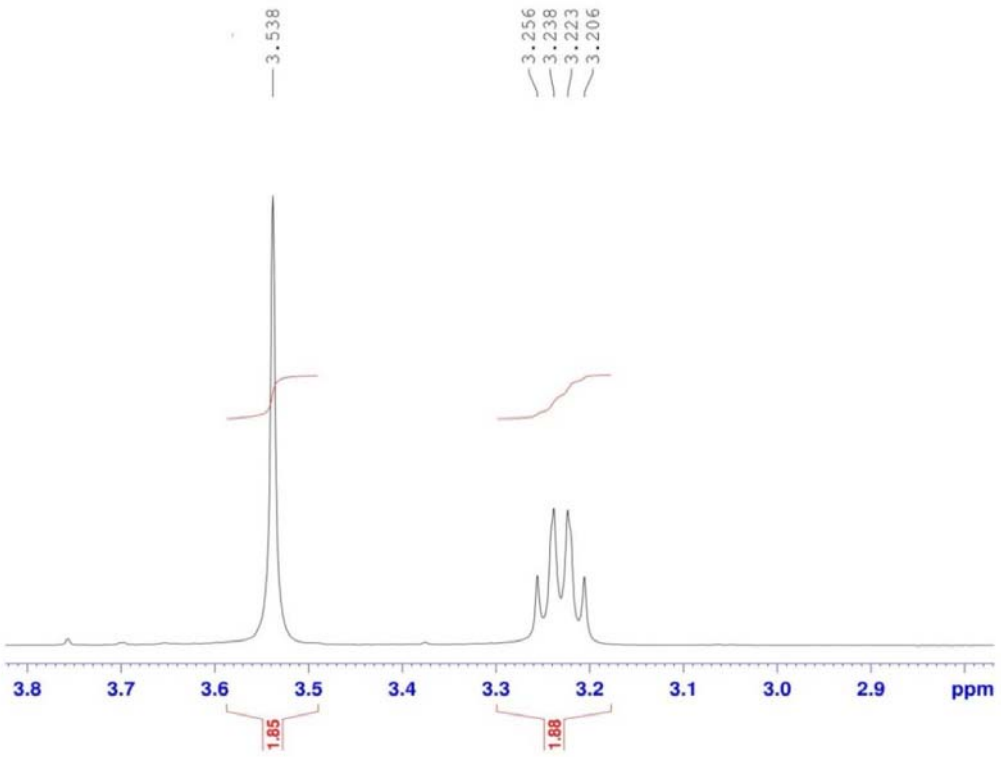

Figure S35. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-butyl-2-(4-chlorophenyl)acetamide (**6**) expanded.

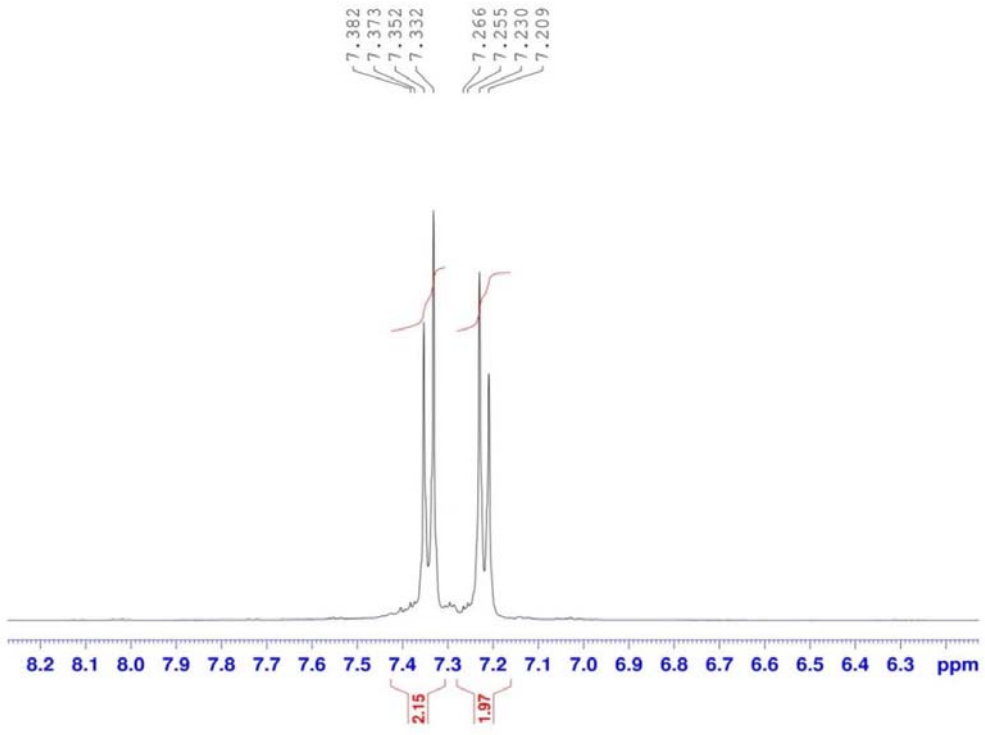

Figure S36. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-butyl-2-(4-chlorophenyl)acetamide.

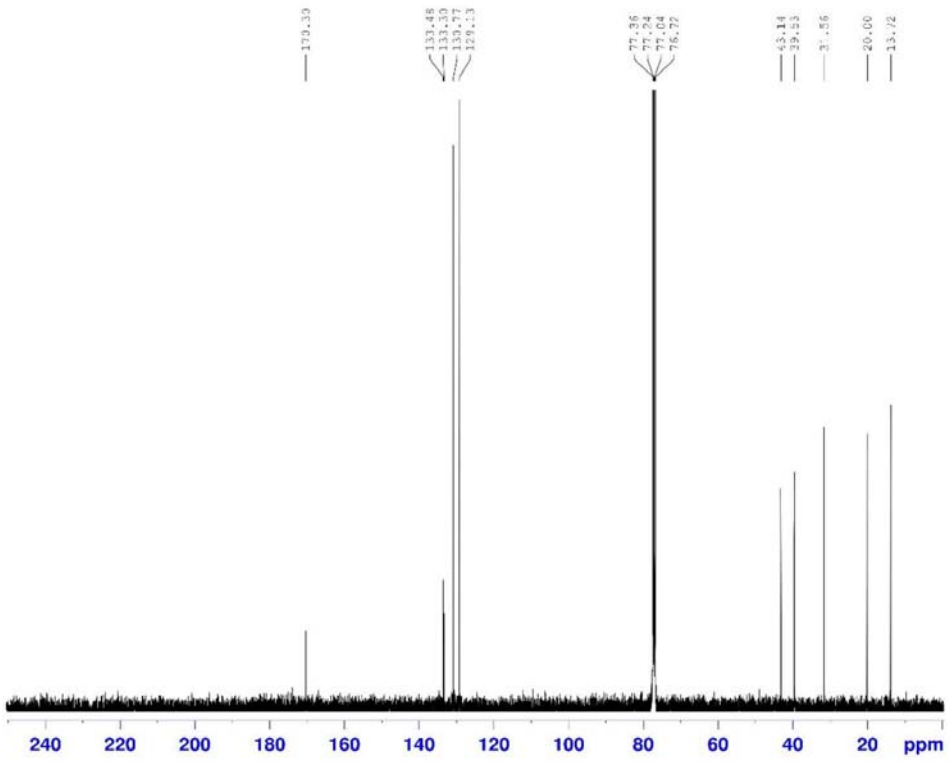

Figure S37. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-butyl-2-(4-chlorophenyl)acetamide (**6**).

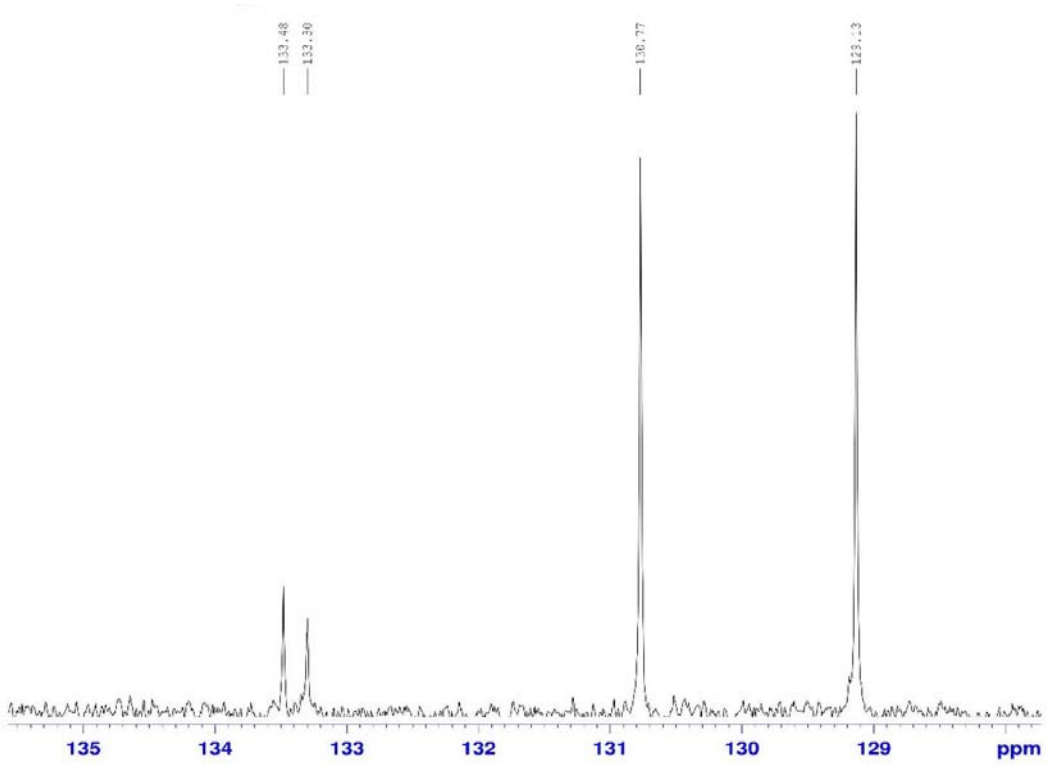

Figure S38. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-butyl-2-(4-chlorophenyl)acetamide (**6**) expanded.

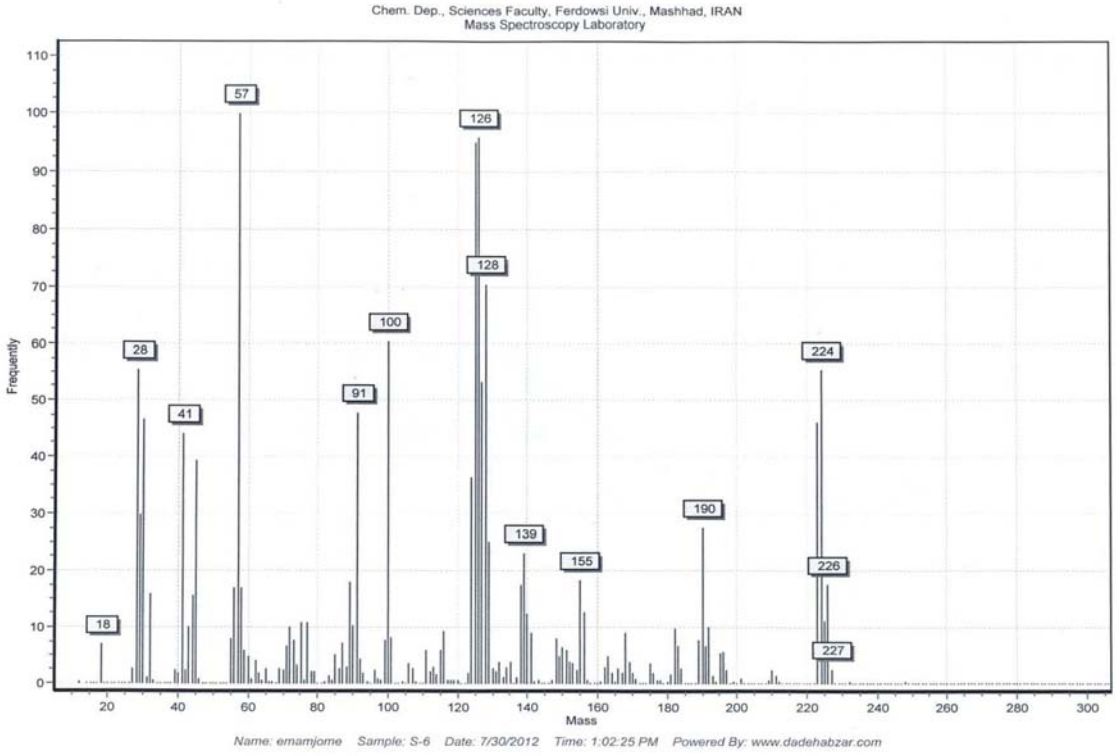

Figure S39. MS spectrum (EI, 70 eV) of *N*-butyl-2-(4-chlorophenyl)acetamide (**6**).

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                    Eager 300 Summarize Results

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Carbon%         64.32457886
Hydrogen%       7.490045547
Sulphur%        0

            1 Sample(s) in Group No : 1
Component Name Average
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Nitrogen%      6.636153698
Carbon%        64.32457886
Hydrogen%      7.490045547
Sulphur%       0
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Calcd for $C_{12}H_{16}ClNO_2$

Nitrogen%	6.21
Carbon%	63.85
Hydrogen%	7.14
Suphur%	0

Figure S40. Elemental analysis data of *N*-butyl-2-(4-chlorophenyl)acetamide (**6**).

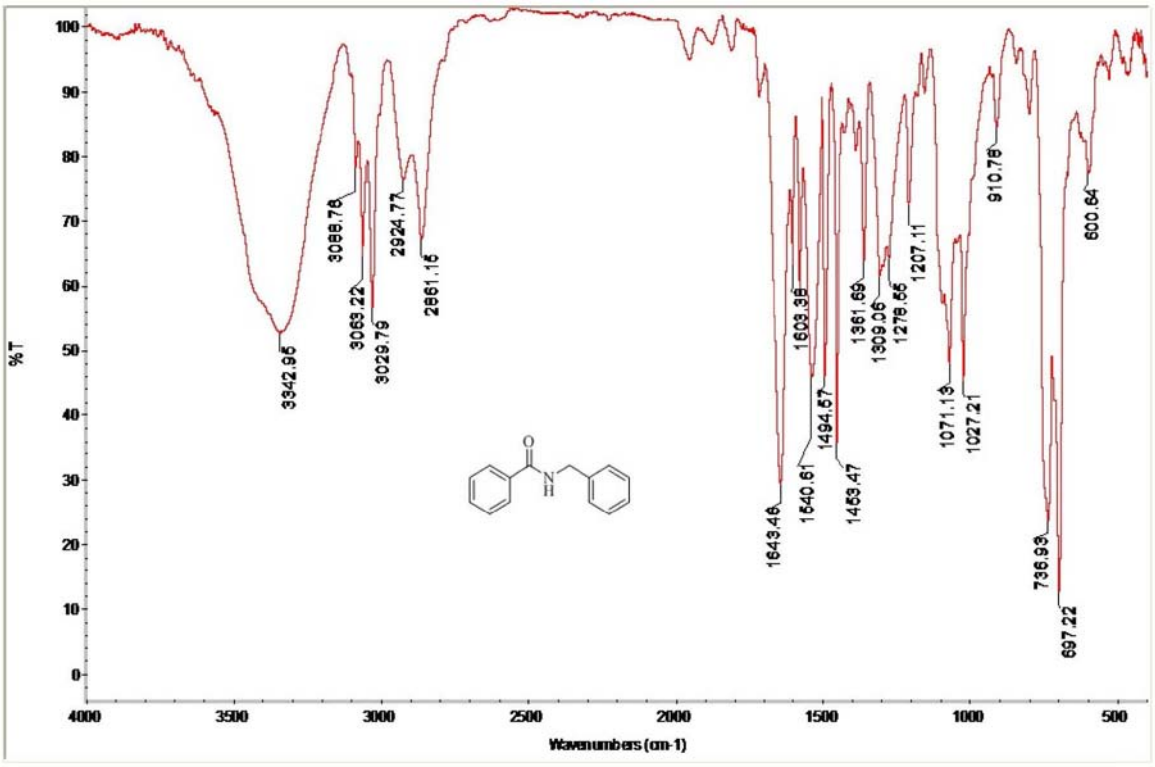

Figure S41. FTIR spectrum of *N*-benzylbenzamide (**7**).

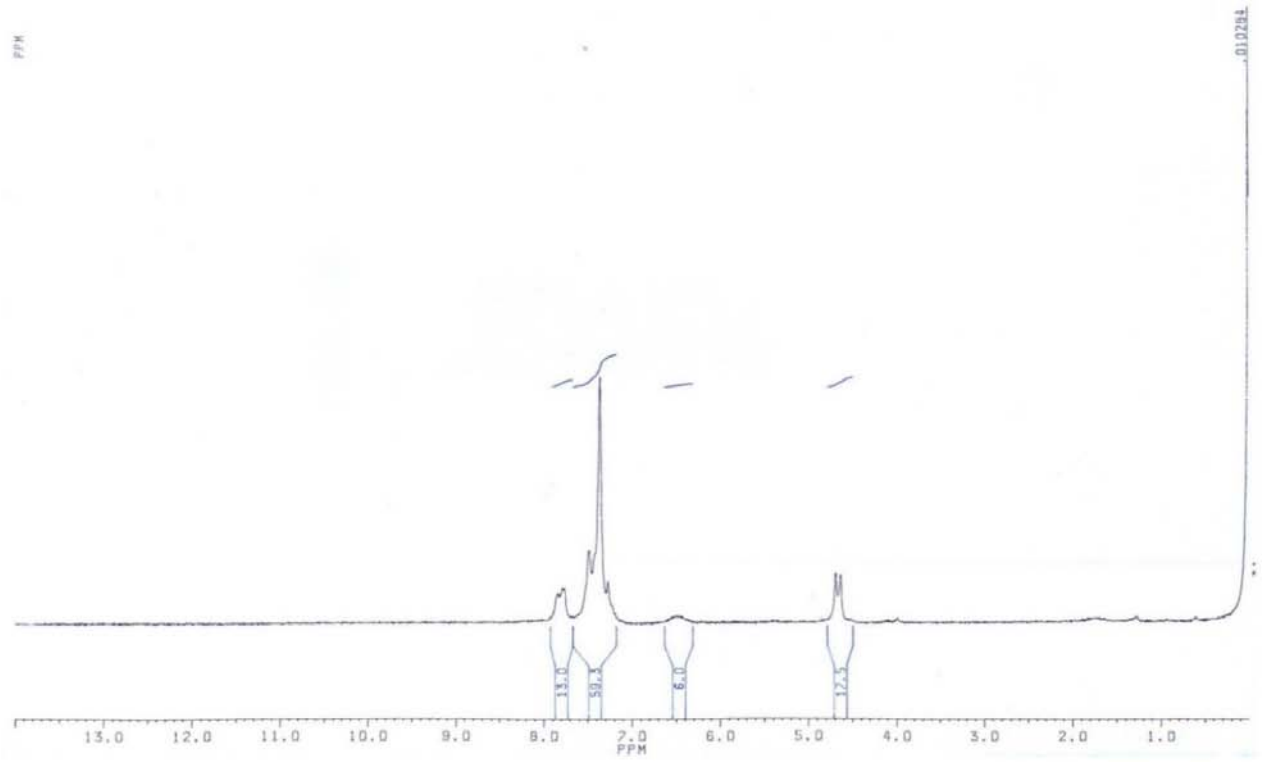

Figure S42. ^{1}H NMR spectrum (100 MHz, $CDCl_3$) of *N*-benzylbenzamide (**7**).

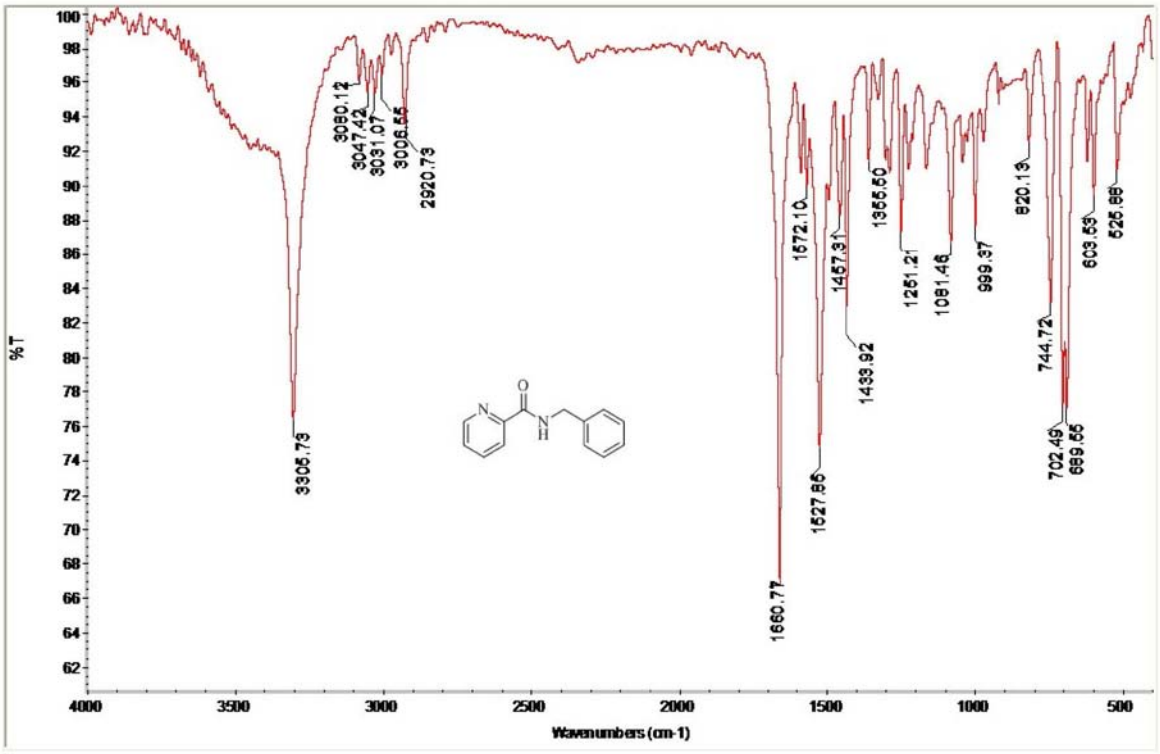

Figure S43. FTIR spectrum of *N*-benzylpicolinamide (**8**).

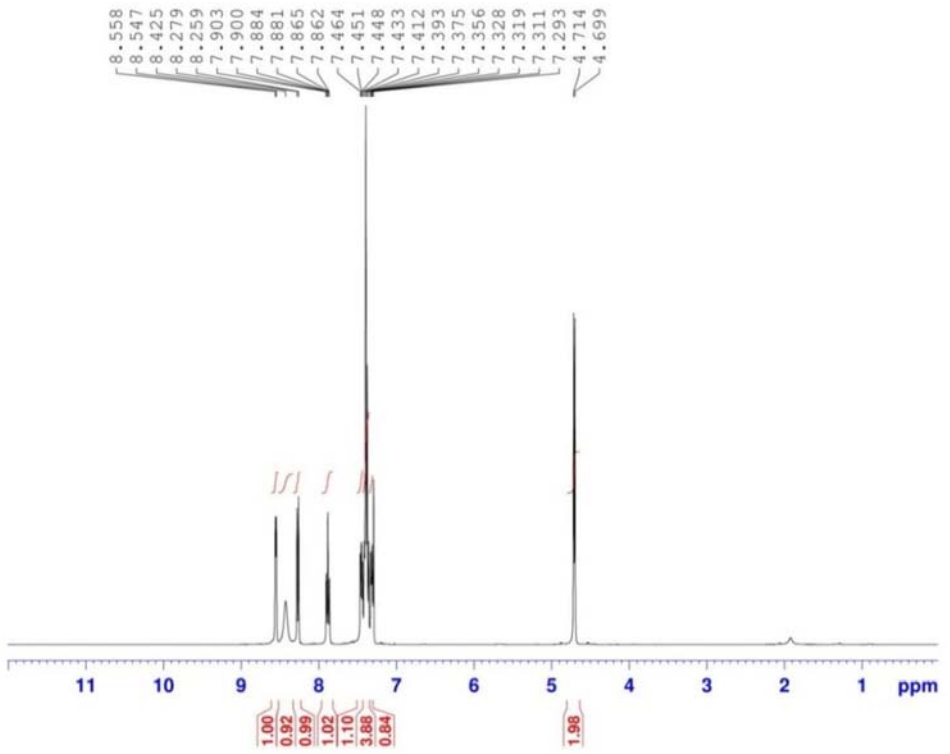

Figure S44. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-benzylpicolinamide (**8**).

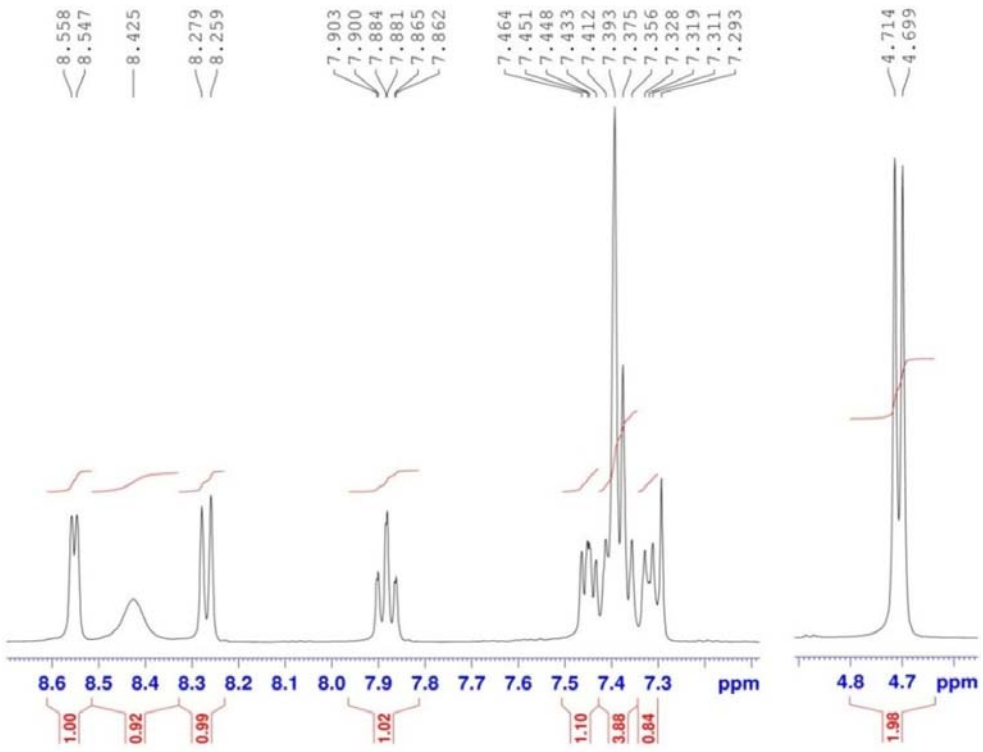

Figure S45. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-benzylpicolinamide (**8**) expanded.

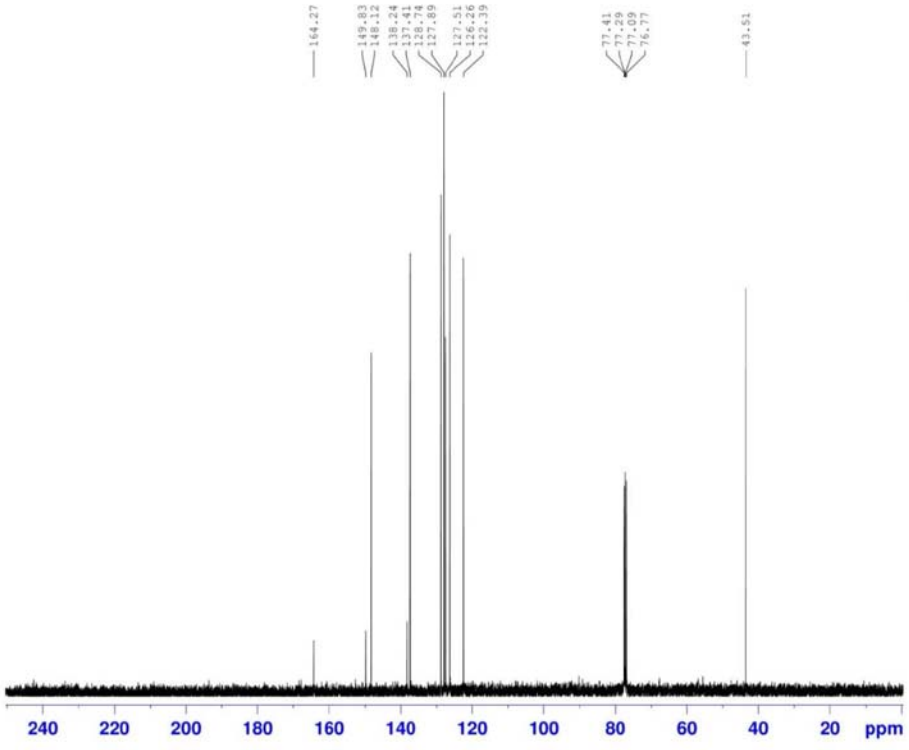

Figure S46. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-benzylpicolinamide (**8**).

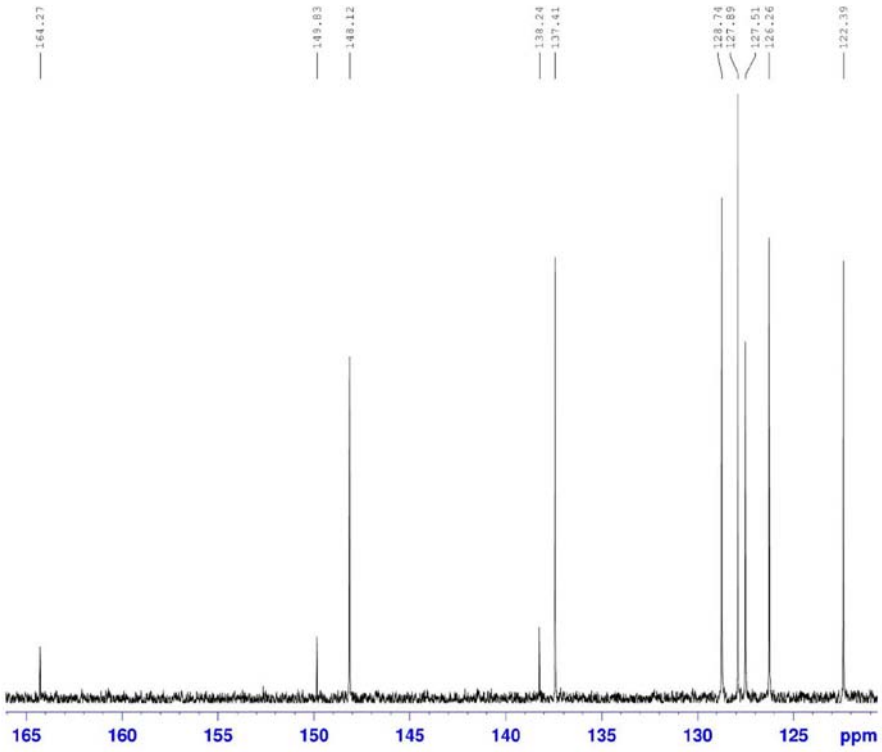

Figure S47. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-benzylpicolinamide (**8**) expanded.

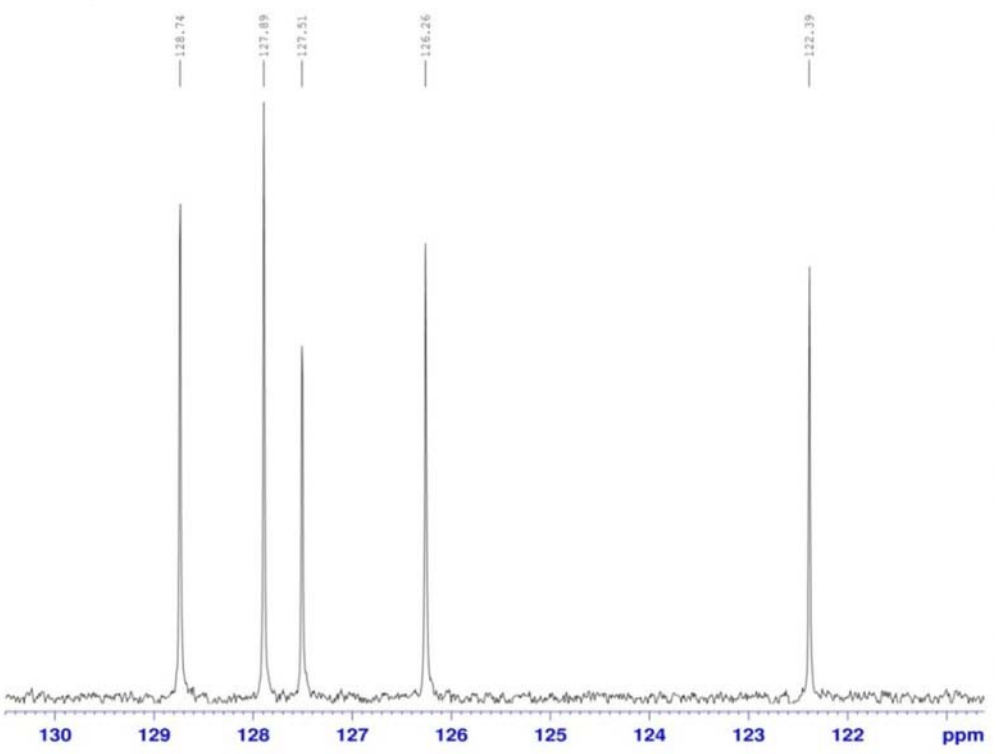

Figure S48. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-benzylpicolinamide (**8**) expanded.

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Sulphur%        0

            1 Sample(s) in Group No : 1
Component Name Average
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Carbon%        73.15912628
Hydrogen%      5.701982021
Sulphur%       0
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Caled for $C_{13}H_{12}N_2O$

Nitrogen%	13.20
Carbon%	73.56
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Figure S49. Elemental analysis data of *N*-benzylpicolinamide (**8**).

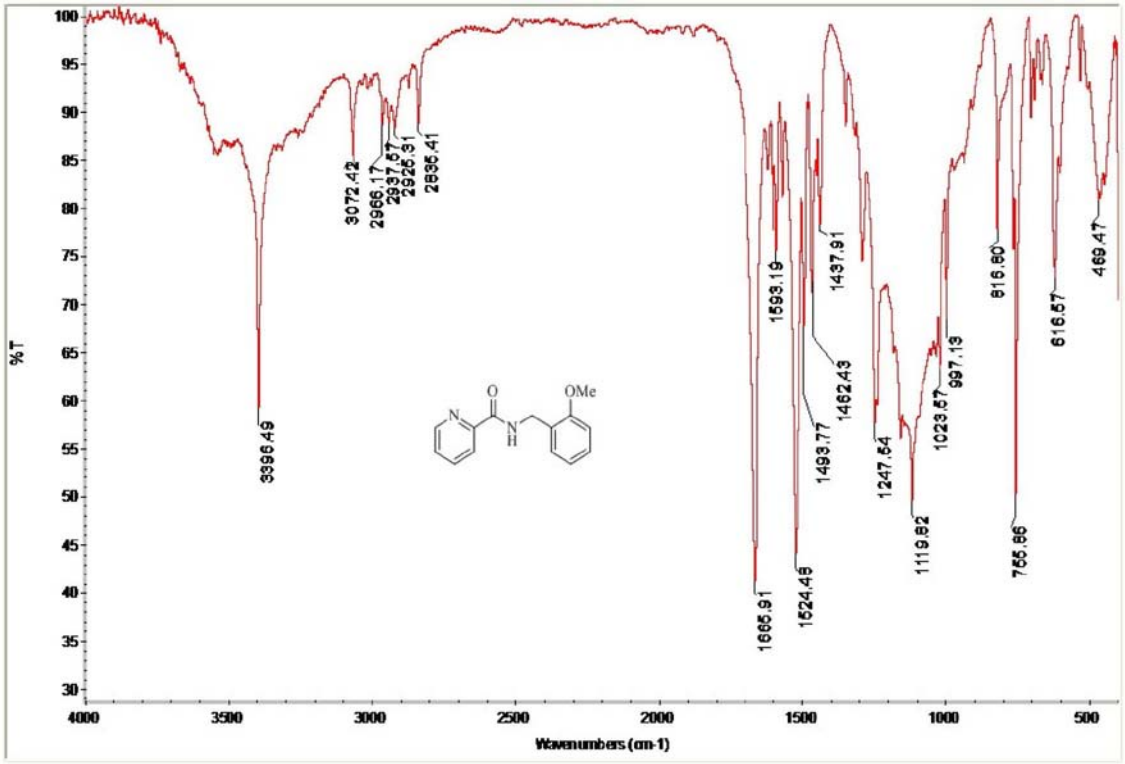

Figure S50. FTIR spectrum of *N*-(2-methoxybenzyl)picolinamide (**9**).

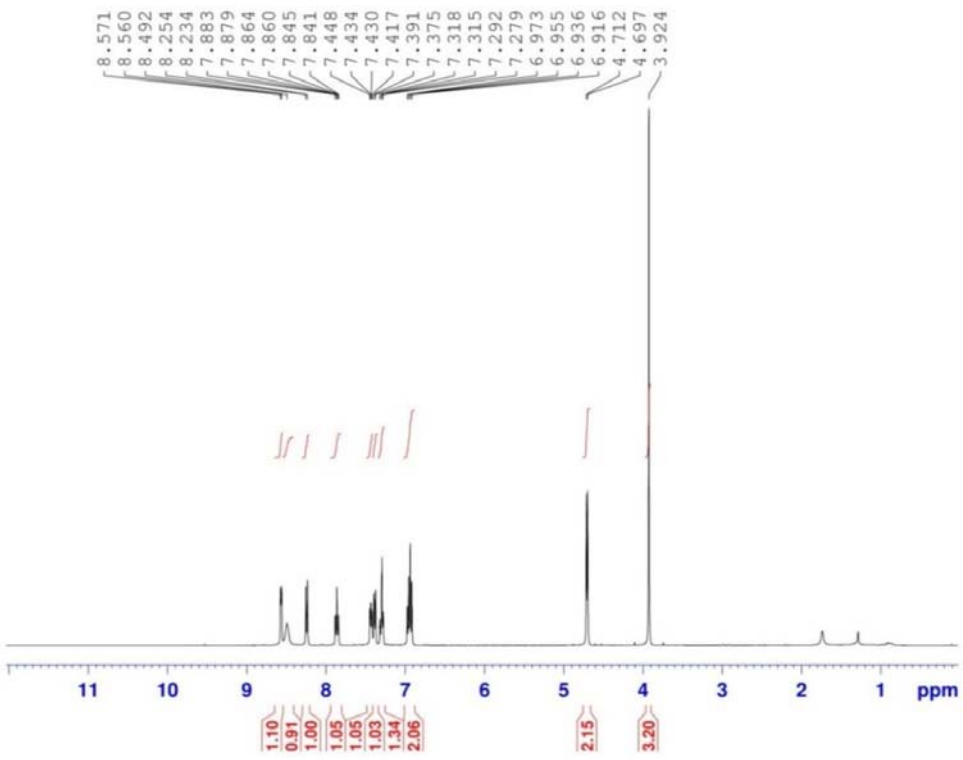

Figure S51. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-(2-methoxybenzyl)picolinamide (**9**).

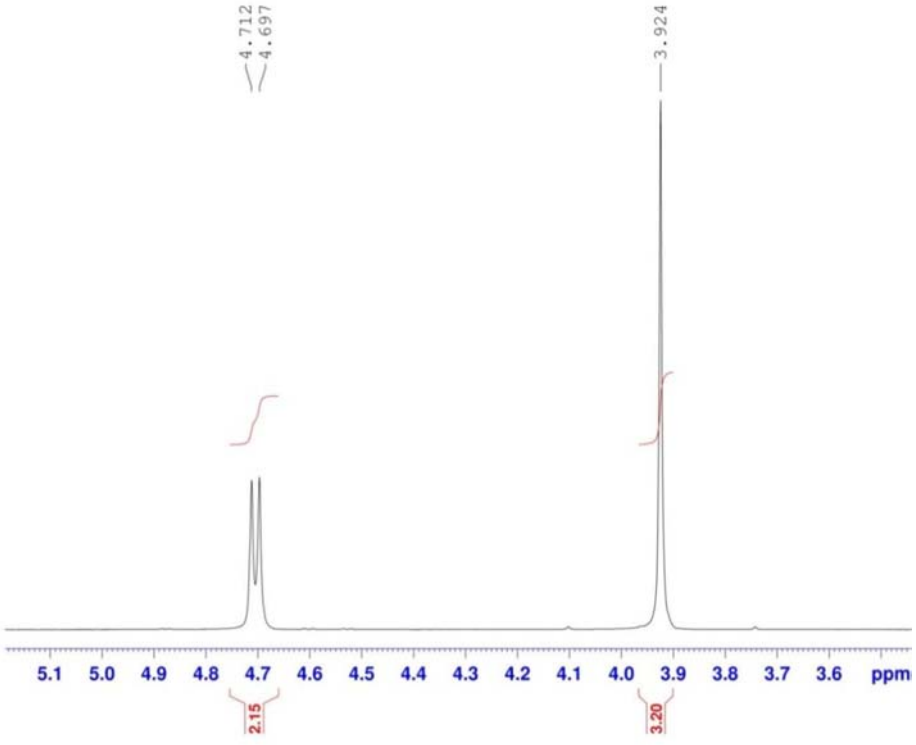

Figure S52. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-(2-methoxybenzyl)picolinamide (**9**) expanded.

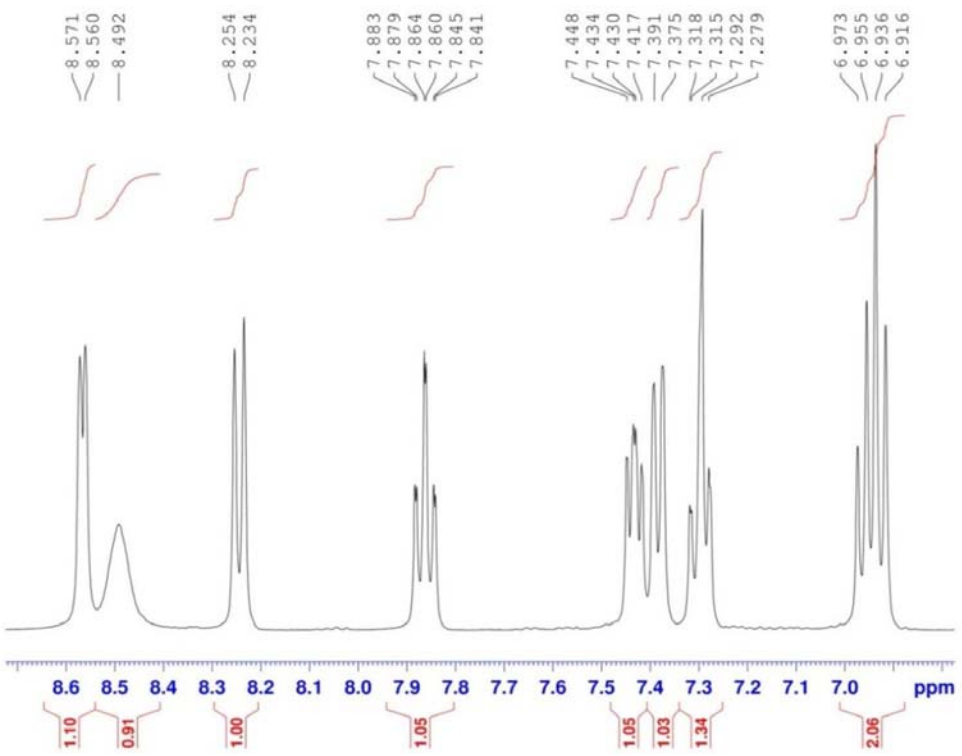

Figure S53. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-(2-methoxybenzyl) picolinamide (**9**) expanded.

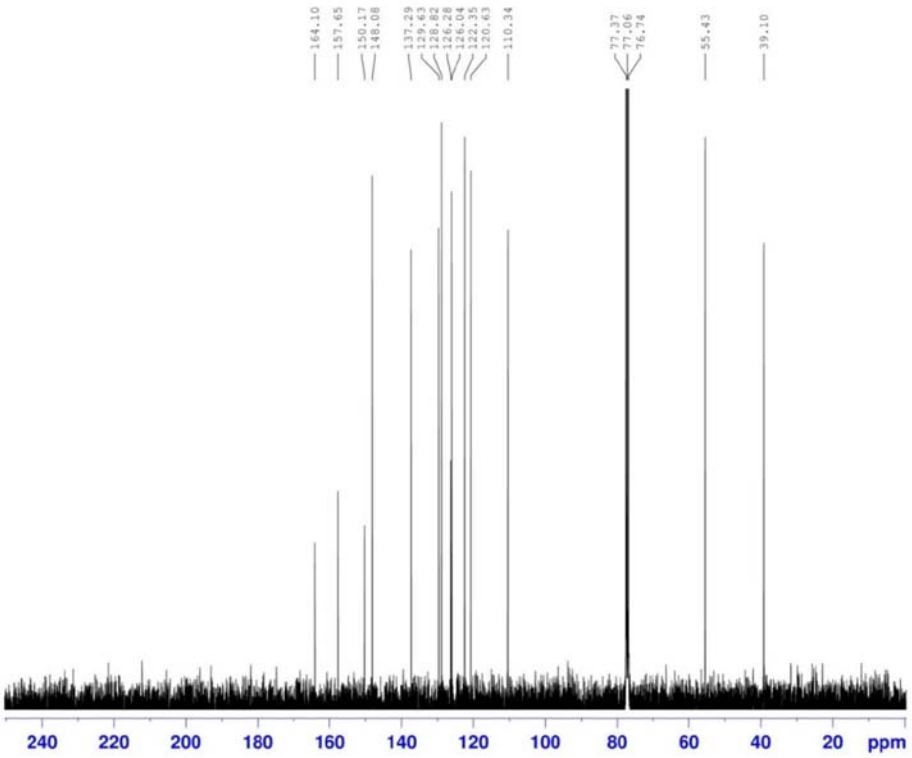

Figure S54. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-(2-methoxybenzyl)picolinamide (**9**).

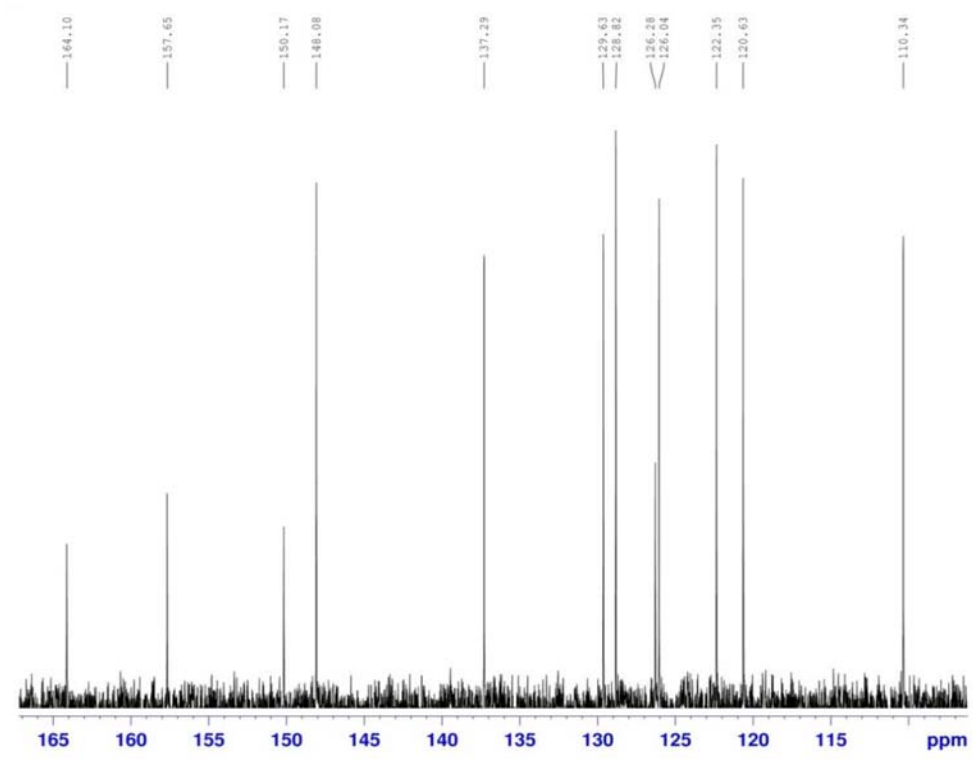

Figure S55. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-(2-methoxybenzyl)picolinamide (**9**) expanded.

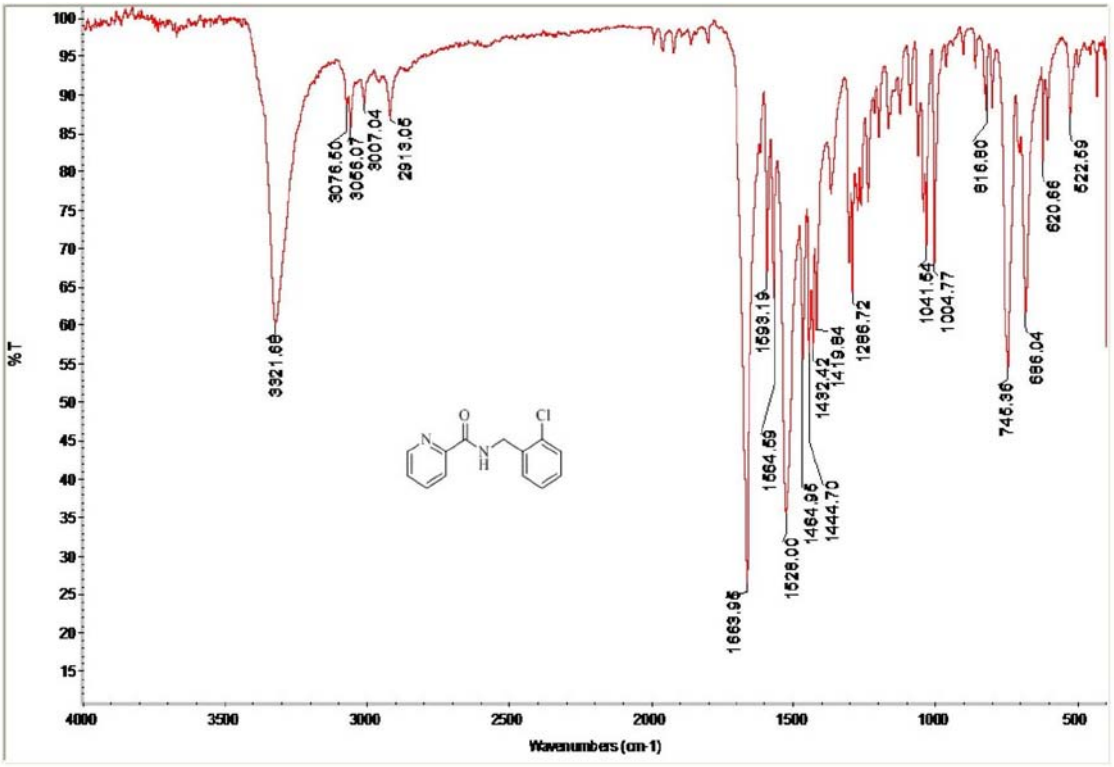

Figure S56. FTIR spectrum of *N*-(2-chlorobenzyl)picolinamide (**10**).

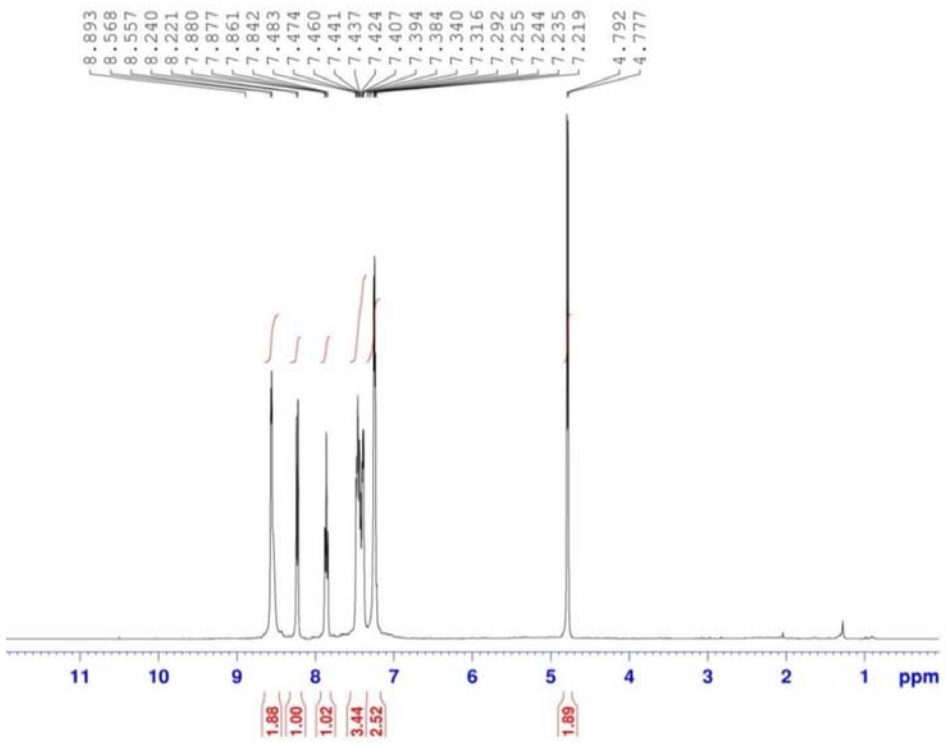

Figure S57. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-(2-chlorobenzyl)picolinamide (**10**).

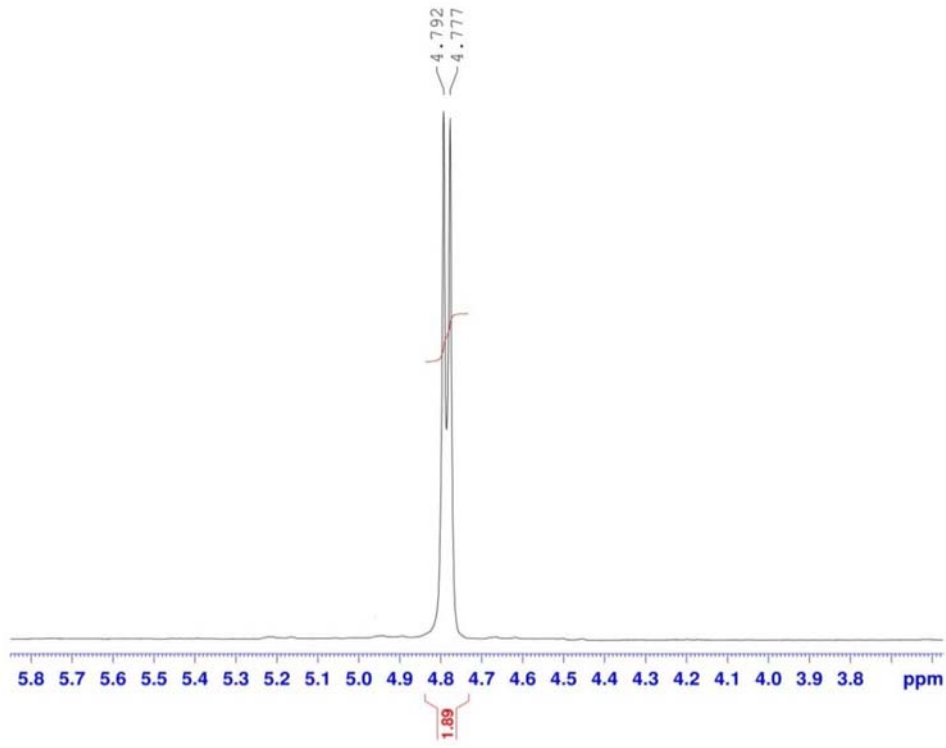

Figure S58. ^{1}H NMR (400 MHz, $CDCl_3$) of *N*-(2-chlorobenzyl)picolinamide (**10**) expanded.

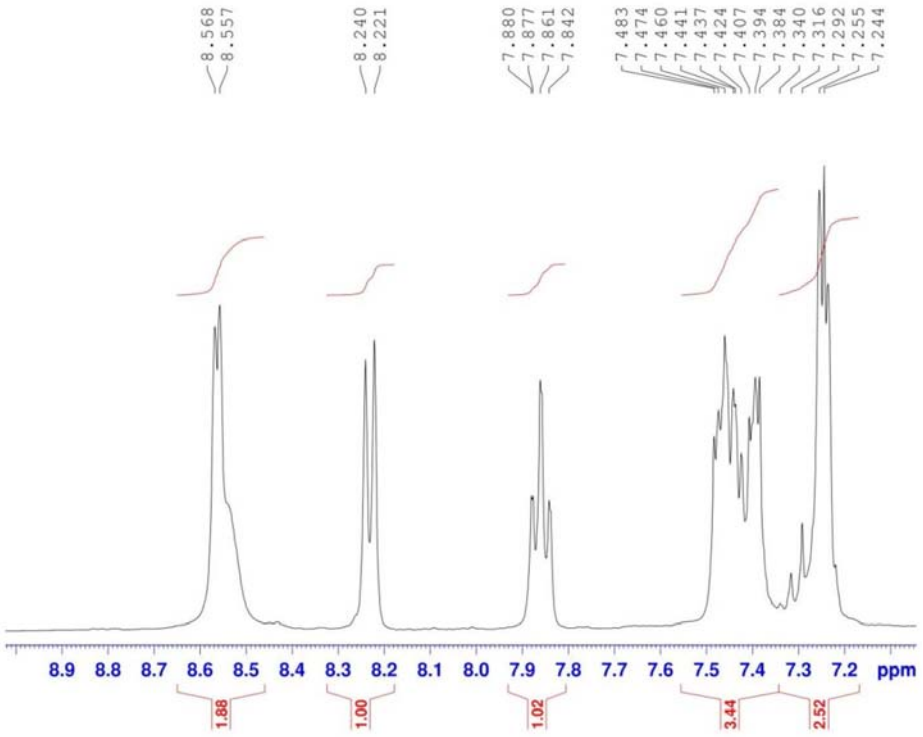

Figure S59. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-(2-chlorobenzyl)picolinamide (**10**) expanded.

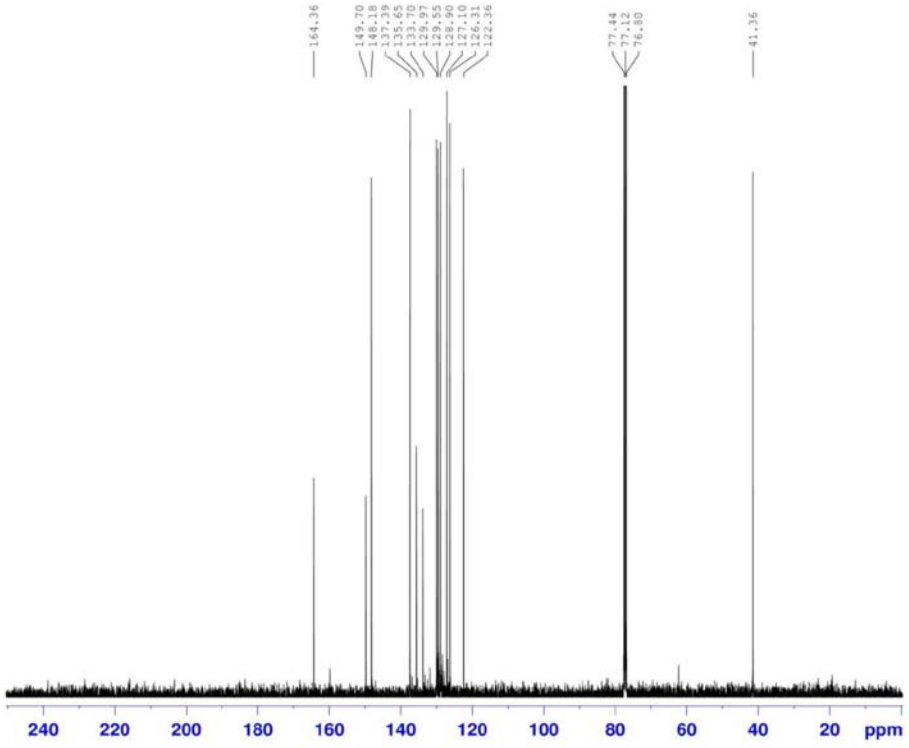

Figure S60. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-(2-chlorobenzyl)picolinamide (**10**).

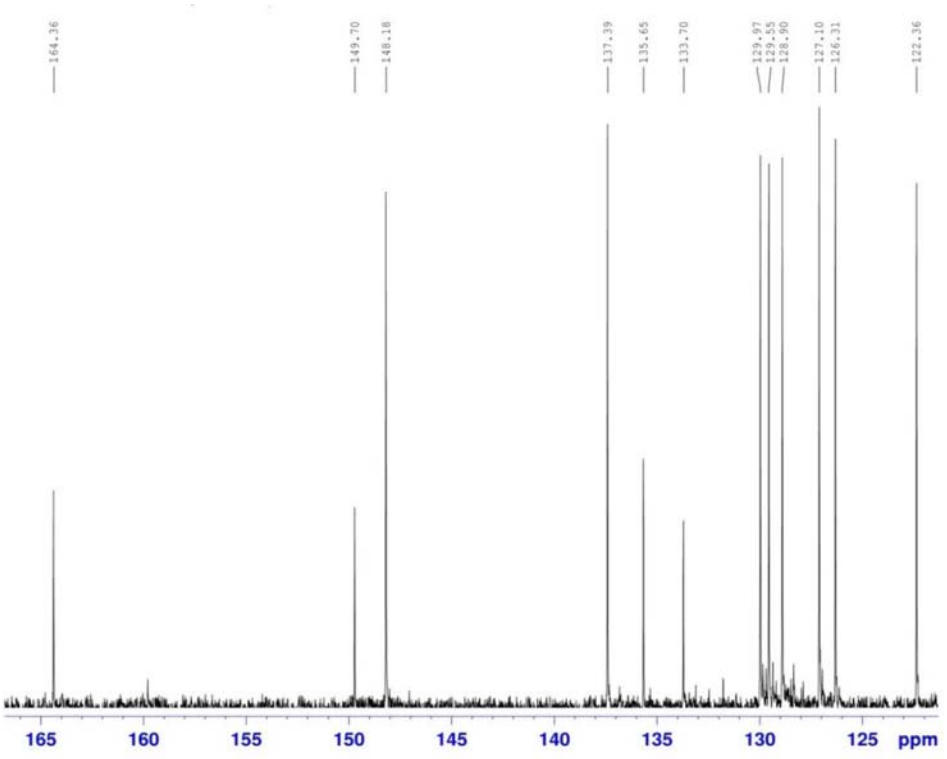

Figure S61. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-(2-chlorobenzyl)picolinamide (**10**) expanded.

Eager 300 Summarize Results

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emamjomeh-80		

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Carbon%	62.86192093
Hydrogen%	4.222644806
Sulphur%	0

Calcd for $C_{13}H_{11}ClN_2O$

Nitrogen%	11.36
Carbon%	63.29
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Suphur%	0

1 Sample(s) in Group No : 1

Component Name	Average
Nitrogen%	10.93560867
Carbon%	62.86192093
Hydrogen%	4.222644806
Sulphur%	0

Figure S62. Elemental analysis data of *N*-(2-chlorobenzyl)picolinamide (**10**).

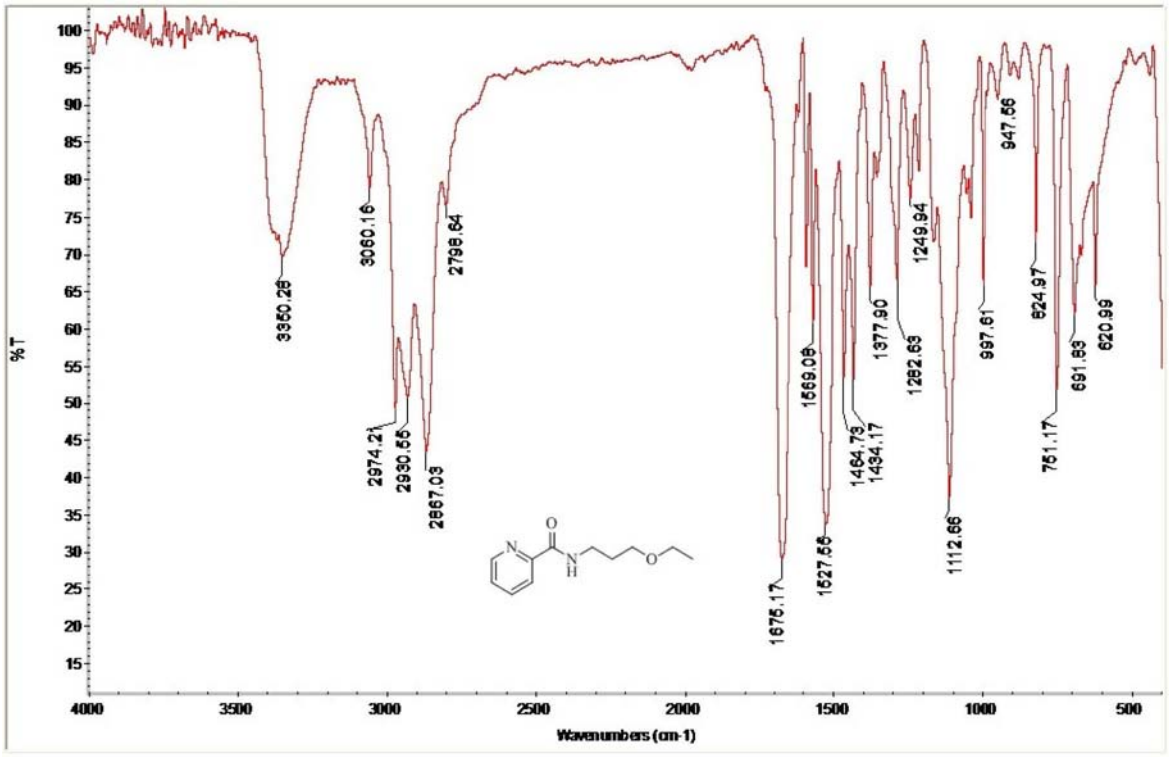

Figure S63. FTIR spectrum of *N*-(3-ethoxypropyl)picolinamide (**11**).

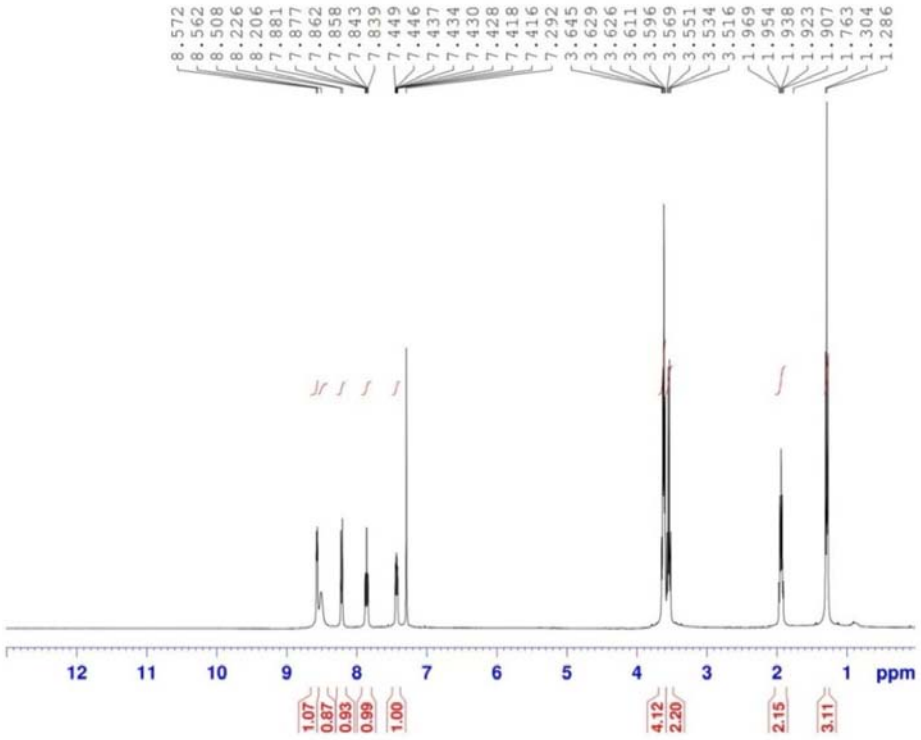

Figure S64. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-(3-ethoxypropyl)picolinamide (**11**).

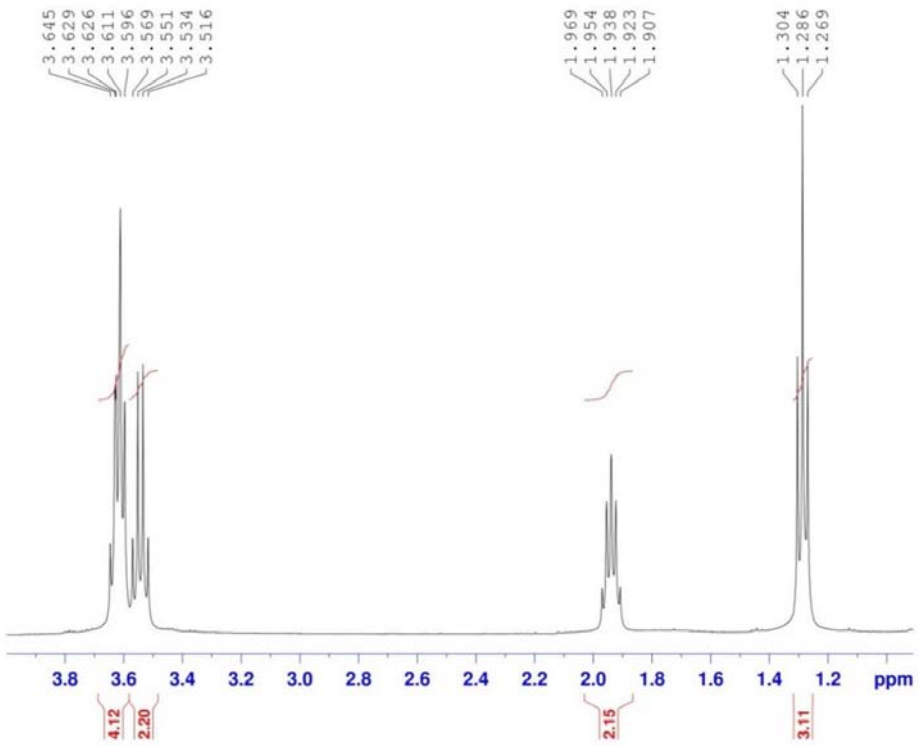

Figure S65. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-(3-ethoxypropyl)picolinamide (**11**) expanded.

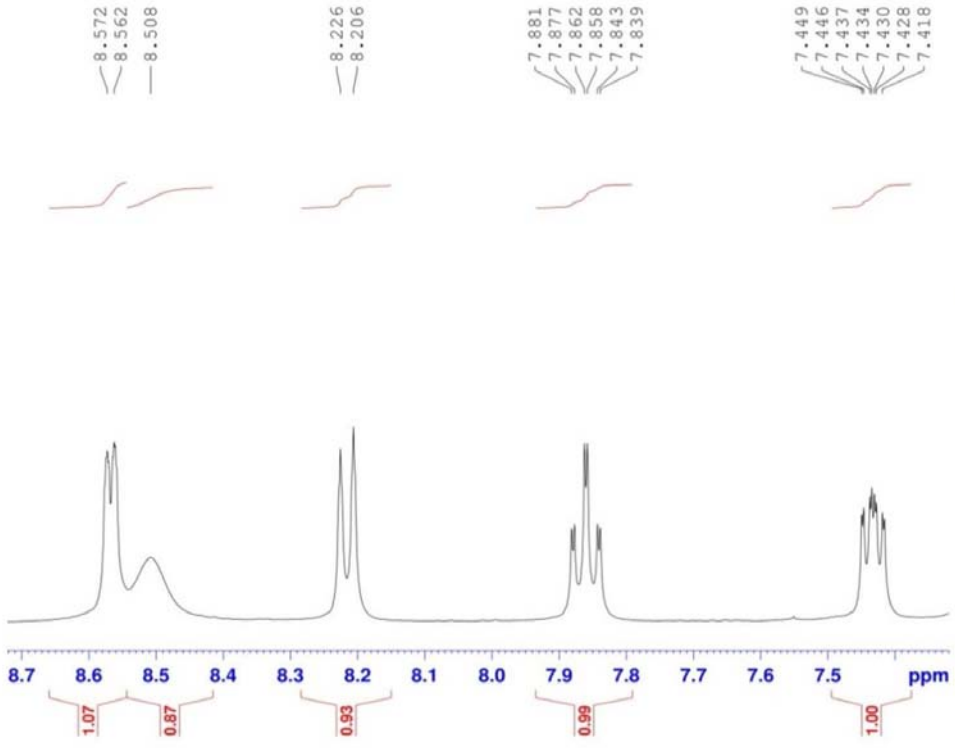

Figure S66. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-(3-ethoxypropyl)picolinamide (**11**) expanded.

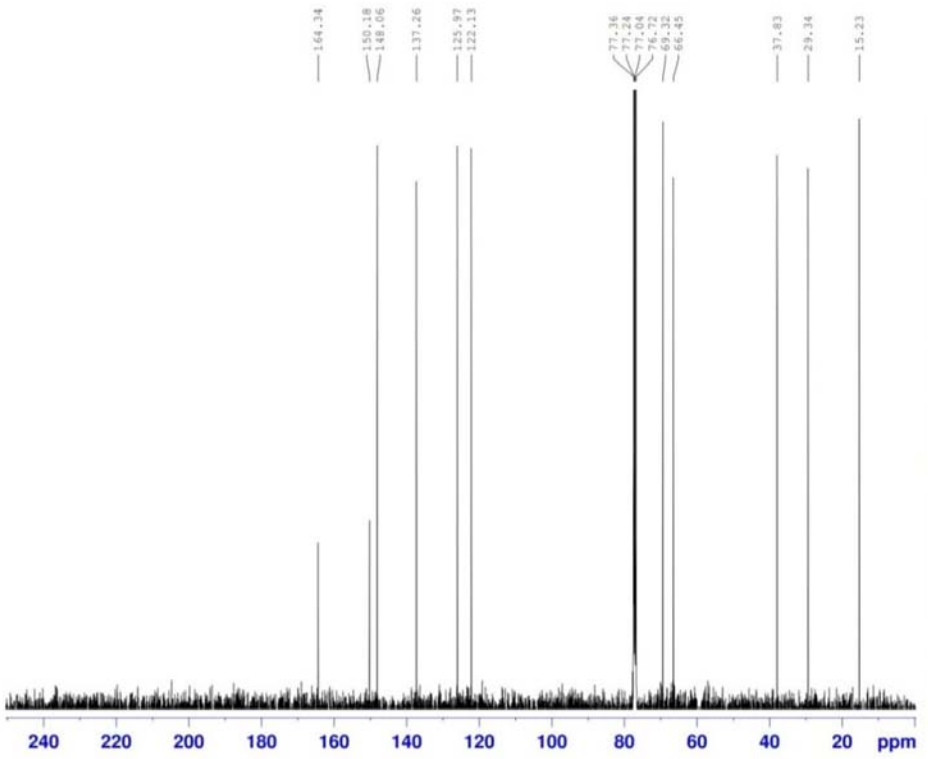

Figure S67. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-(3-ethoxypropyl)picolinamide (**11**).

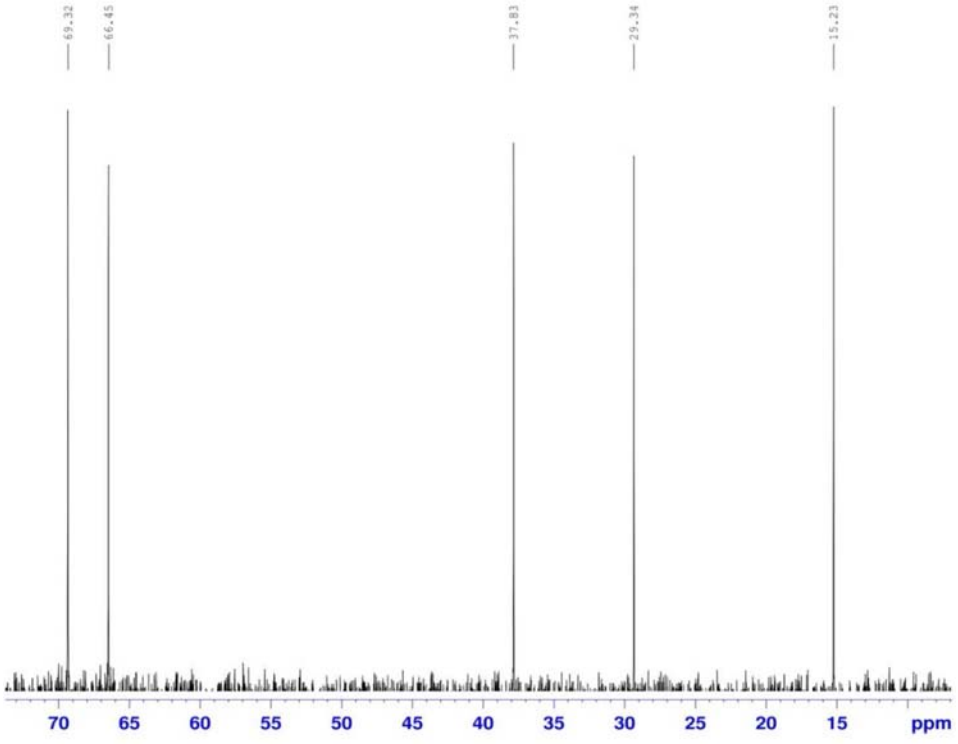

Figure S68. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-(3-ethoxypropyl)picolinamide (**11**).

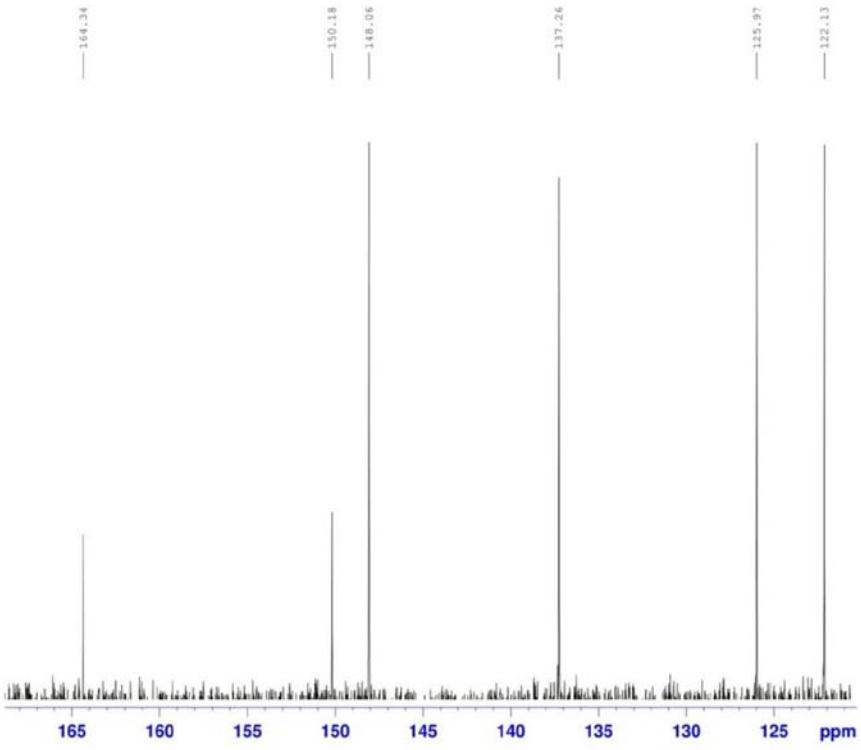

Figure S69. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-(3-ethoxypropyl)picolinamide (**11**) expanded.

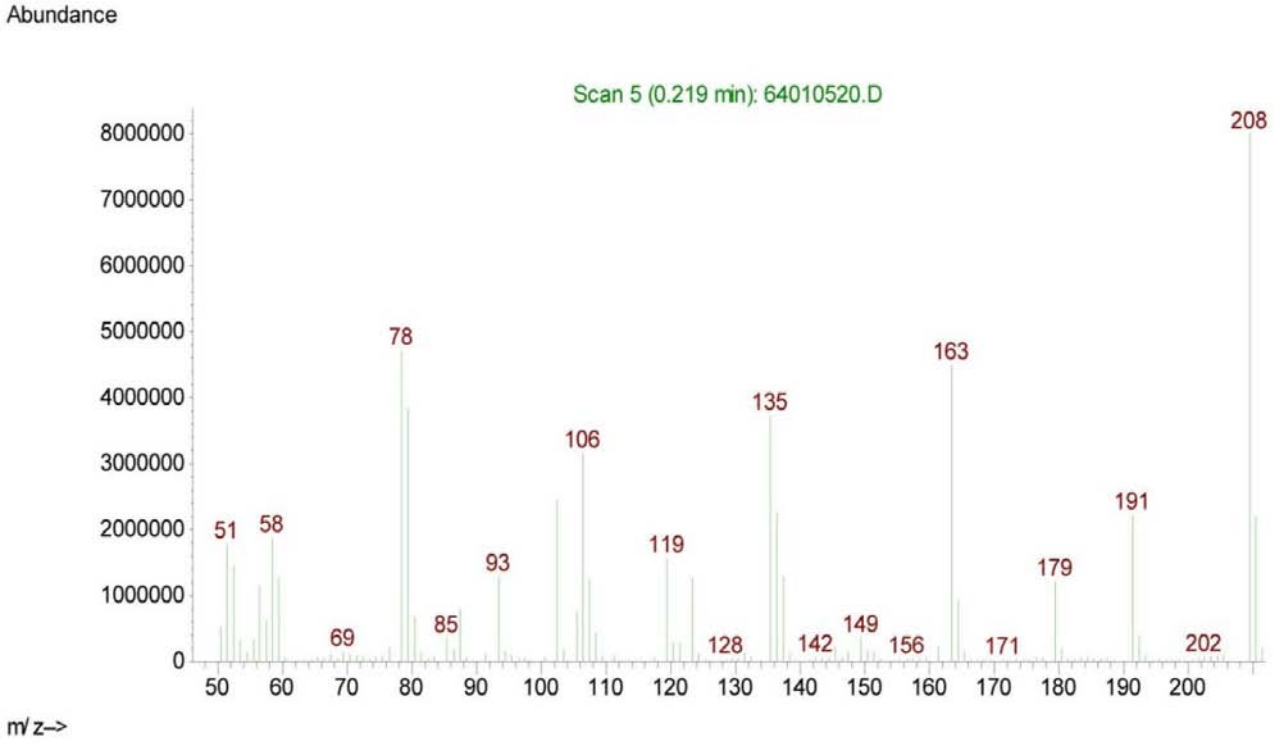

Figure S70. MS spectrum (EI, 70 eV) of *N*-(3-ethoxypropyl)picolinamide (**11**).

06.08.12 10:10

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Document: 900511 (varioEL), Name: eassuperuser, Access: varioEL superuser
Elementar Analysensysteme GmbH VarioEL V5.19.11 21. Oct. 09, CHNS Mode, S. No.: 11092035
Page 1/1

Figure S71. Elemental analysis data of *N*-(3-ethoxypropyl)picolinamide (**11**).

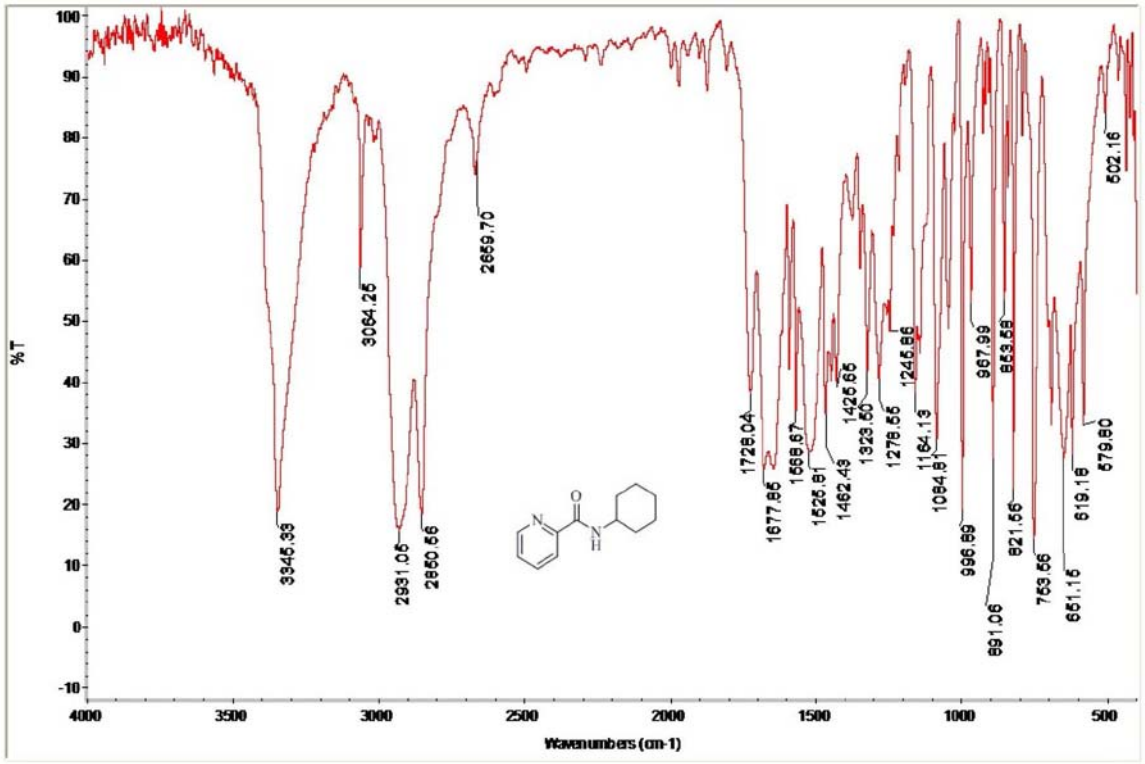

Figure S72. FTIR spectrum of *N*-cyclohexylpicolinamide (**12**).

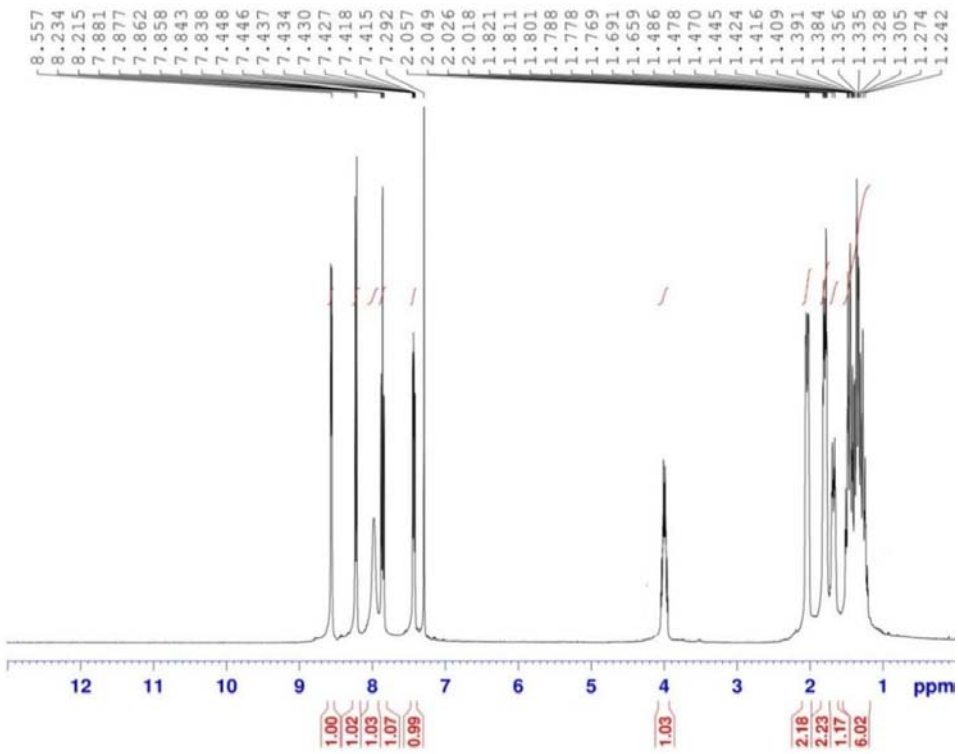

Figure S73. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-cyclohexylpicolinamide (**12**).

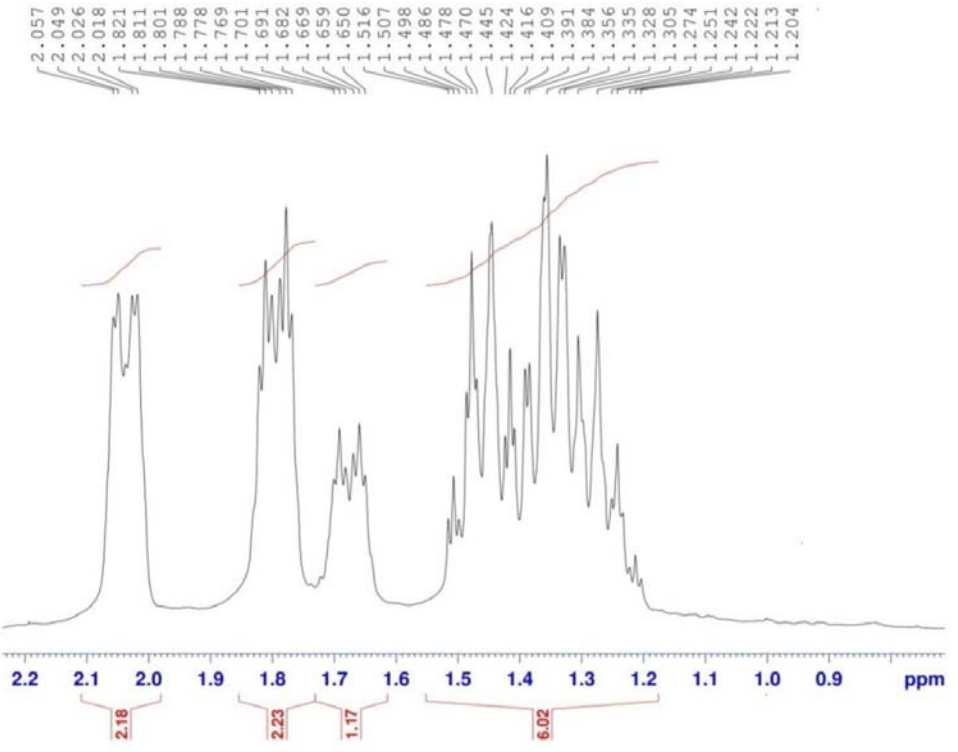

Figure S74. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-cyclohexylpicolinamide (**12**) expanded.

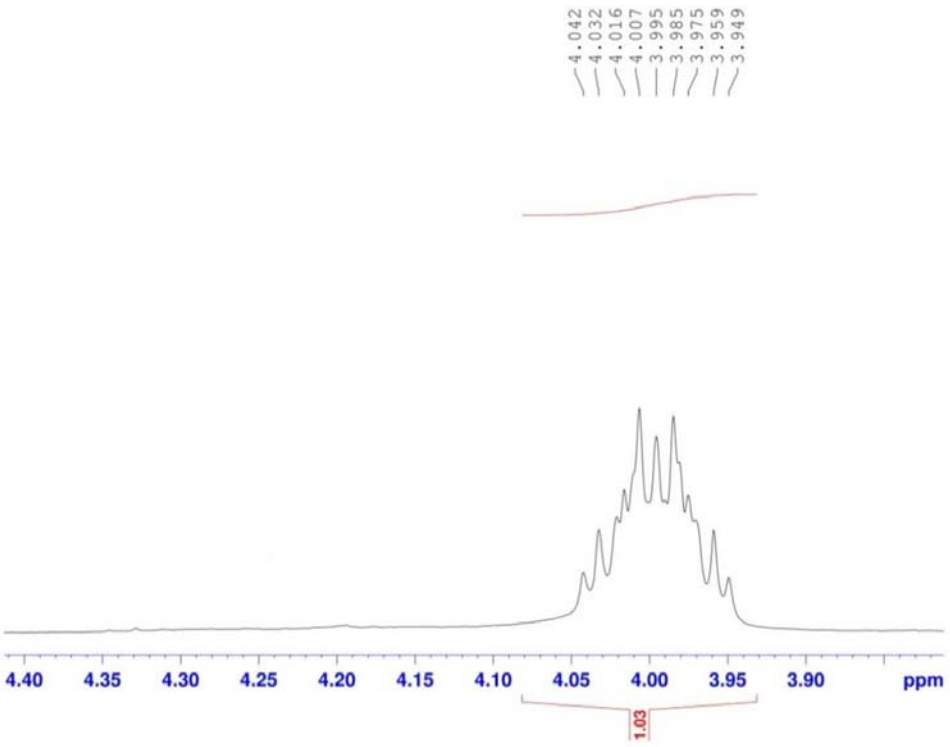

Figure S75. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-cyclohexylpicolinamide (**12**) expanded.

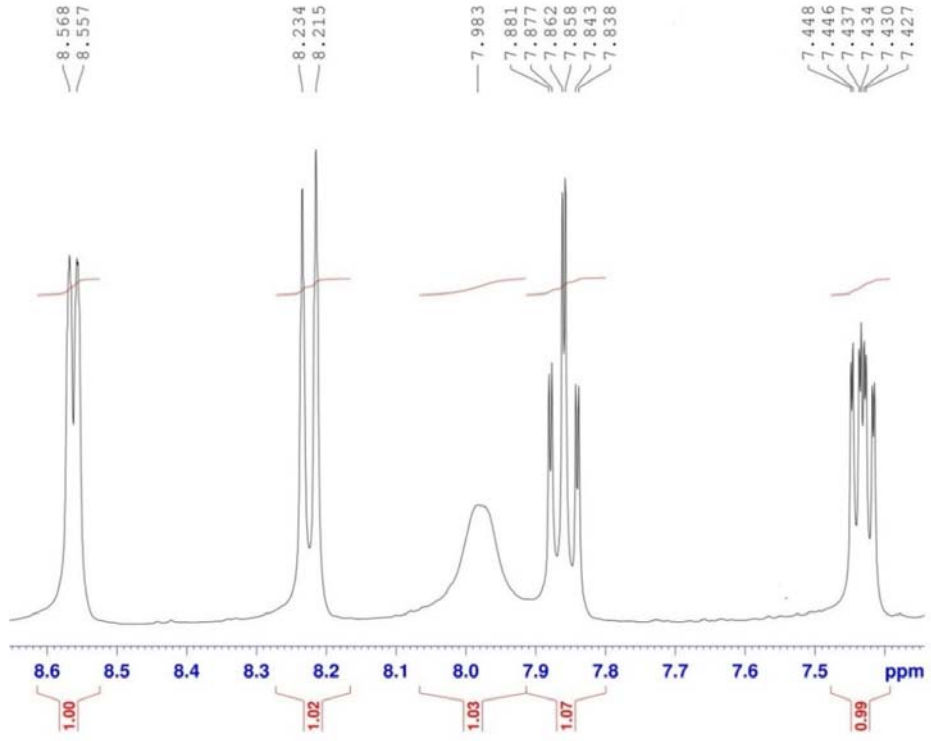

Figure S76. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-cyclohexylpicolinamide (**12**) expanded.

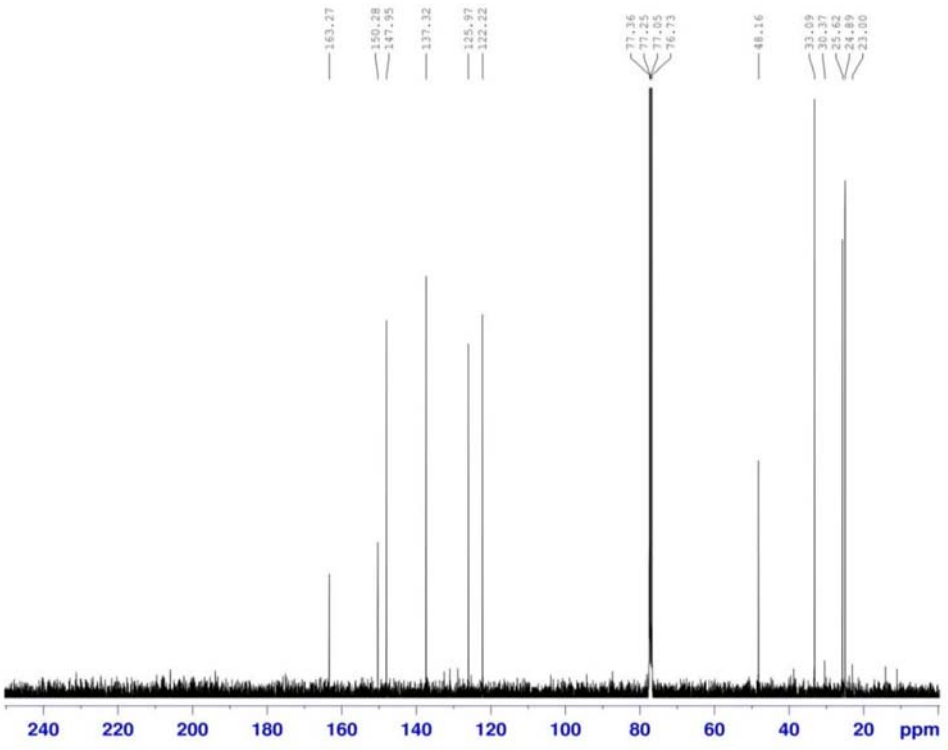

Figure S77. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-cyclohexylpicolinamide (**12**).

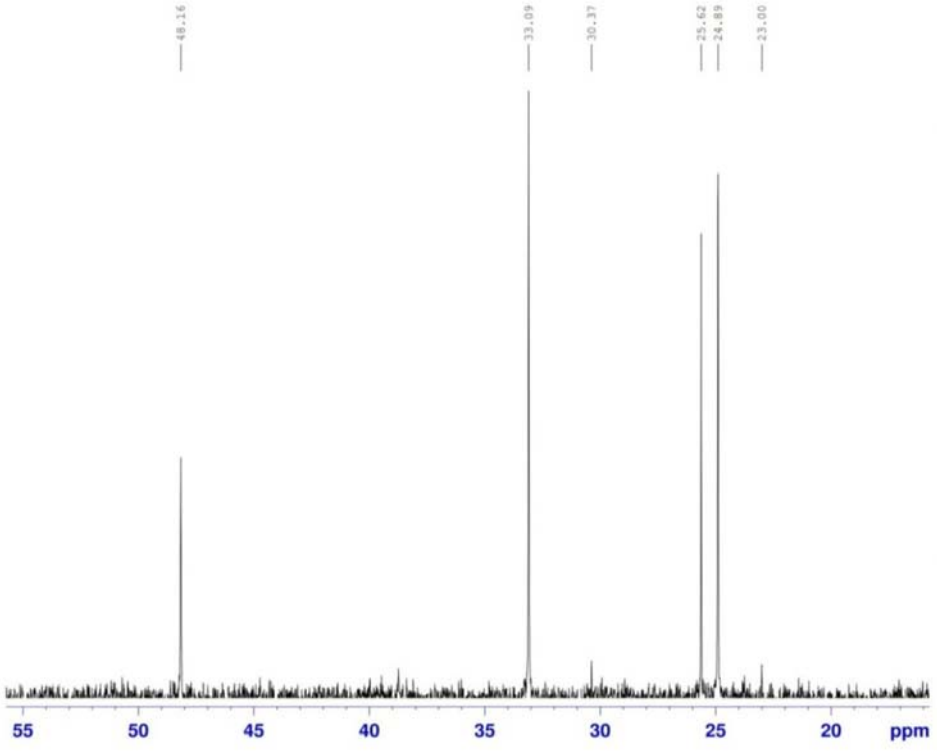

Figure S78. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-cyclohexylpicolinamide (**12**) expanded.

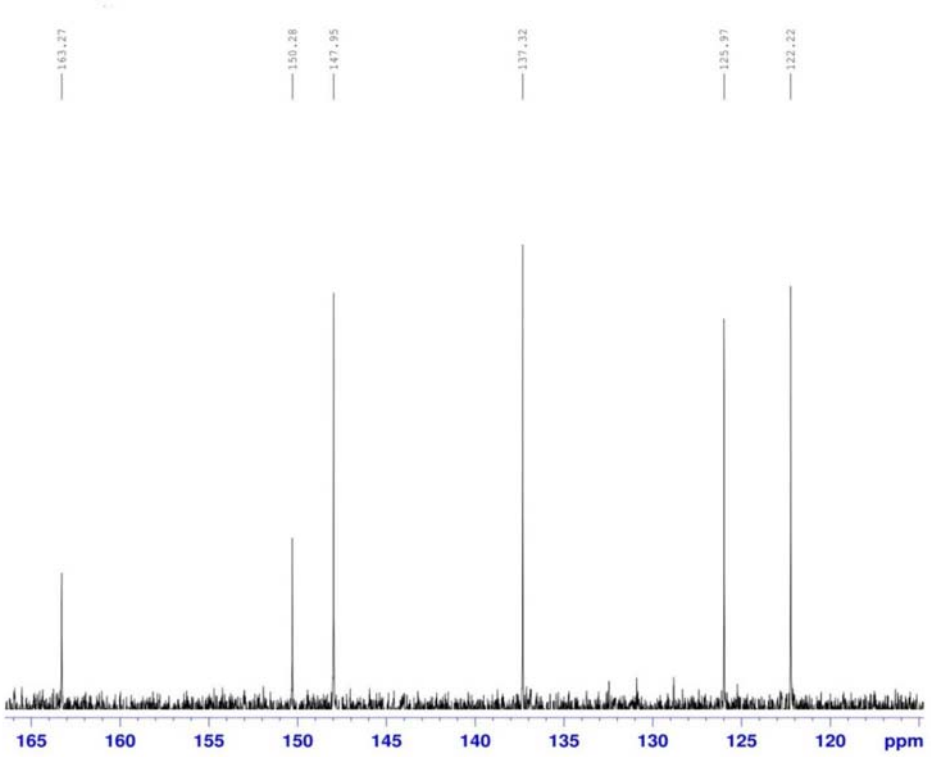

Figure S79. ^{13}C NMR (100 MHz, $CDCl_3$) of *N*-cyclohexylpicolinamide (**12**) expanded.

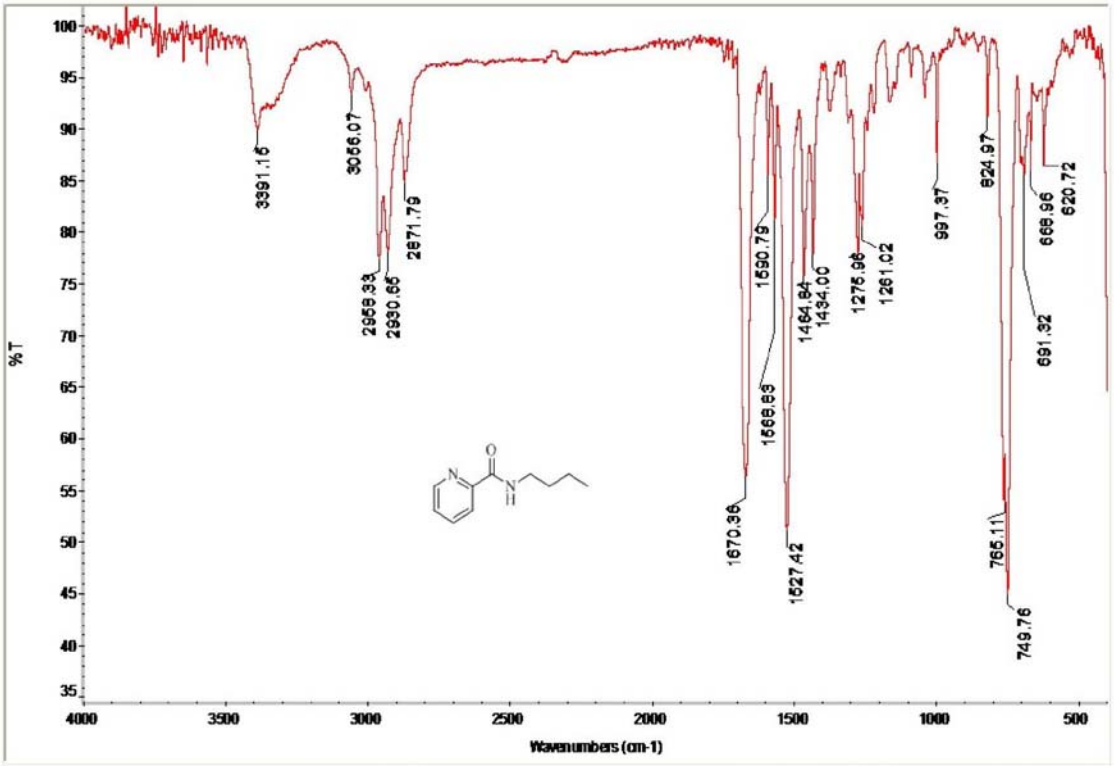

Figure S80. FTIR spectrum of *N*-butylpicolinamide (**13**).

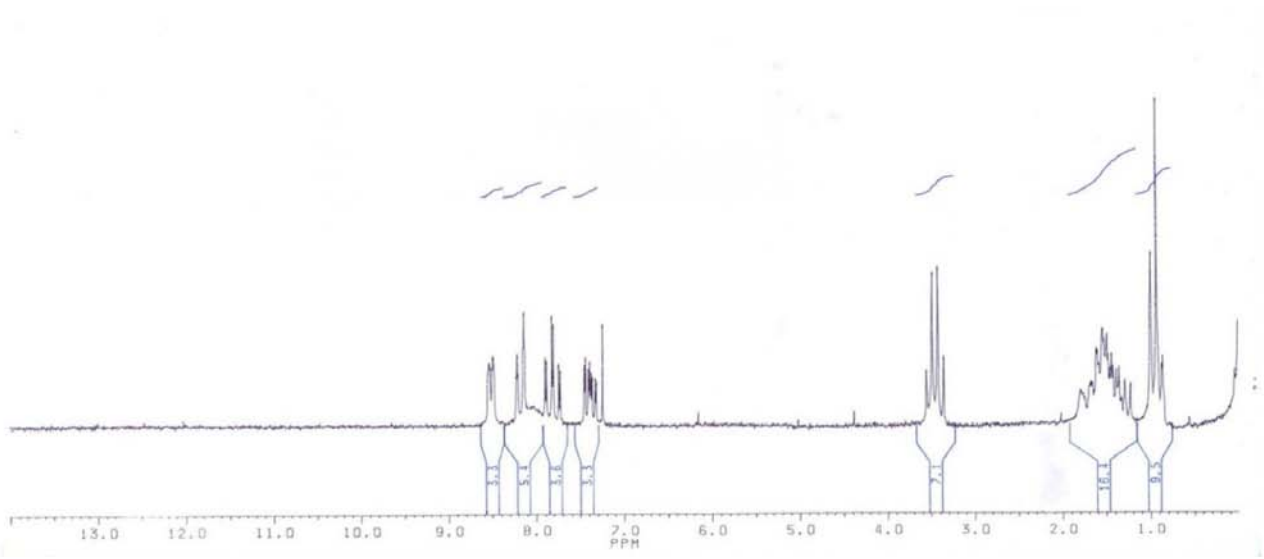

Figure S81. ^{1}H NMR spectrum (100 MHz, $CDCl_3$) of *N*-butylpicolinamide (**13**).

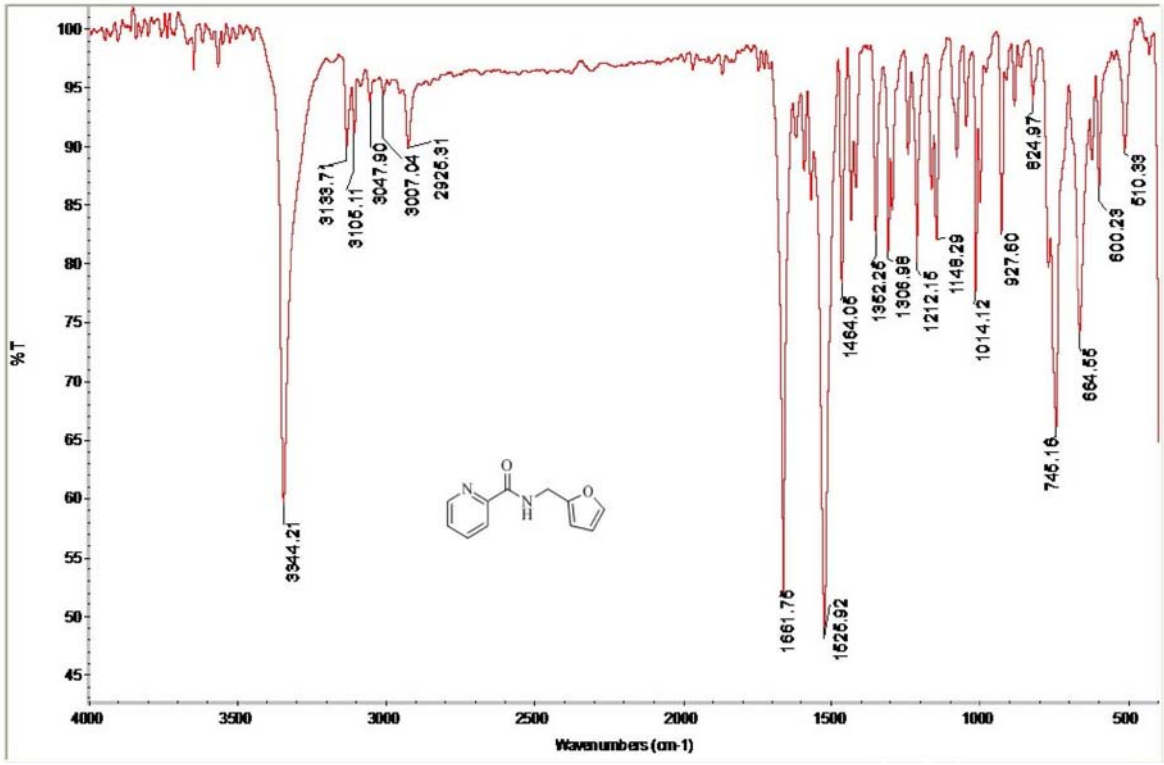

Figure S82. FTIR spectrum of *N*-(furan-2-ylmethyl)picolinamide (**14**).

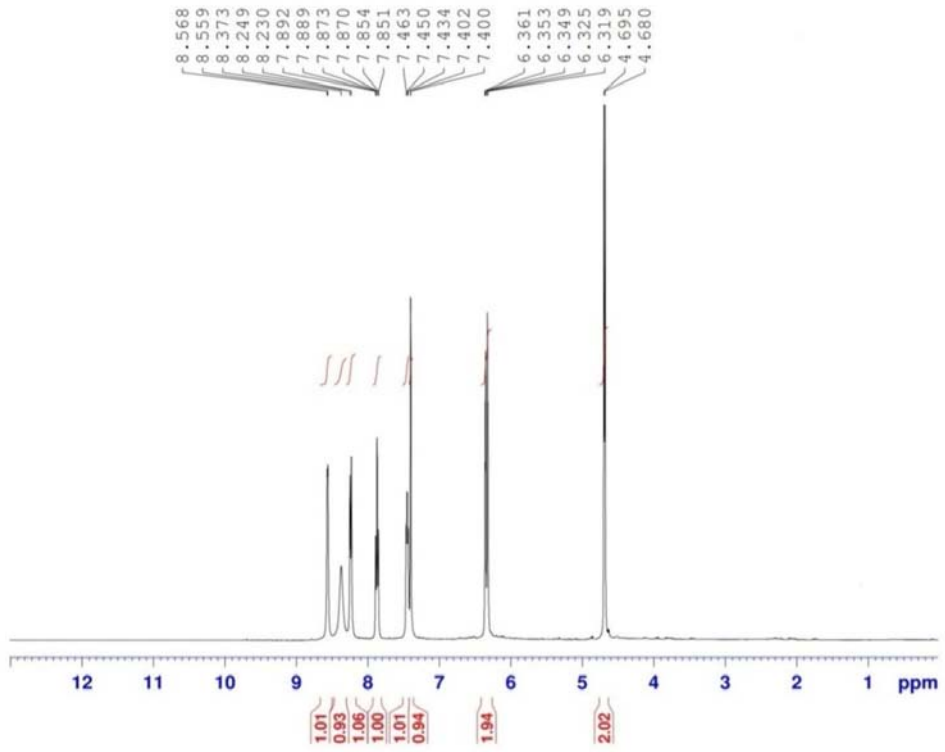

Figure S83. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-(furan-2-ylmethyl)picolinamide (**14**).

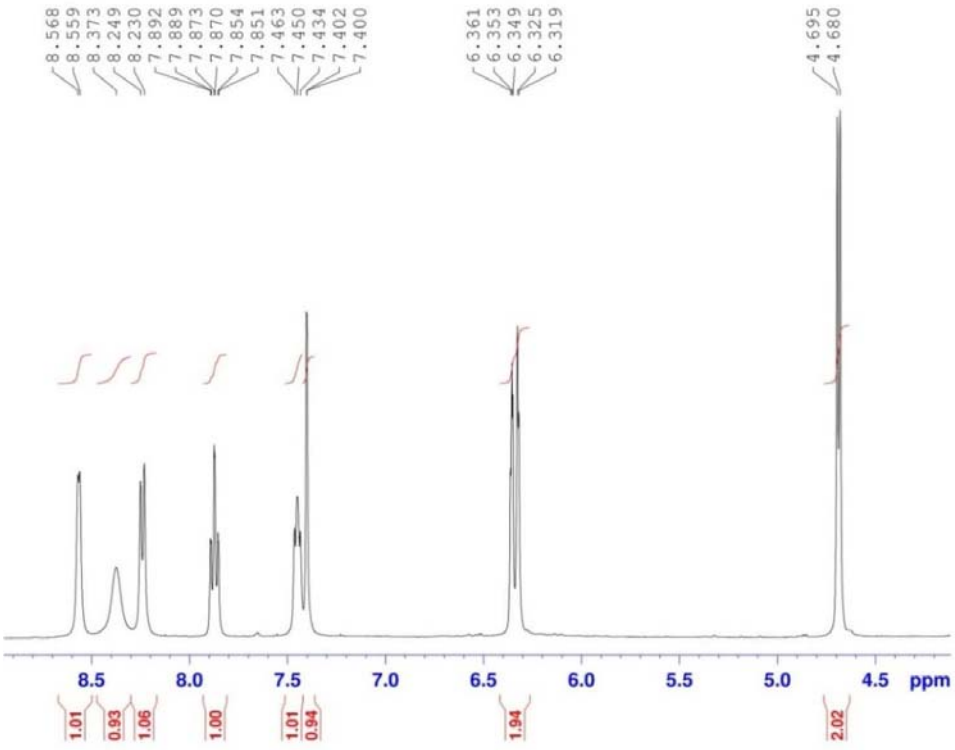

Figure S84. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-(furan-2-ylmethyl)picolinamide (**14**) expanded.

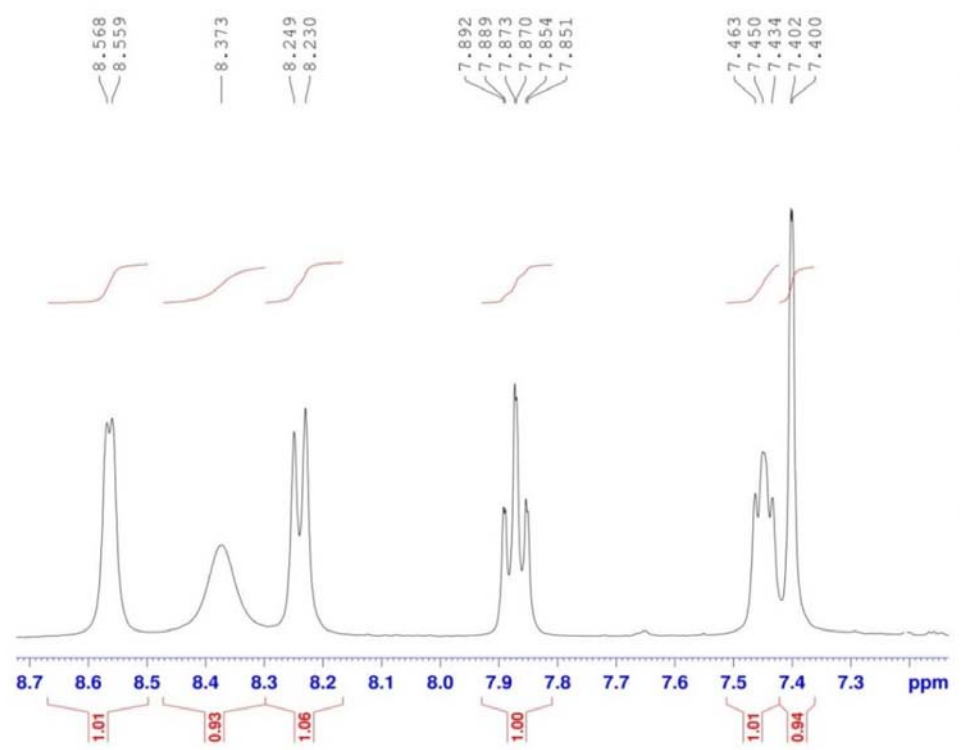

Figure S85. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-(furan-2-ylmethyl)picolinamide (**14**) expanded.

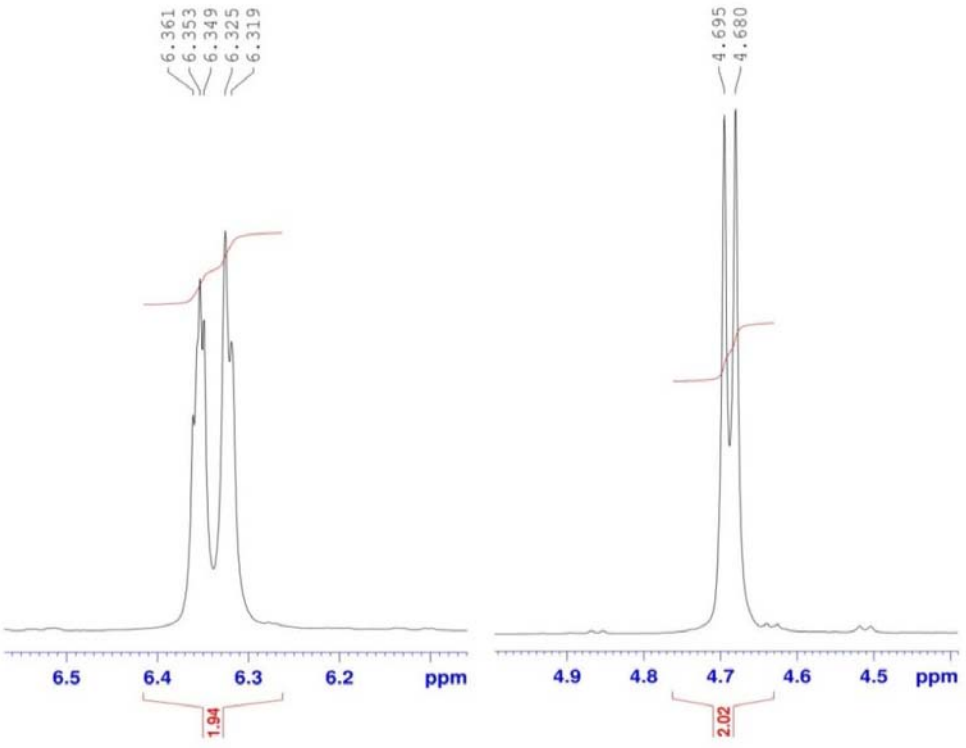

Figure S86. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-(furan-2-ylmethyl)picolinamide (**14**) expanded.

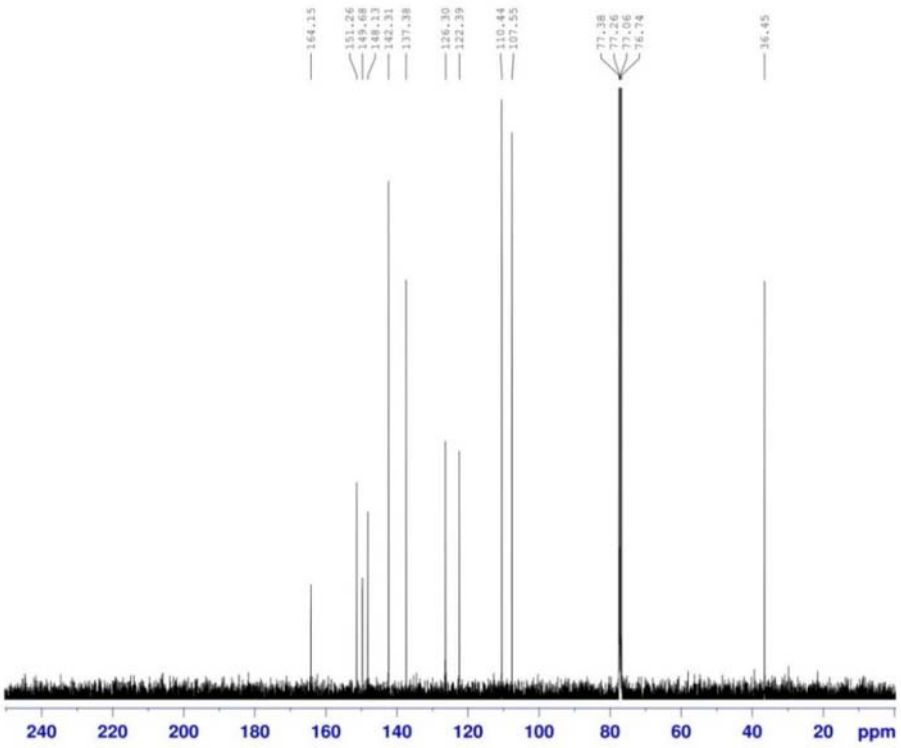

Figure S87. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-(furan-2-ylmethyl)picolinamide (**14**).

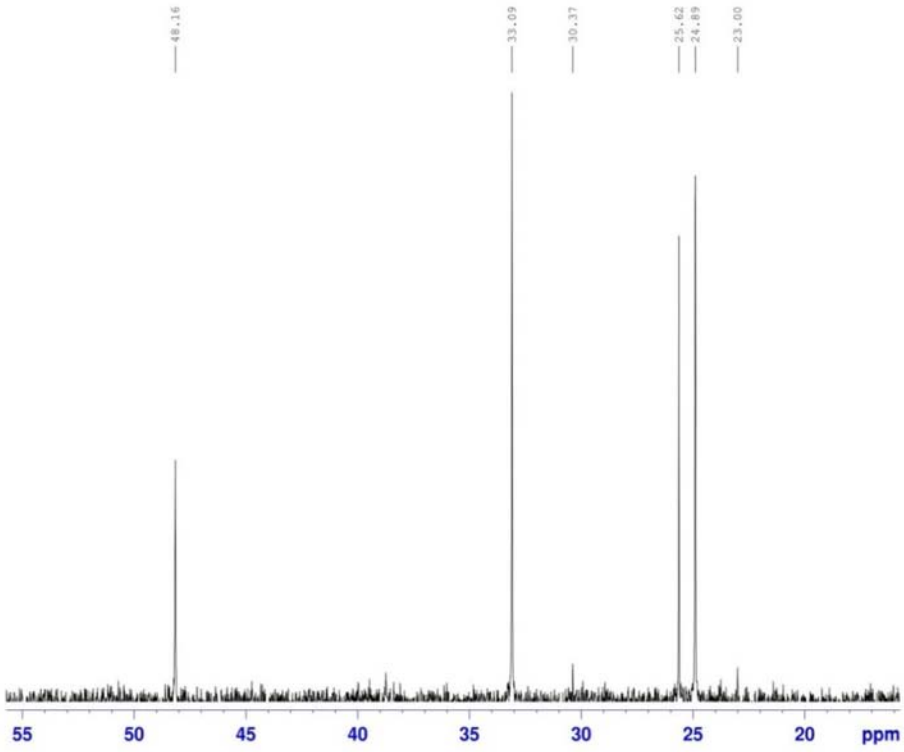

Figure S88. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-(furan-2-ylmethyl)picolinamide (**14**) expanded.

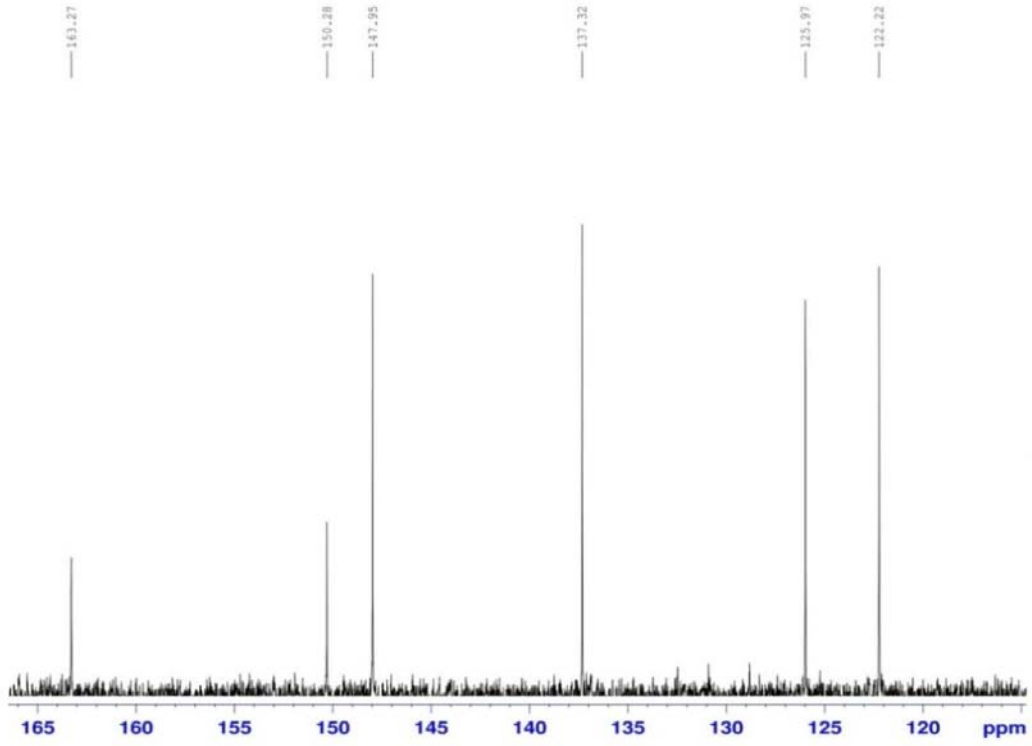

Figure S89. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-(furan-2-ylmethyl)picolinamide (**14**) expanded.

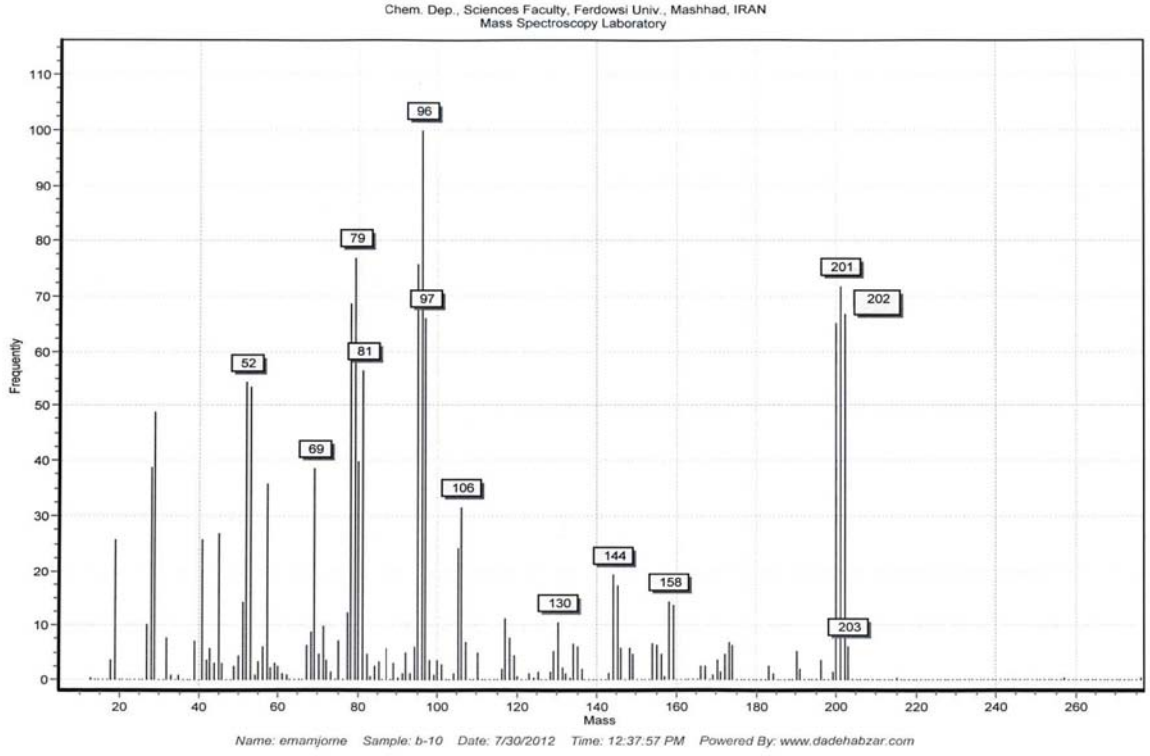

Figure S90. MS spectrum (EI, 70 eV) of *N*-(furan-2-ylmethyl)picolinamide (**14**).

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Sulphur%        0
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Calcd for $C_{11}H_{10}N_2O_2$

Nitrogen%	13.85
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Component Name  Average
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Nitrogen%       13.91787334
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Sulphur%        0
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Figure S91. Elemental analysis data of *N*-(furan-2-ylmethyl)picolinamide (**14**).

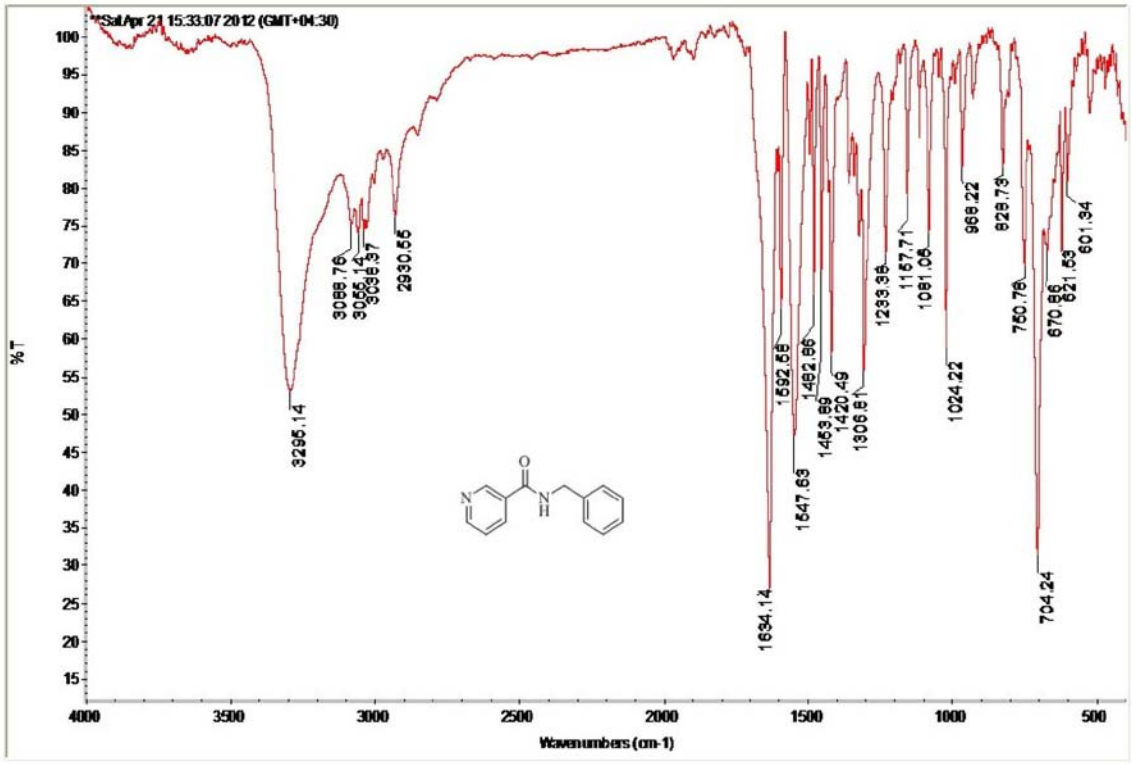

Figure S92. FTIR spectrum of *N*-benzylnicotinamide (**15**).

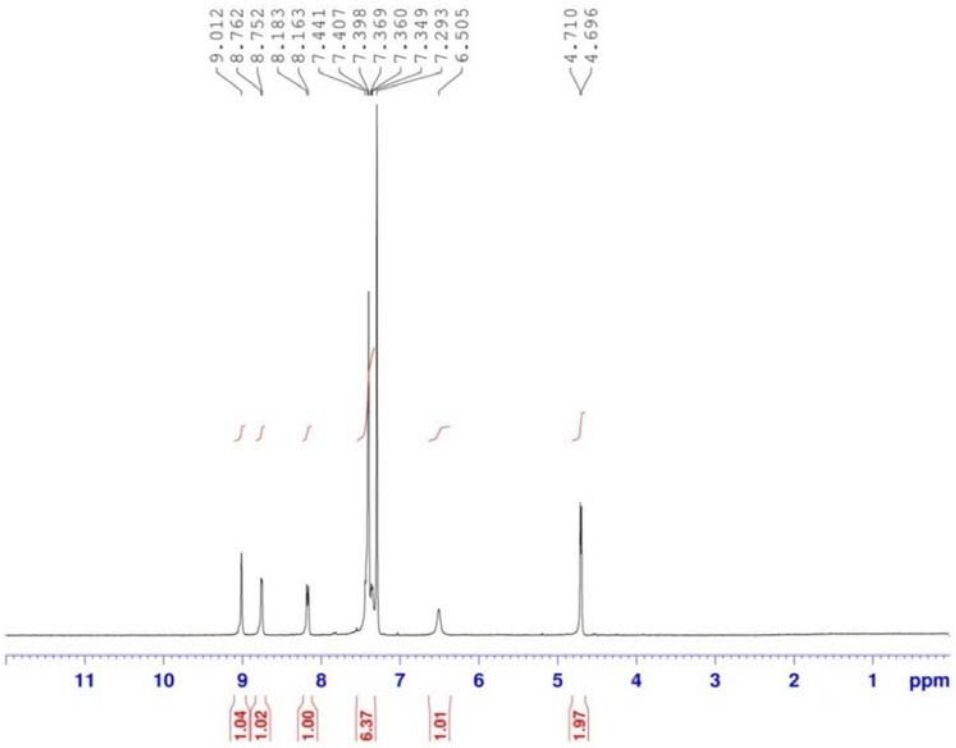

Figure S93. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-benzylnicotinamide (**15**).

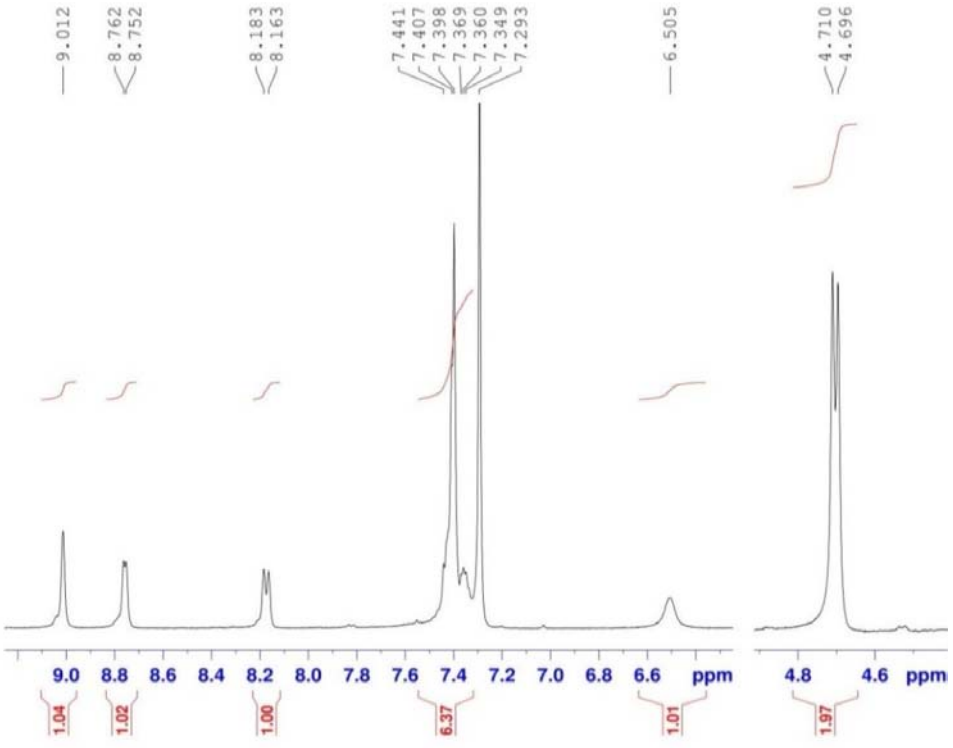

Figure S94. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-benzylnicotinamide (**15**) expanded.

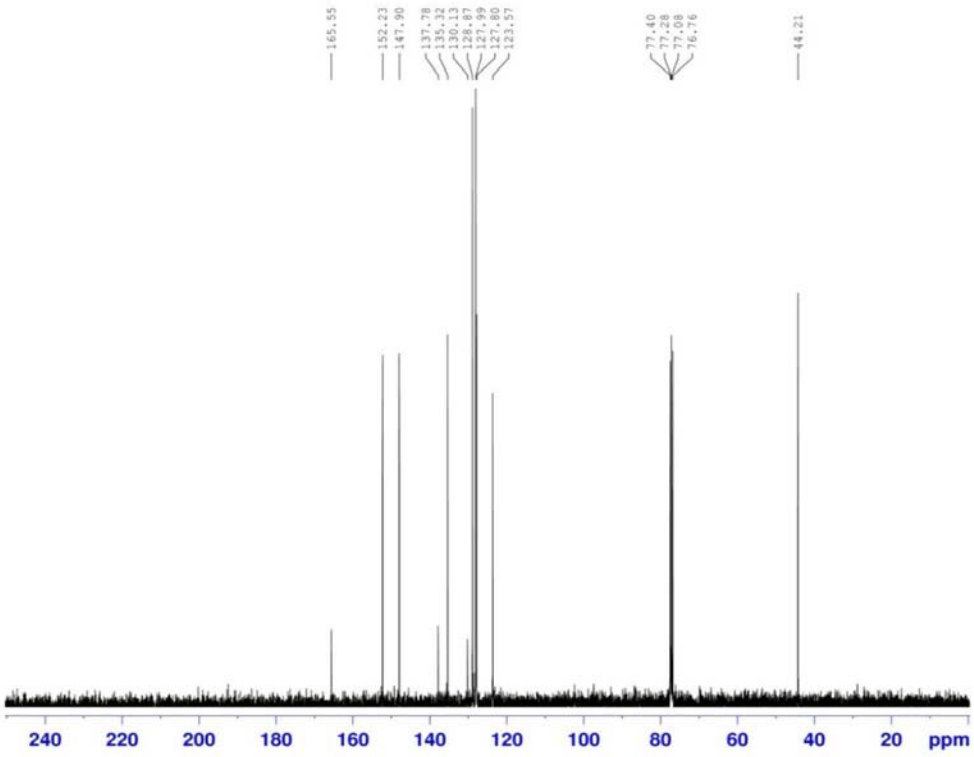

Figure S95. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-benzylnicotinamide (**15**).

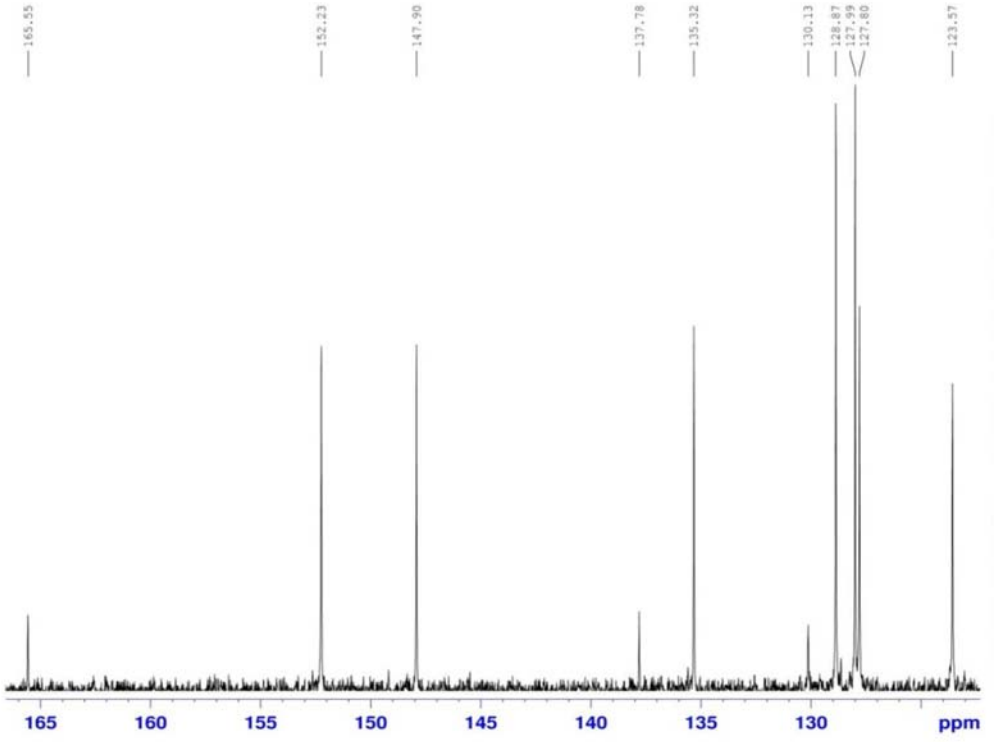

Figure S96. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-benzylnicotinamide (**15**) expanded.

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            1 Sample(s) in Group No : 1
Component Name Average
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Carbon%        73.0827713
Hydrogen%      5.643310547
Sulphur%       0
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Calcd for $C_{13}H_{12}N_2O$

Nitrogen%	13.20
Carbon%	73.56
Hydrogen%	5.70
Suphur%	0

Figure S97. Elemental analysis data of *N*-benzylnicotinamide (**15**).

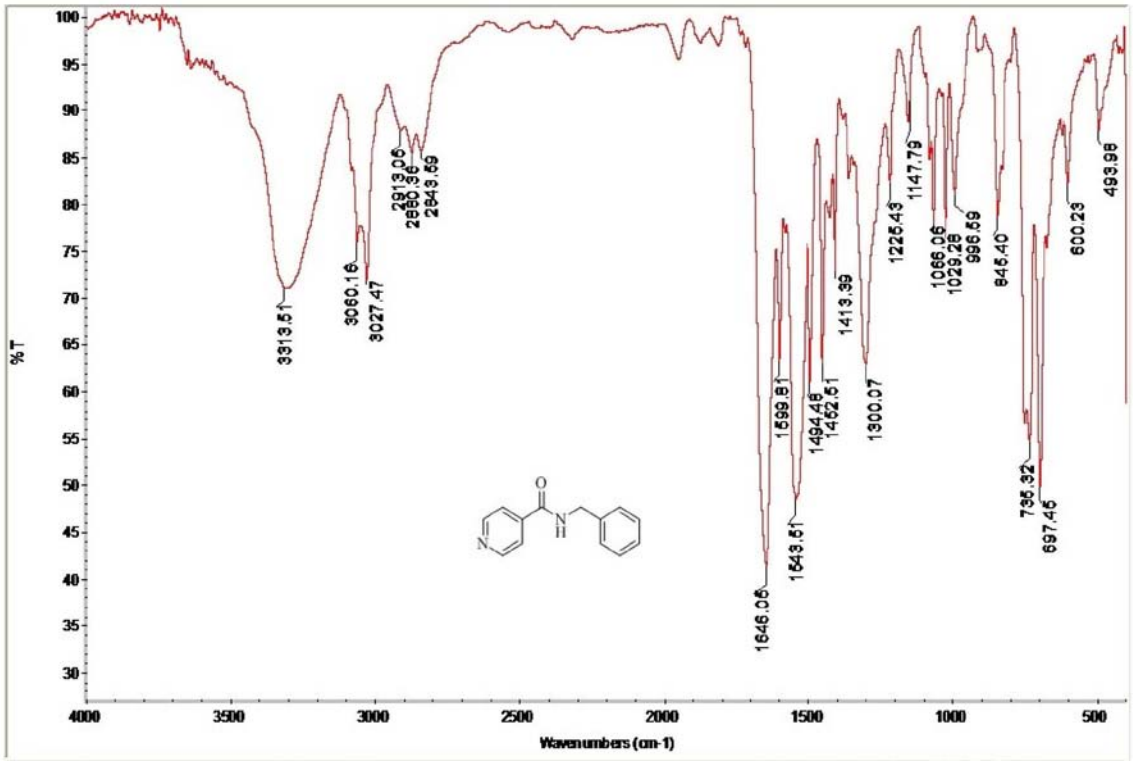

Figure S98. FTIR spectrum of *N*-benzylisonicotinamide (**16**).

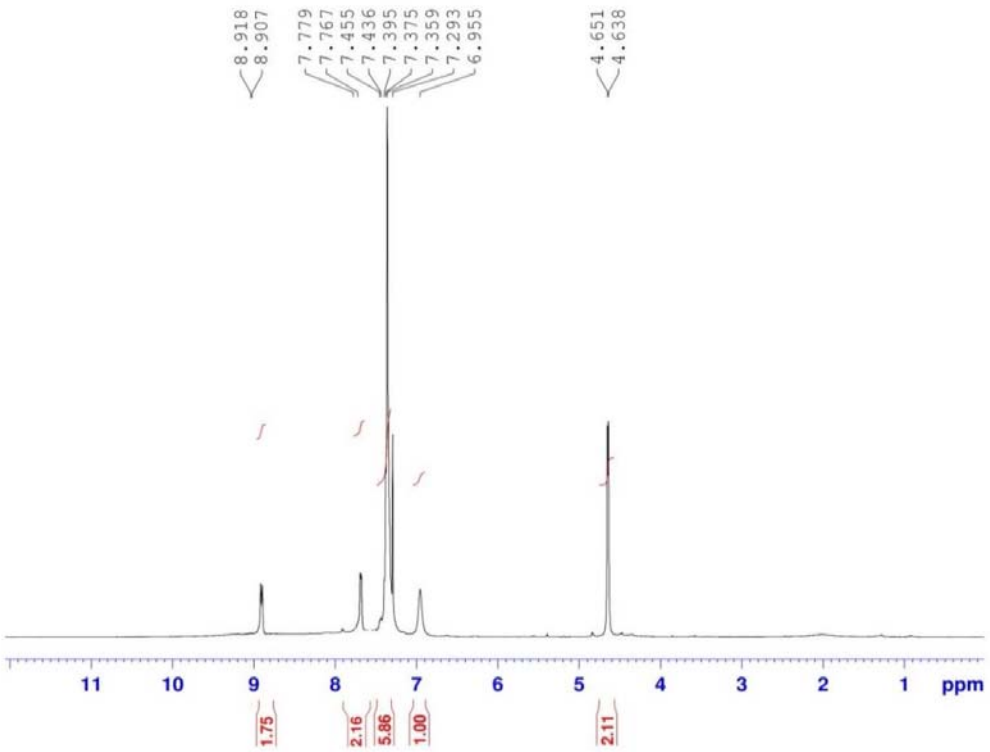

Figure S99. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-benzylisonicotinamide (**16**).

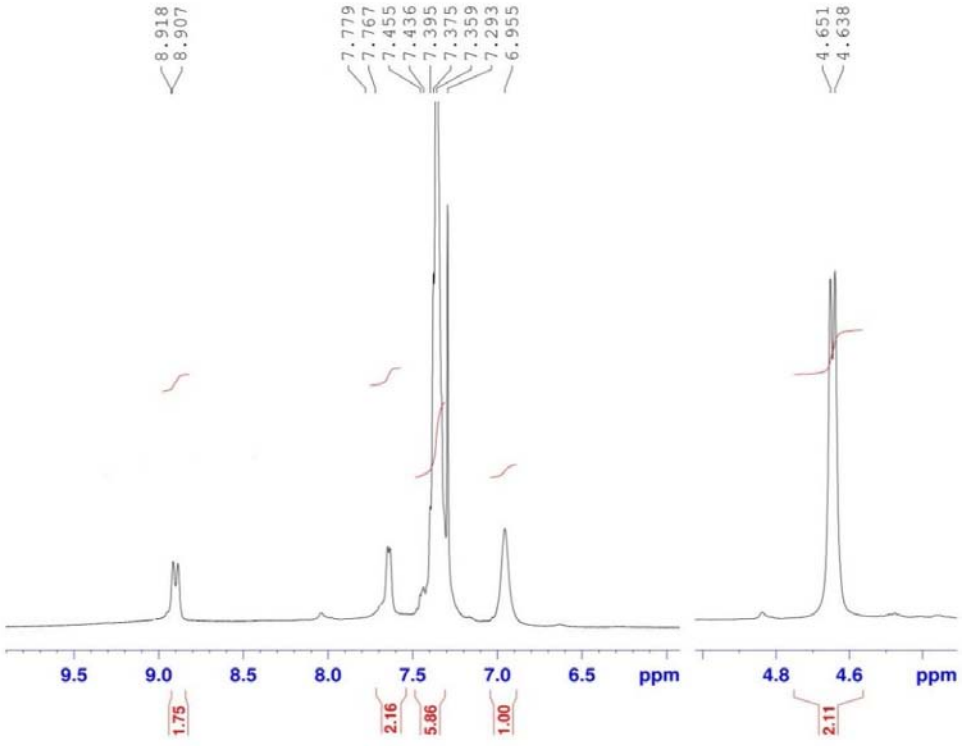

Figure S100. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-benzylisonicotinamide (**16**) expanded.

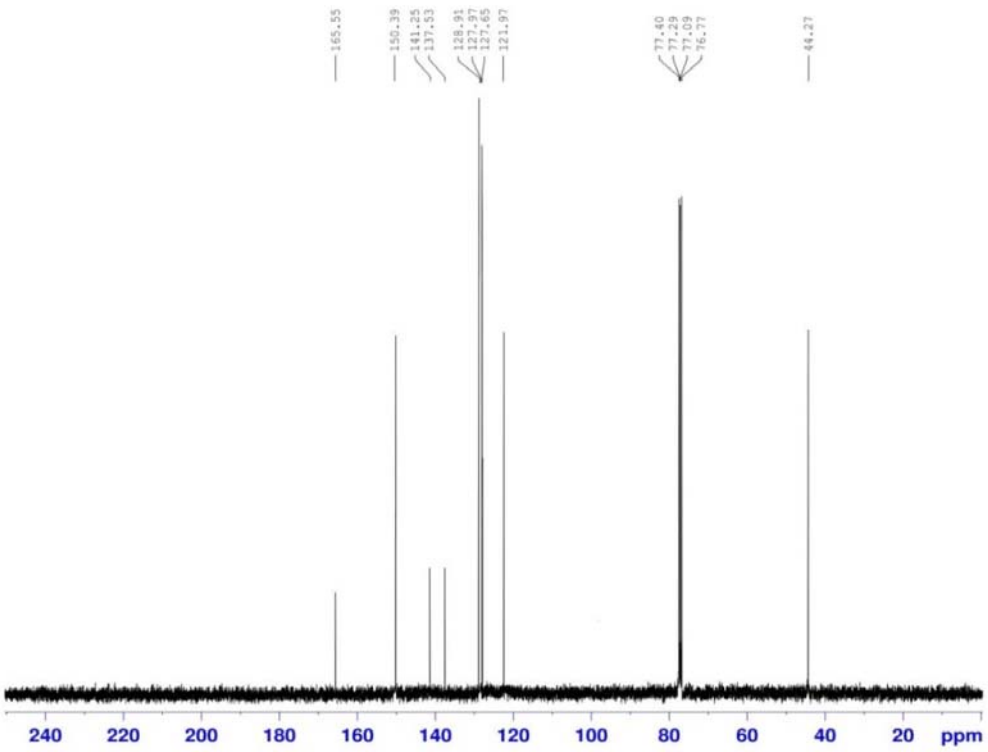

Figure S101. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-benzylisonicotinamide (**16**).

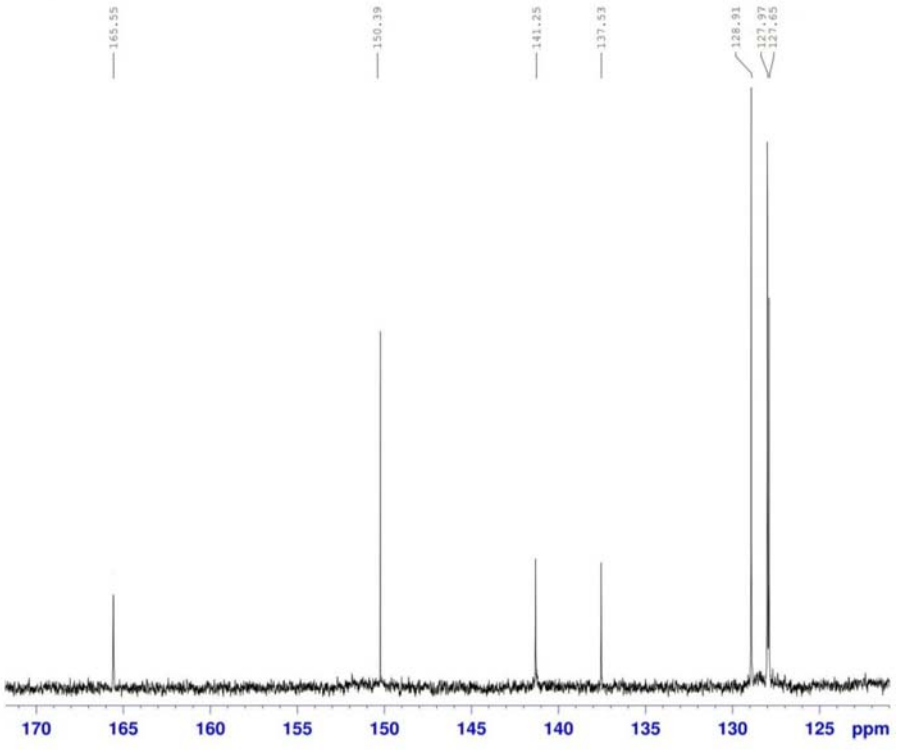

Figure S102. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-benzylisonicotinamide (**16**) expanded.

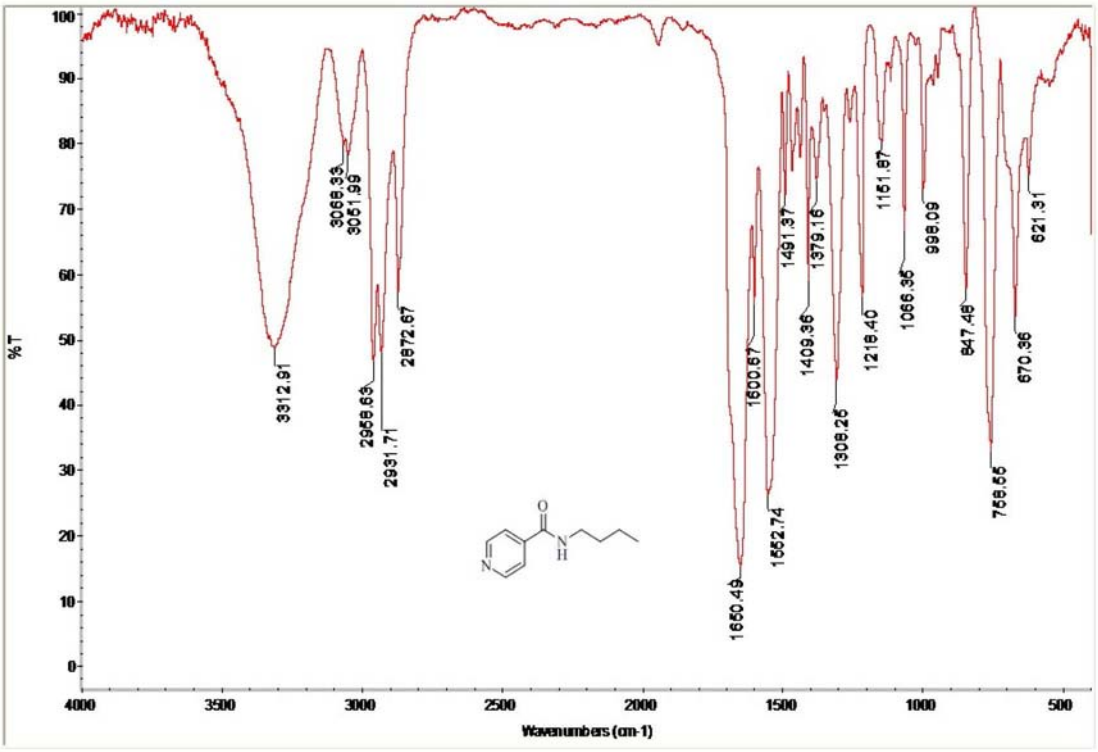

Figure S103. FTIR spectrum of *N*-butylisonicotinamid (**17**).

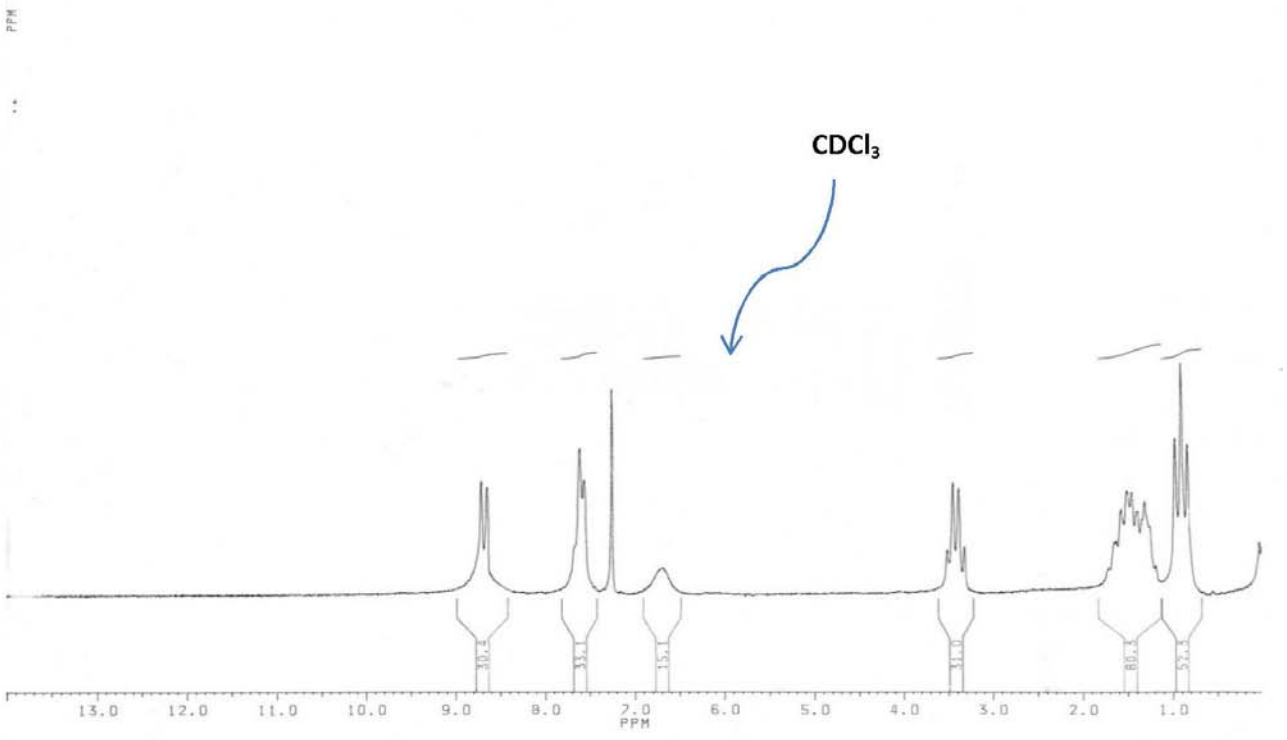

Figure S104. ^{1}H NMR spectrum (100 MHz, $CDCl_3$) of *N*-butylisonicotinamide (**17**).

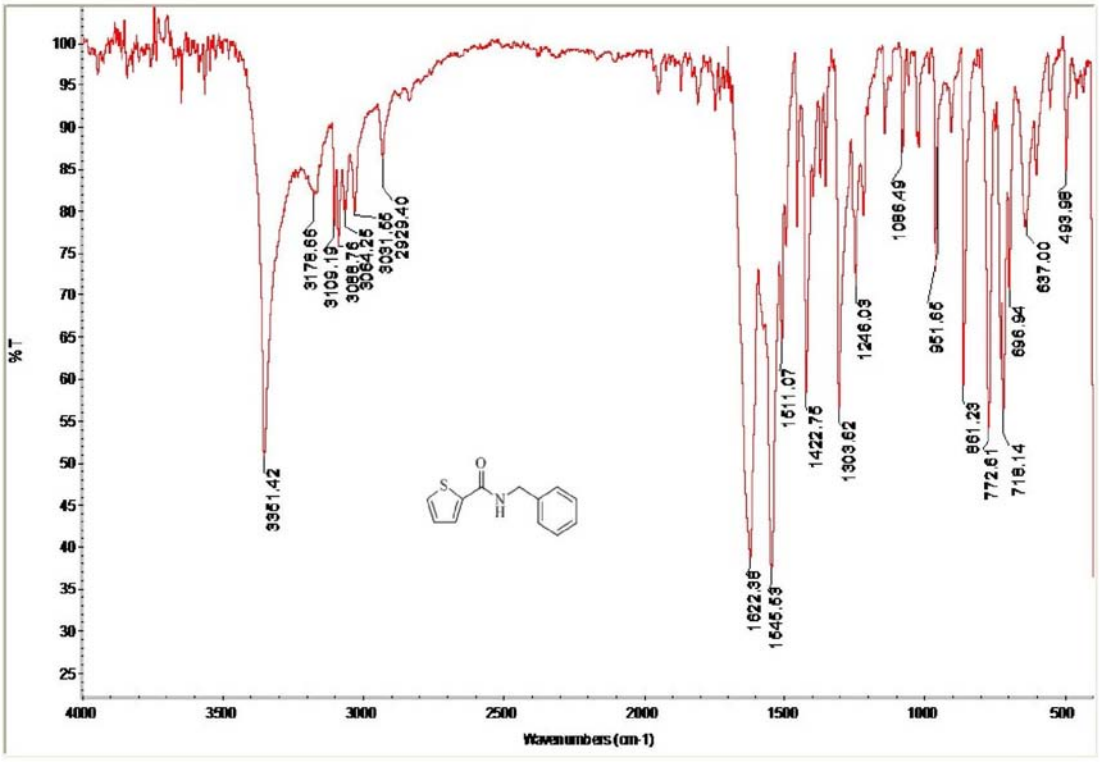

Figure S105. FTIR spectrum of *N*-benzylthiophene-2-carboxamide (**18**).

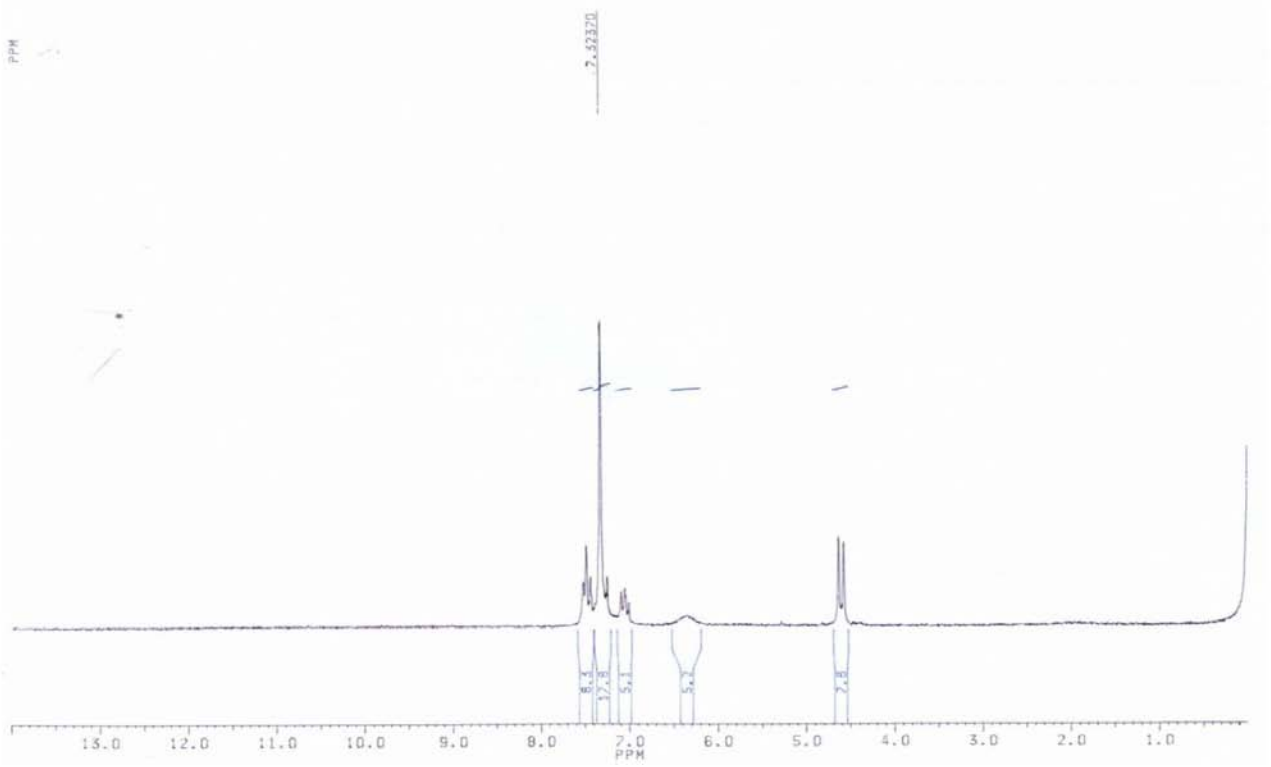

Figure S106. ^{1}H NMR spectrum (100 MHz, $CDCl_3$) of *N*-benzylthiophene-2-carboxamide(**18**).

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Hydrogen%       5.336242676
Sulphur%        13.9931646

            1 Sample(s) in Group No : 1
Component Name Average
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Carbon%        66.81091003
Hydrogen%      5.336242676
Sulphur%       13.9931646
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Calcd for $C_{12}H_{11}NOS$

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Figure S107. Elemental analysis data of *N*-benzylthiophene-2-carboxamide (**18**).

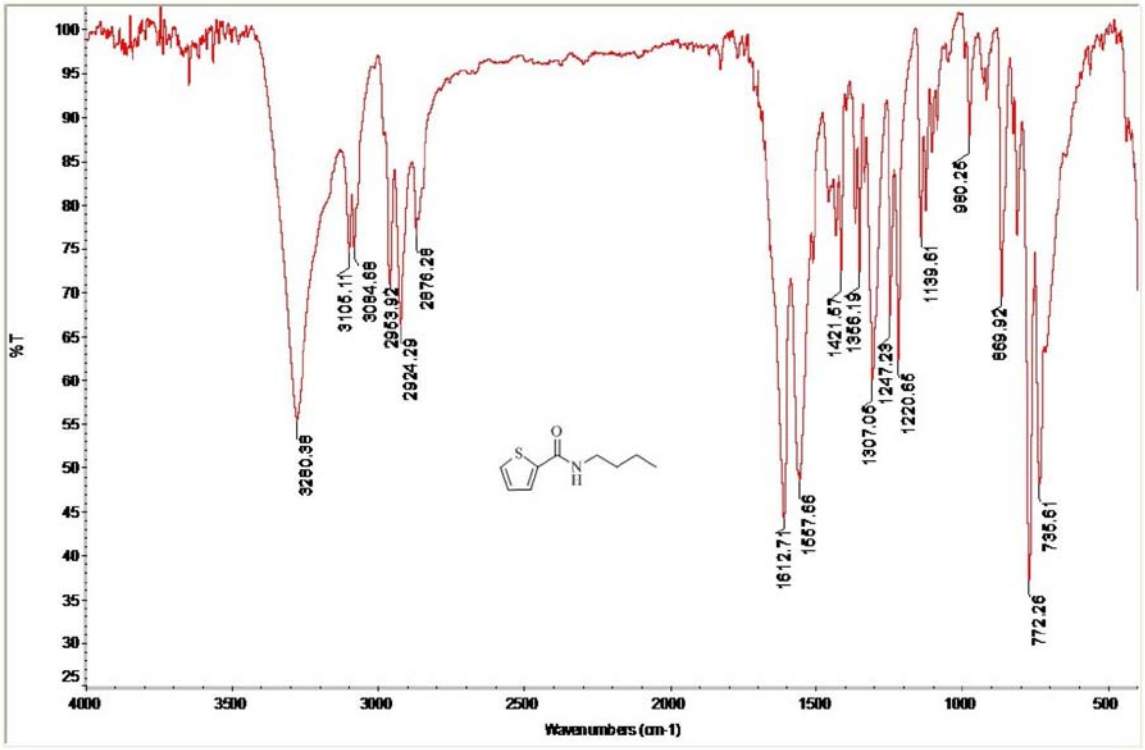

Figure S108. FTIR spectrum of *N*-butylthiophene-2-carboxamid (**19**).

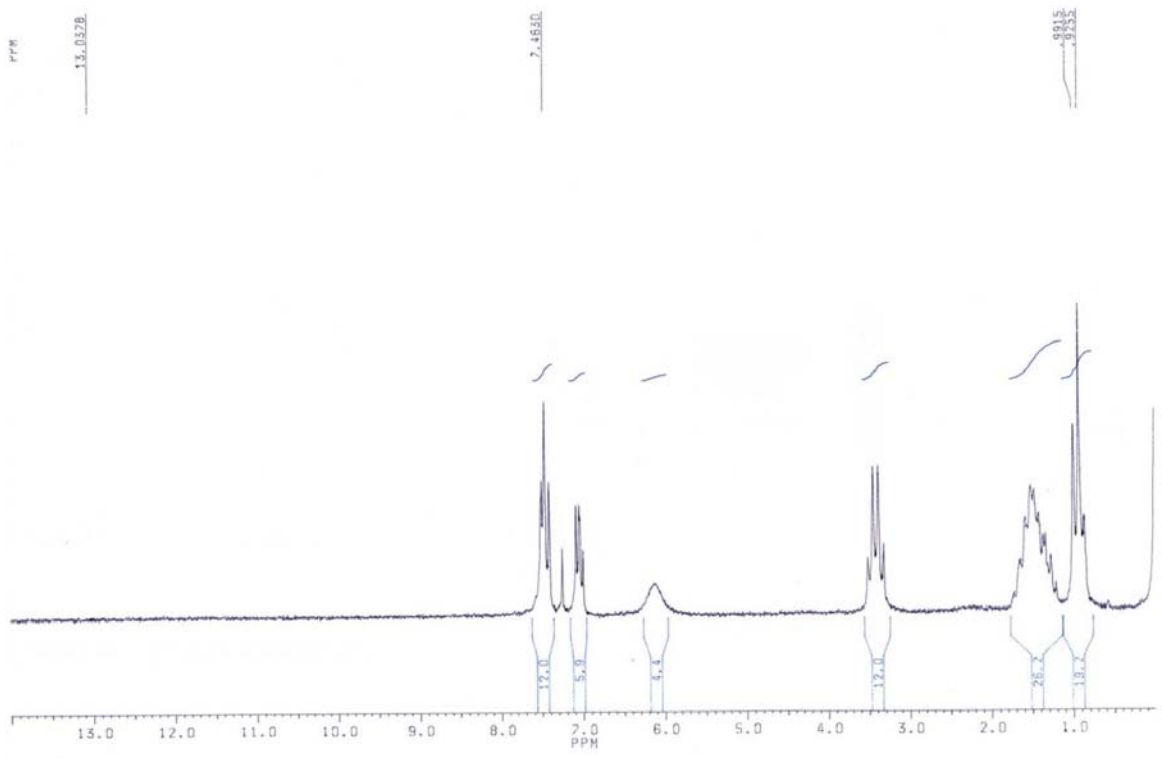

Figure S109. ^{1}H NMR spectrum (100 MHz, $CDCl_3$) of *N*-butylthiophene-2-carboxamid (**19**).

Eager 300 Summarize Results

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emamjome-151

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Sulphur%	17.28616905

Caled for C9H13NOS

Nitrogen%	7.64
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1 Sample(s) in Group No : 1

Component Name	Average
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Carbon%	59.02895737
Hydrogen%	7.385498047
Sulphur%	17.28616905

Figure S110. Elemental analysis data of *N*-butylthiophene-2-carboxamid (**19**).

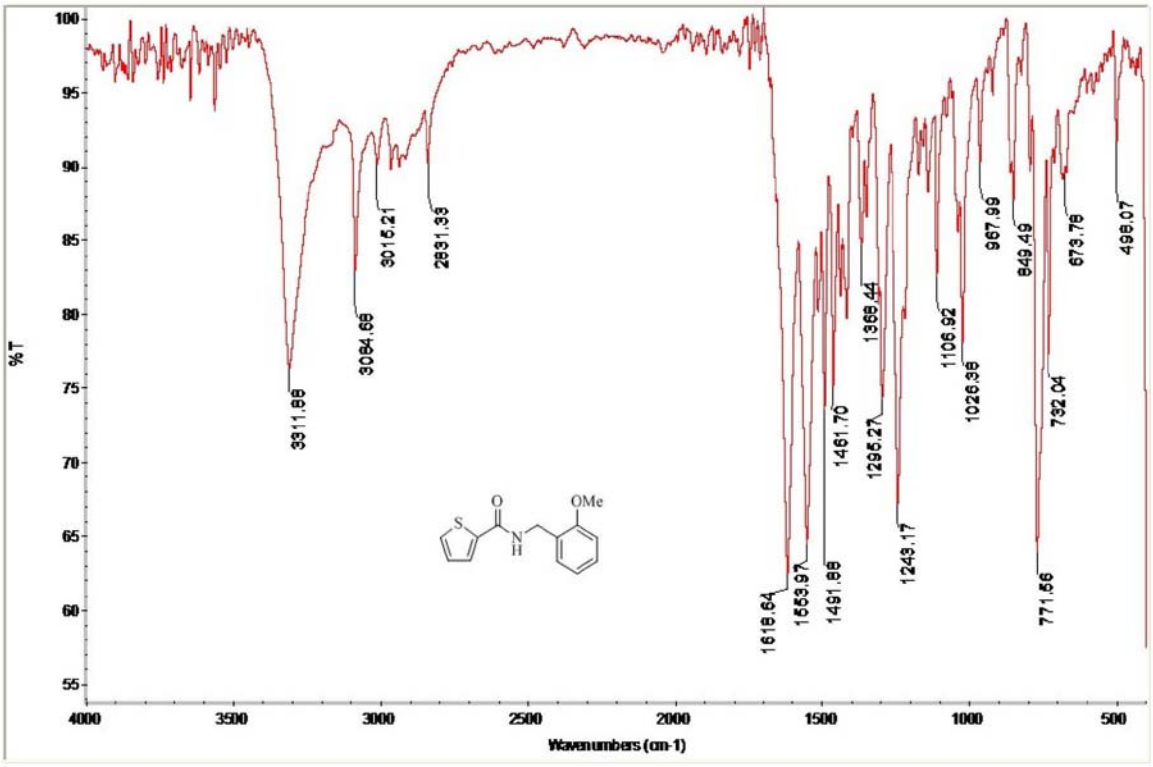

Figure S111. FTIR spectrum of *N*-(2-methoxybenzyl)thiophene-2-carboxamide (**20**).

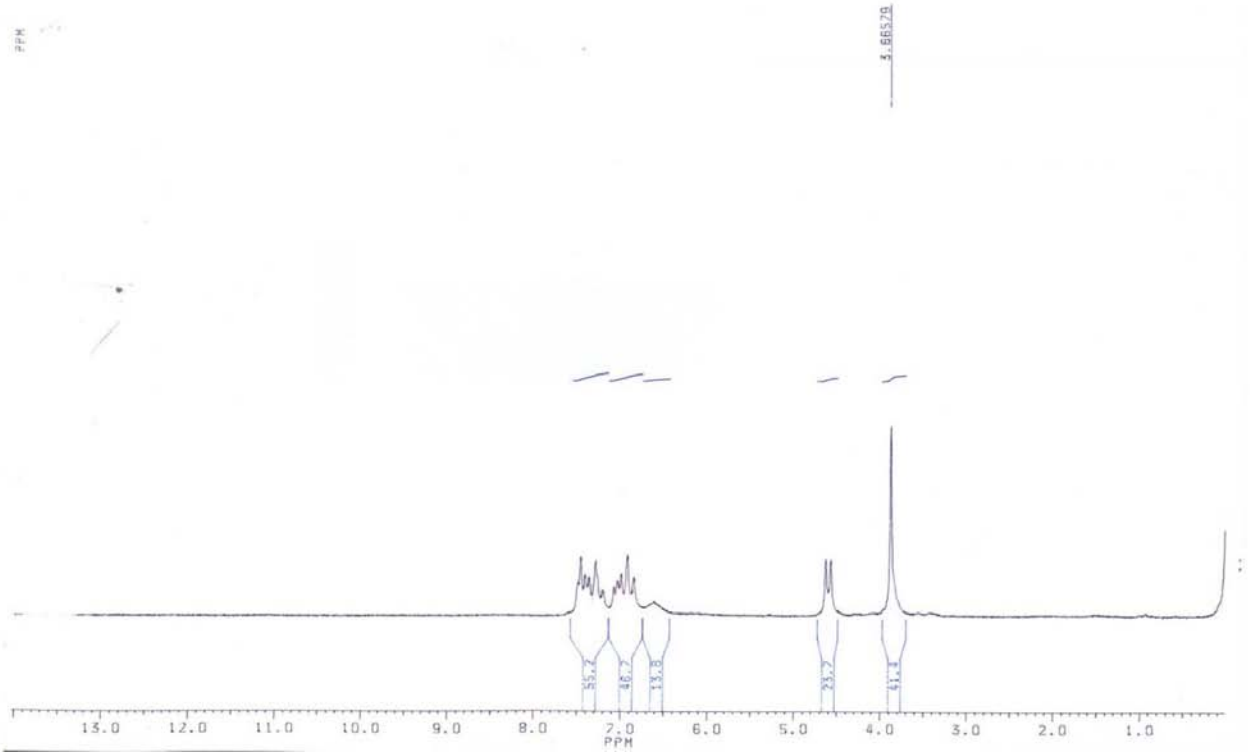

Figure S112. ^{1}H NMR spectrum (100 MHz, $CDCl_3$) of *N*-(2-methoxybenzyl)thiophene-2-carboxamide (**20**).

Eager 300 Summarize Results

Date : 20/06/2012 at 11:59:49
Method Name : NCHS
Method Filename : Copy of Copy of N C H S-bkp .mth

Filename AS Method Vial

emamjomeh-176

#	Group	Sample Name	Type	Weig.	Pro.F	---	---
176	1	h3	UNK	1.027	6.25	---	

Component name	Element %
Nitrogen%	6.198968601
Carbon%	62.93164902
Hydrogen%	5.579735756
Sulphur%	12.70624828

Calcd for $C_{13}H_{13}NO_2S$

Nitrogen%	5.66
Carbon%	63.13
Hydrogen%	5.30
Suphur%	12.97

1 Sample(s) in Group No : 1

Component Name	Average
Nitrogen%	6.198968601
Carbon%	62.93164902
Hydrogen%	5.579735756
Sulphur%	12.70624828

Figure S113. Elemental analysis data of *N*-(2-methoxybenzyl)thiophene-2-carboxamide (**20**).

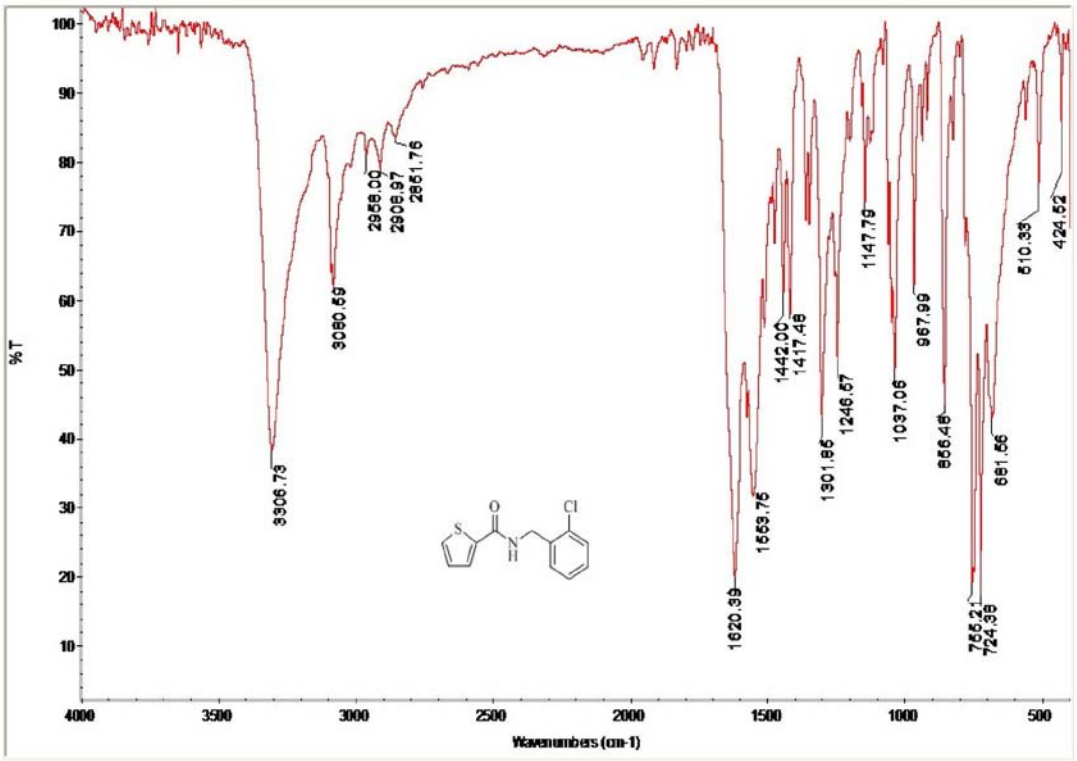

Figure S114. FTIR spectrum of *N*-(2-chlorobenzyl)thiophene-2-carboxamide (**21**).

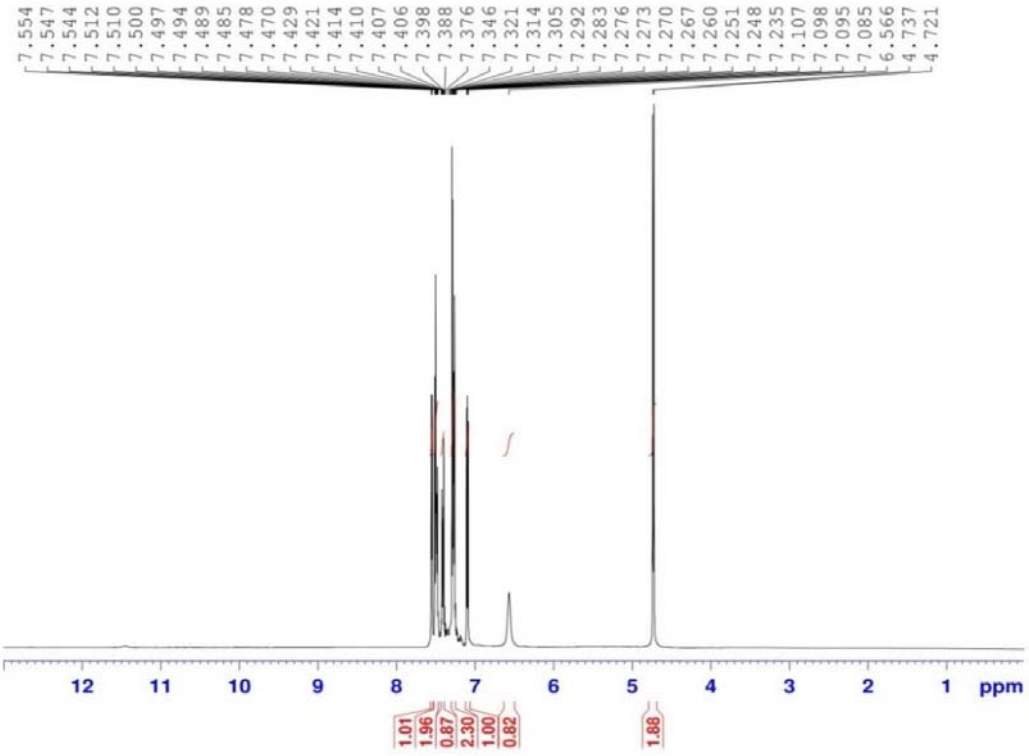

Figure S115. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-(2-chlorobenzyl)thiophene-2-carboxamide (**21**).

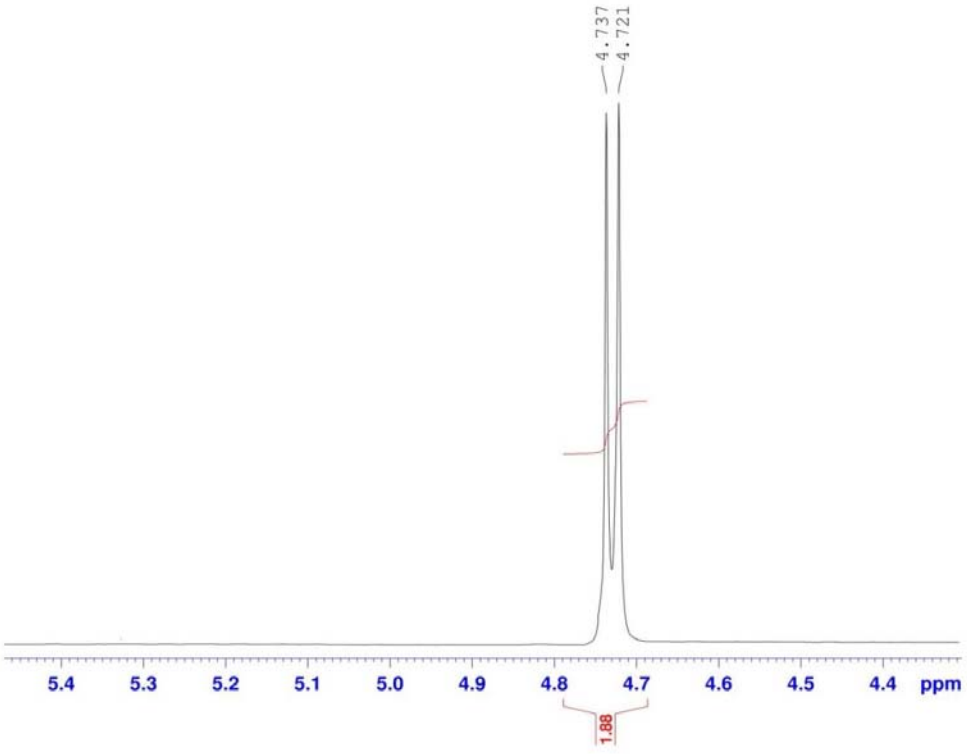

Figure S116. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-(2-chlorobenzyl)thiophene-2-carboxamide (**21**) expanded.

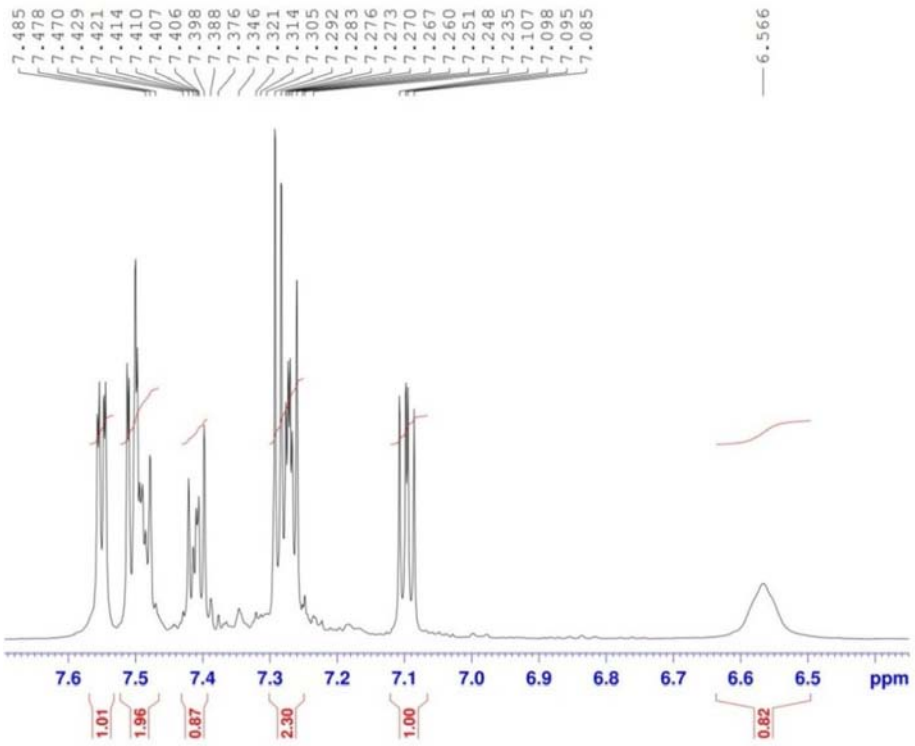

Figure S117. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-(2-chlorobenzyl)thiophene-2-carboxamide (**21**) expanded.

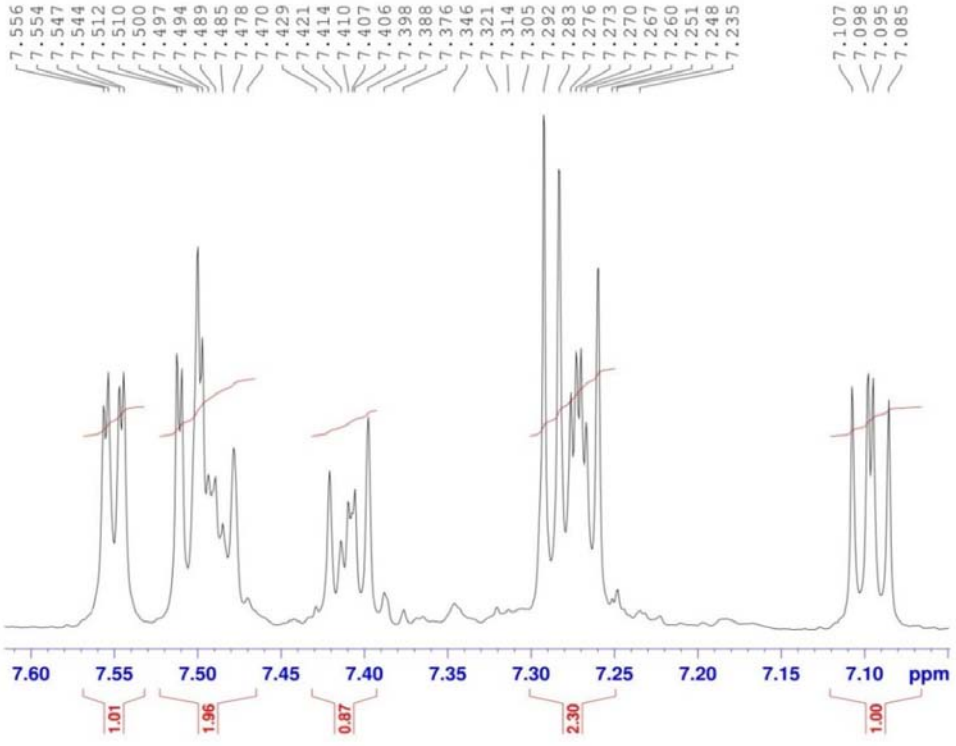

Figure S118. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-(2-chlorobenzyl)thiophene-2-carboxamide (**21**) expanded.

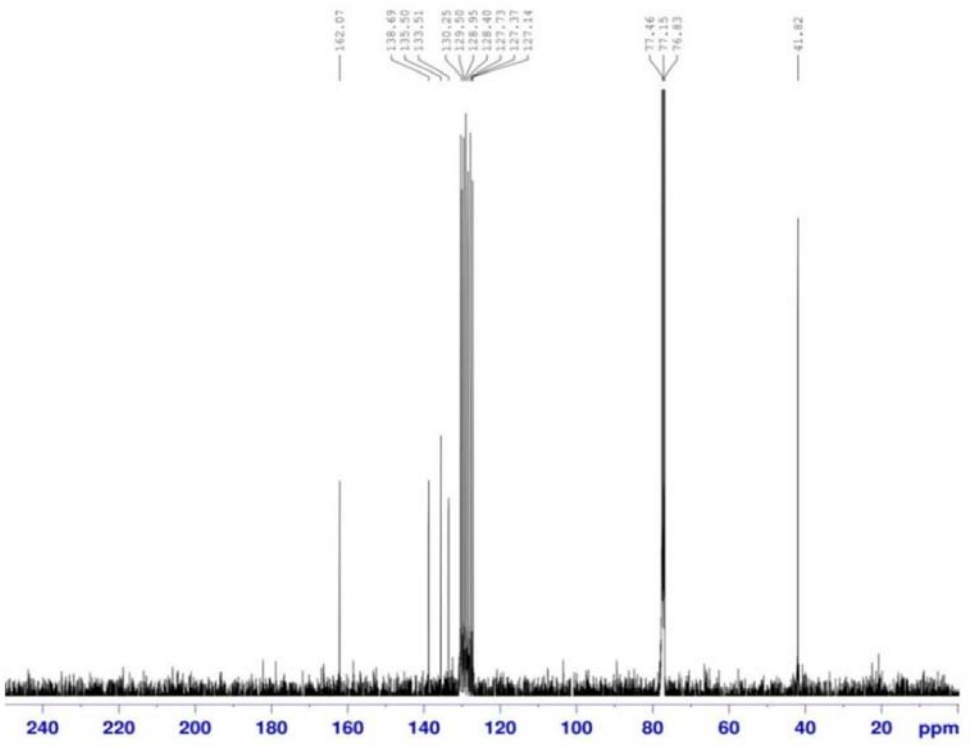

Figure S119. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-(2-chlorobenzyl)thiophene-2-carboxamide (**21**).

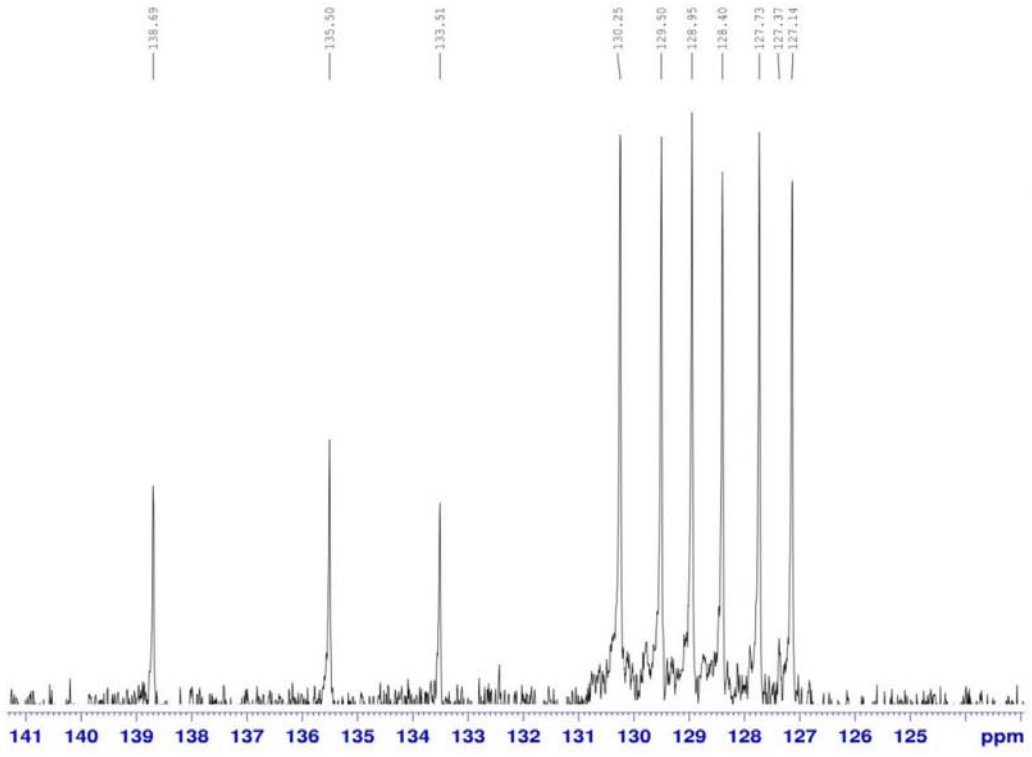

Figure S120. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-(2-chlorobenzyl)thiophene-2-carboxamide (**21**) expanded.

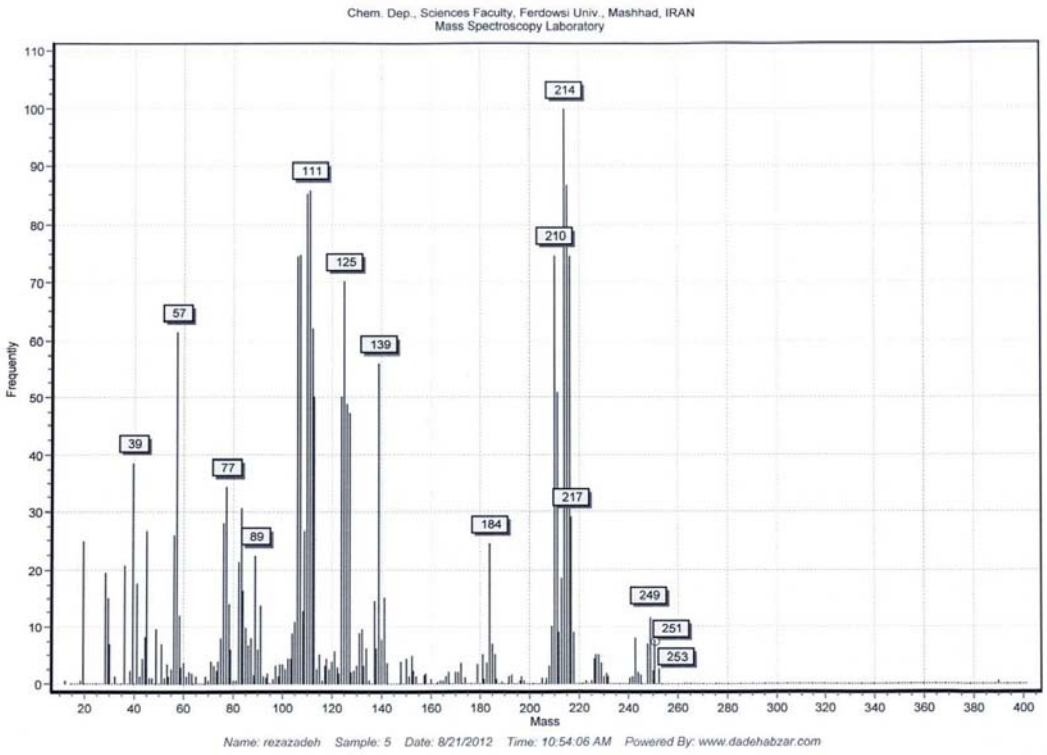

Figure S121. MS spectrum (EI, 70 eV) of *N*-(2-chlorobenzyl)thiophene-2-carboxamide (**21**).

Eager 300 Summarize Results

Date : 25/06/2012 at 11:41:18
Method Name : NCHS
Method Filename : Copy of Copy of N C H S-bkp .mth

Filename	AS Method	Vial
emamjome-19		

#	Group	Sample Name	Type	Weig.	Pro.F	---
19	1	h5	UNK	1.064	6.25	---

Component name	Element %
Nitrogen%	5.756523228
Carbon%	57.4144783
Hydrogen%	4.259230137
Sulphur%	12.55812168

Calcd for $C_{12}H_{10}ClNOS$

Nitrogen%	5.56
Carbon%	57.25
Hydrogen%	4.00
Suphur%	12.74

1 Sample(s) in Group No : 1

Component Name	Average
Nitrogen%	5.756523228
Carbon%	57.4144783
Hydrogen%	4.259230137
Sulphur%	12.55812168

Figure S122. Elemental analysis data of *N*-(2-chlorobenzyl)thiophene-2-carboxamide (**21**).

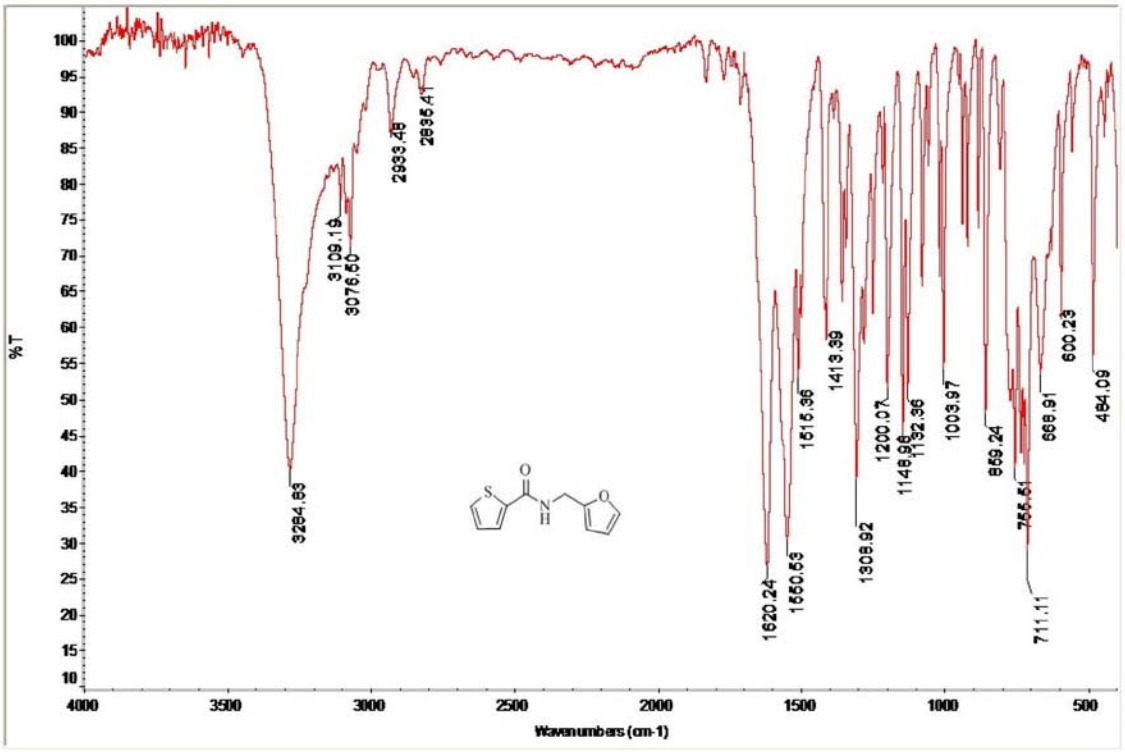

Figure S123. FTIR spectrum of *N*-(furan-2-ylmethyl)thiophene-2-carboxamide (**22**).

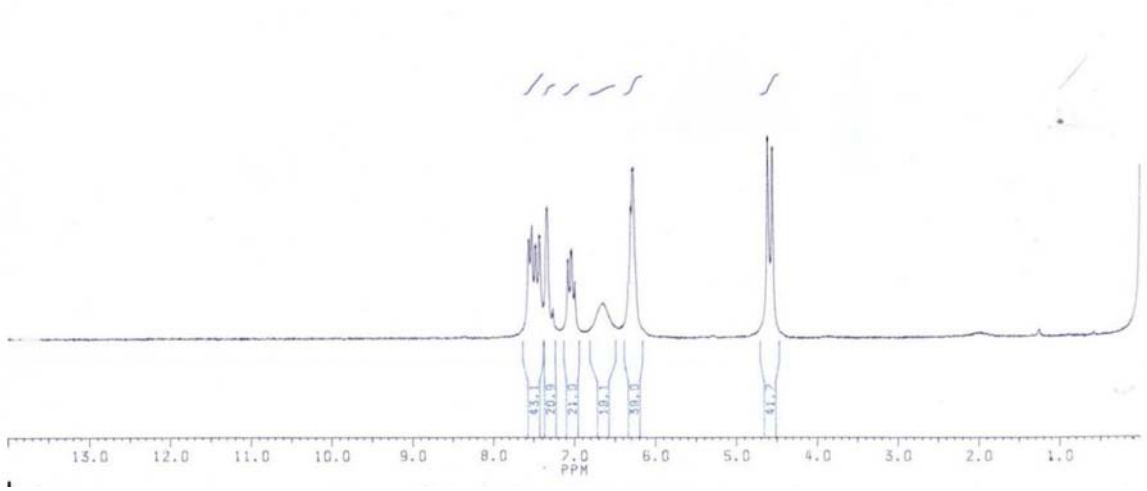

Figure S124. ^{1}H NMR spectrum (100 MHz, $CDCl_3$) of *N*-(furan-2-ylmethyl)thiophene-2-carboxamid (**22**).

Eager 300 Summarize Results

Date : 15/08/2012 at 12:08:16
Method Name : NCHS
Method Filename : Copy of Copy of N C H S-bkp .mth

Filename AS Method Vial

emamjome-70

#	Group	Sample Name	Type	Weig.	Pro.F	---	---
70	1	h-4	UNK	1.241	6.25	---	

Component name	Element %
Nitrogen%	7.040726185
Carbon%	58.35287476
Hydrogen%	4.636273861
Sulphur%	15.43068123

Calcd for $C_{10}H_9NO_2S$

Nitrogen%	6.76
Carbon%	57.95
Hydrogen%	4.38
Suphur%	15.47

1 Sample(s) in Group No : 1

Component Name	Average
Nitrogen%	7.040726185
Carbon%	58.35287476
Hydrogen%	4.636273861
Sulphur%	15.43068123

Figure S125. Elemental analysis data of *N*-(furan-2-ylmethyl)thiophene-2-carboxamide (**22**).

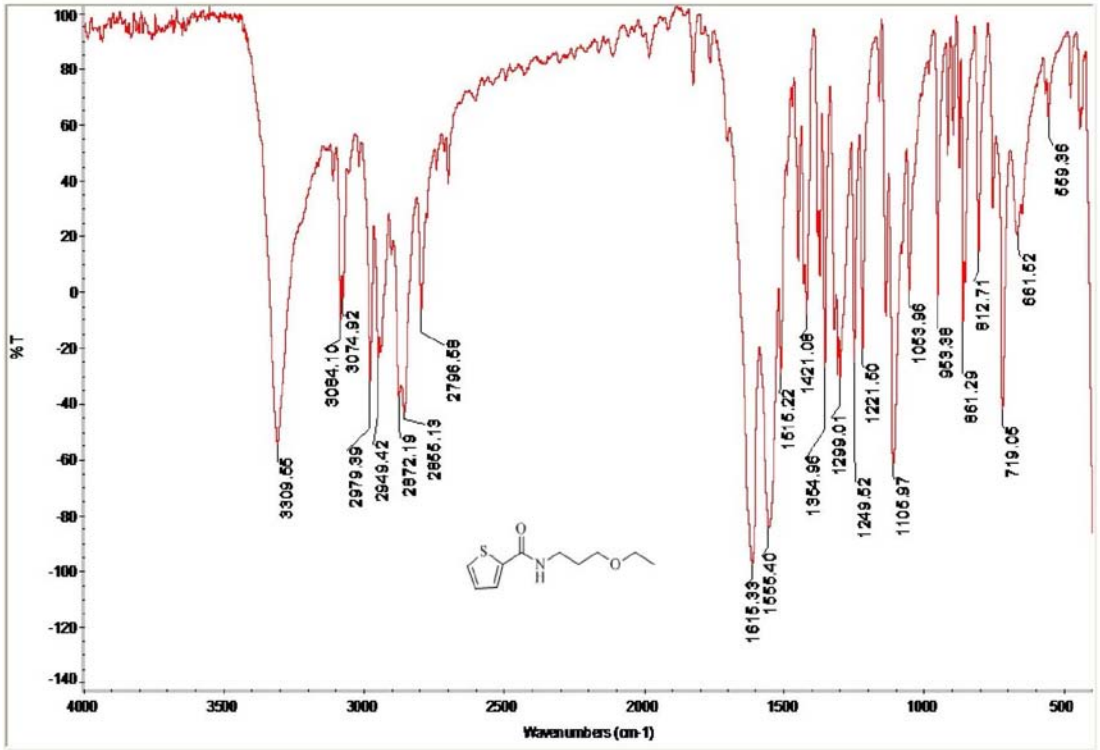

Figure S126. FTIR spectrum of *N*-(3-ethoxypropyl)thiophene-2-carboxamide (**23**).

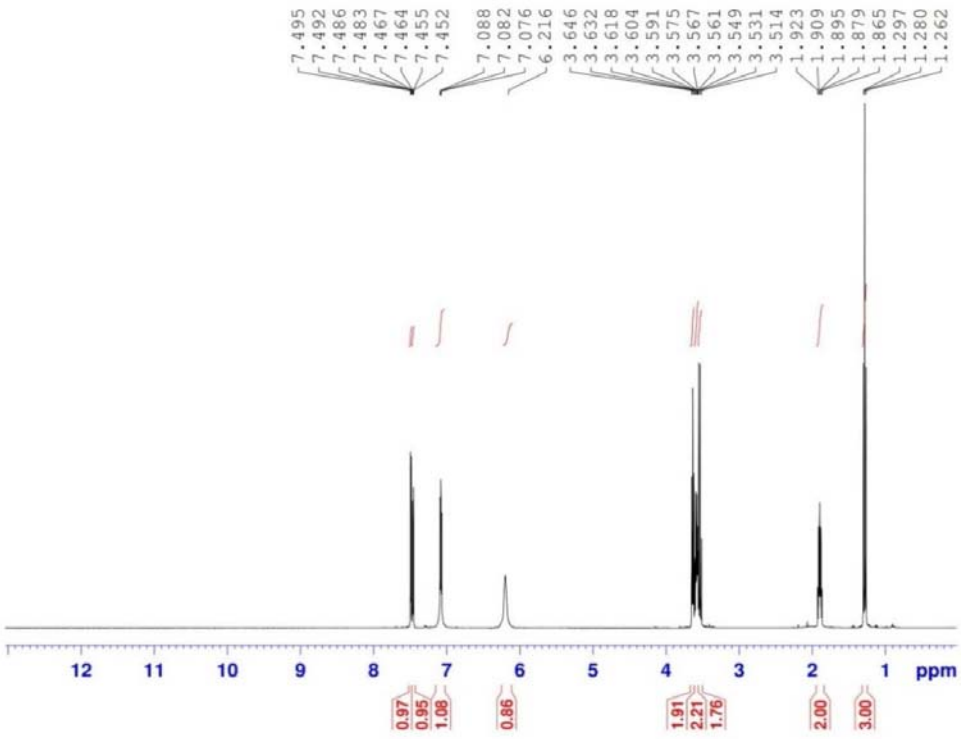

Figure S127. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-(3-ethoxypropyl)thiophene-2-carboxamide (**23**).

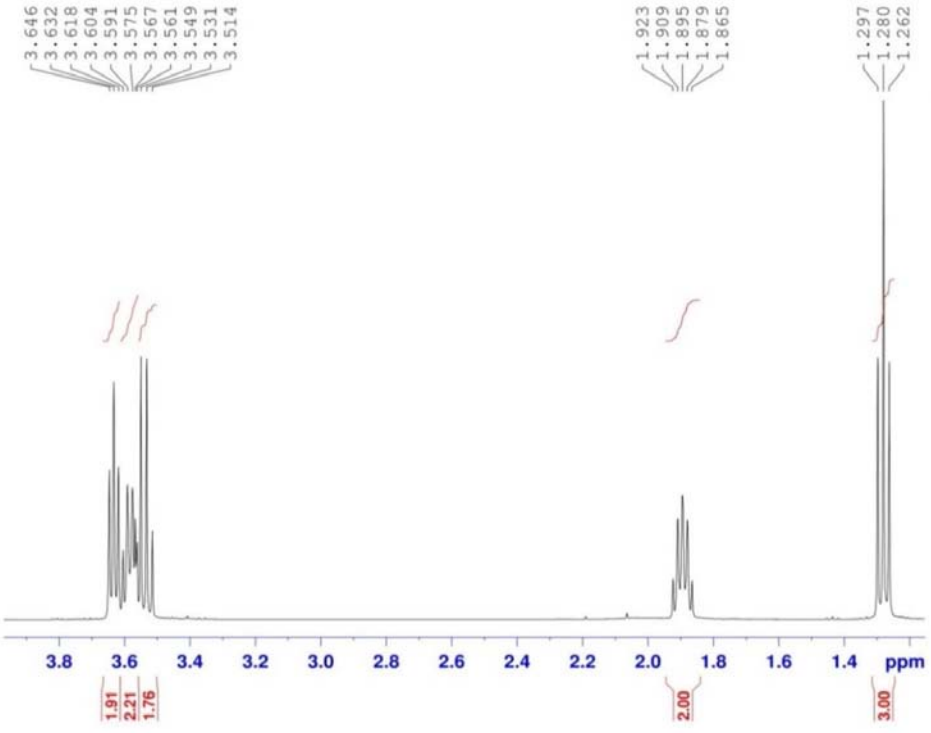

Figure S128. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-(3-ethoxypropyl)thiophene-2-carboxamide (**23**) expanded.

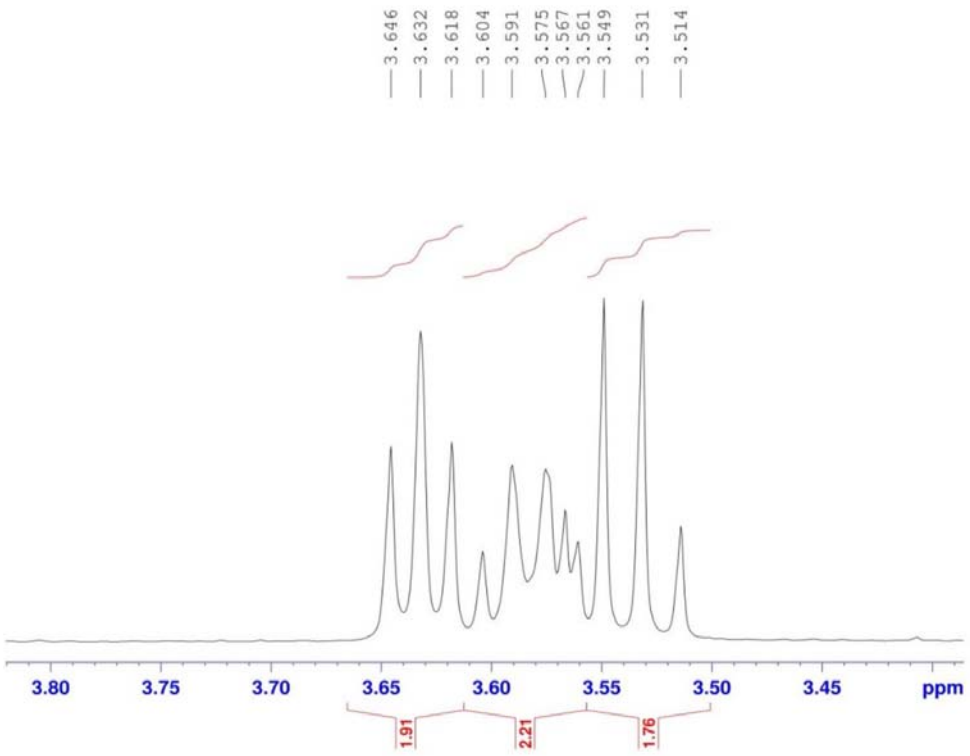

Figure S129. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-(3-ethoxypropyl)thiophene-2-carboxamide (**23**) expanded.

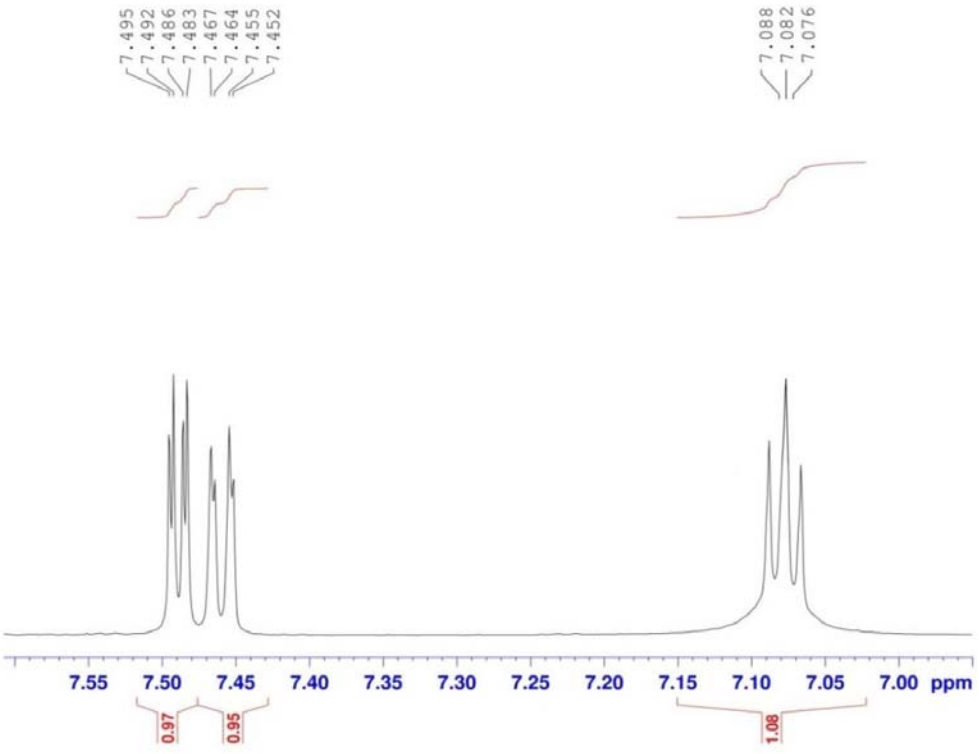

Figure S130. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of *N*-(3-ethoxypropyl)thiophene-2-carboxamide (**23**) expanded.

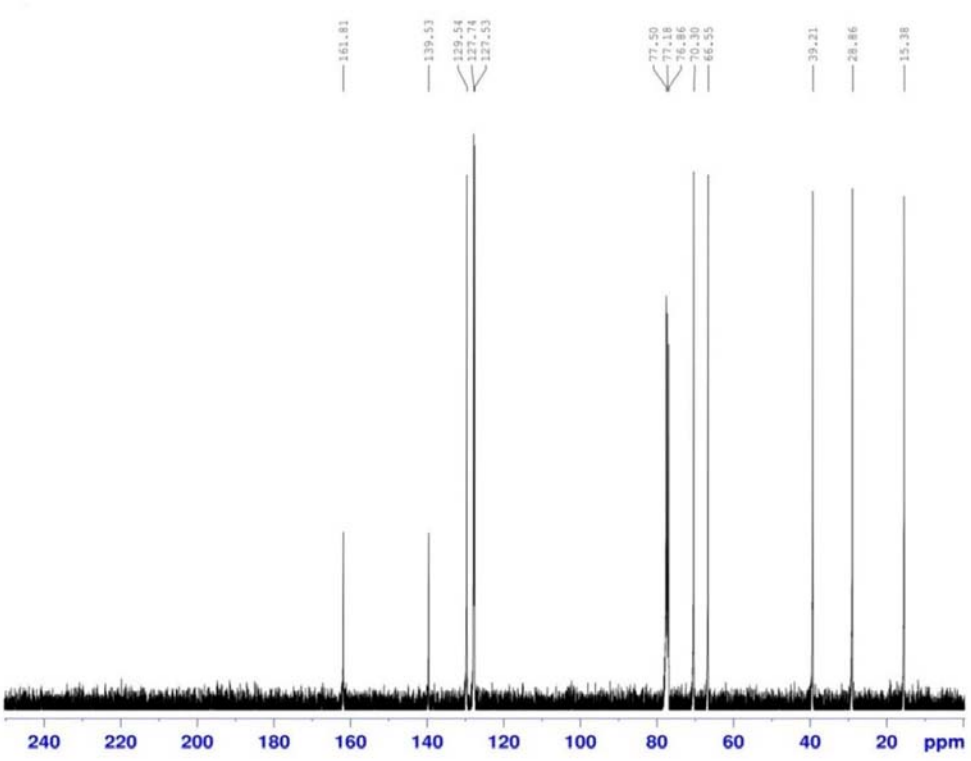

Figure S131. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-(3-ethoxypropyl)thiophene-2-carboxamide (**23**).

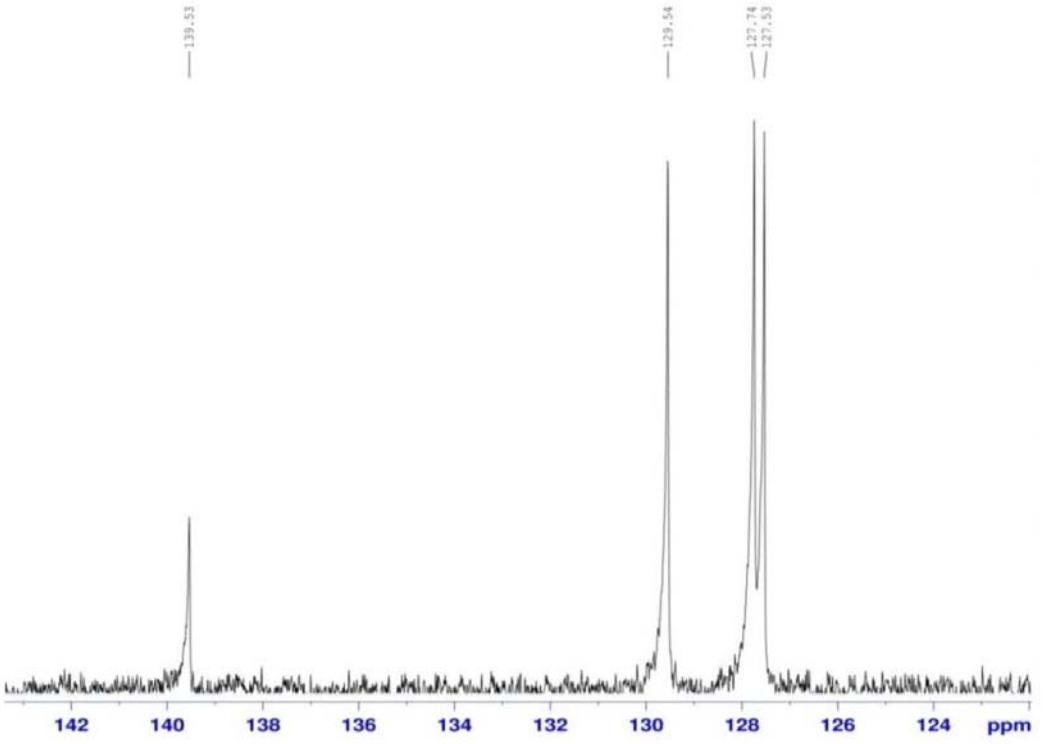

Figure S132. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of *N*-(3-ethoxypropyl)thiophene-2-carboxamide (**23**) expanded.

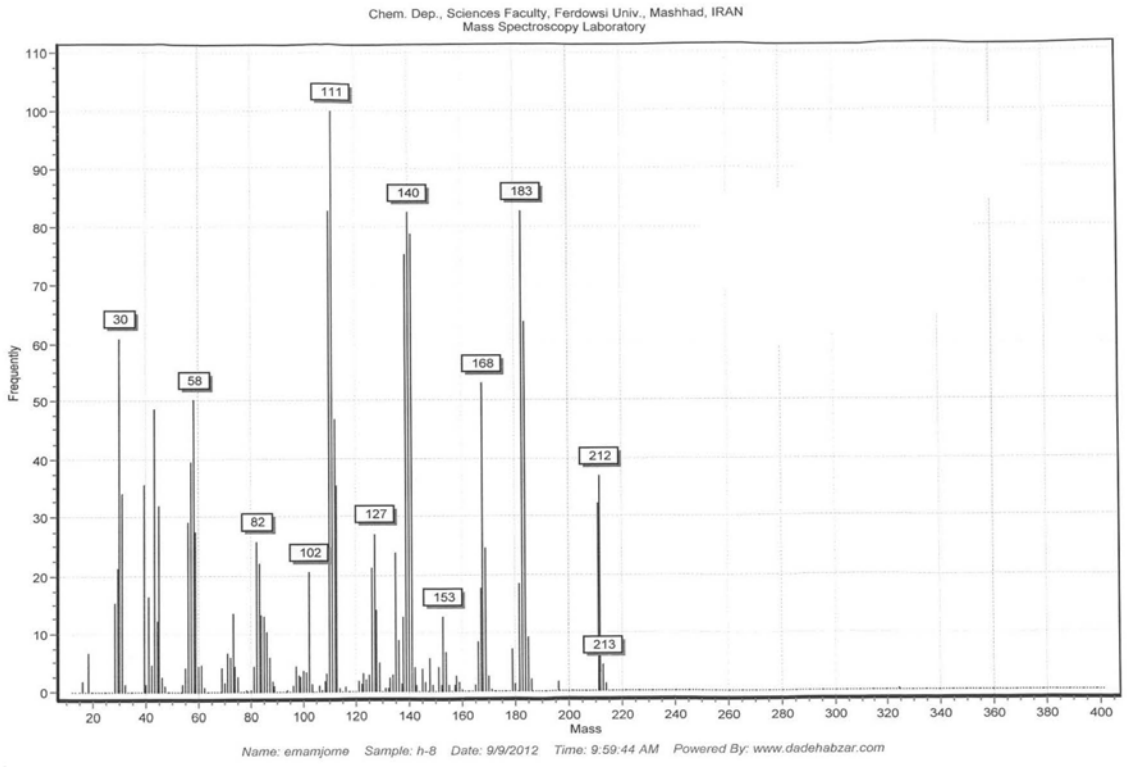

Figure S133. MS spectrum (EI, 70 eV) of *N*-(3-ethoxypropyl)thiophene-2-carboxamide (**23**).

Eager 300 Summarize Results

Date : 01/08/2012 at 13:10:41
Method Name : NCHS
Method Filename : Copy of Copy of N C H S-bkp .mth

Filename	AS Method	Vial
emamjome-54		

#	Group	Sample Name	Type	Weig.	Pro.F		
54	1	h-8	UNK	1.109	6.25	---	

Component name	Element %
Nitrogen%	6.881211758
Carbon%	56.86362457
Hydrogen%	7.642203808
Sulphur%	14.79428101

Calcd for $C_{10}H_{15}NO_2S$

Nitrogen%	6.57
Carbon%	56.31
Hydrogen%	7.09
Suphur%	15.03

1 Sample(s) in Group No : 1

Component Name	Average
Nitrogen%	6.881211758
Carbon%	56.86362457
Hydrogen%	7.642203808
Sulphur%	14.79428101

Figure S134. Elemental analysis data of *N*-(3-ethoxypropyl)thiophene-2-carboxamide (**23**).

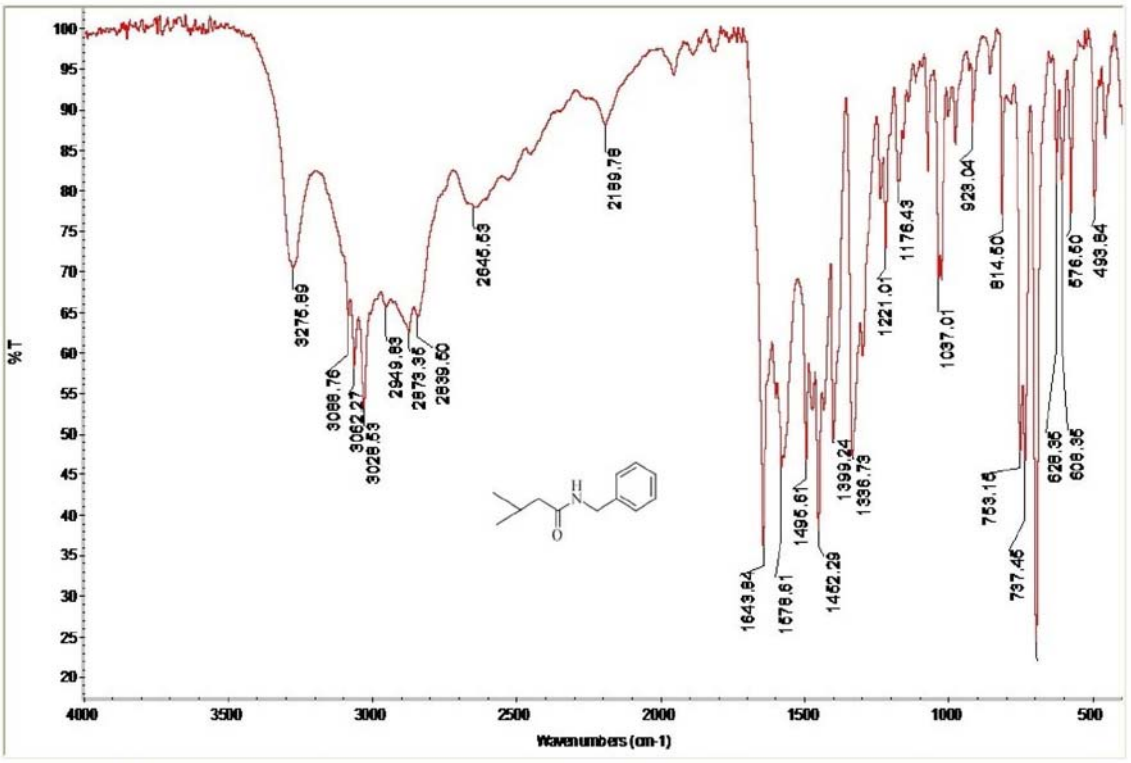

Figure S135. FTIR spectrum of *N*-benzyl-3-methylbutanamide (**24**).

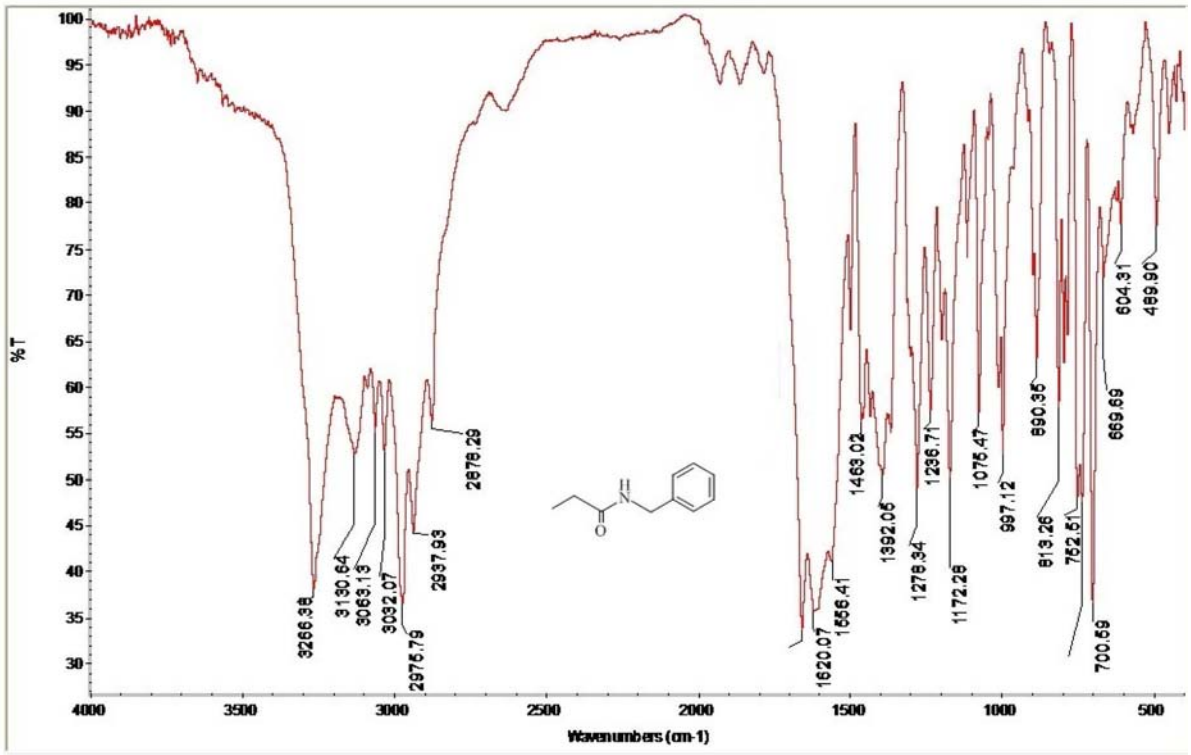

Figure S136. FTIR of *N*-benzylpropionamide (**25**).