

## Supporting Information

### **Design of Schiff base complex of copper coated on epoxy modified core-shell MNPs as an environmentally friendly and novel catalyst for the one-pot synthesis of various chromene-annulated heterocycles**

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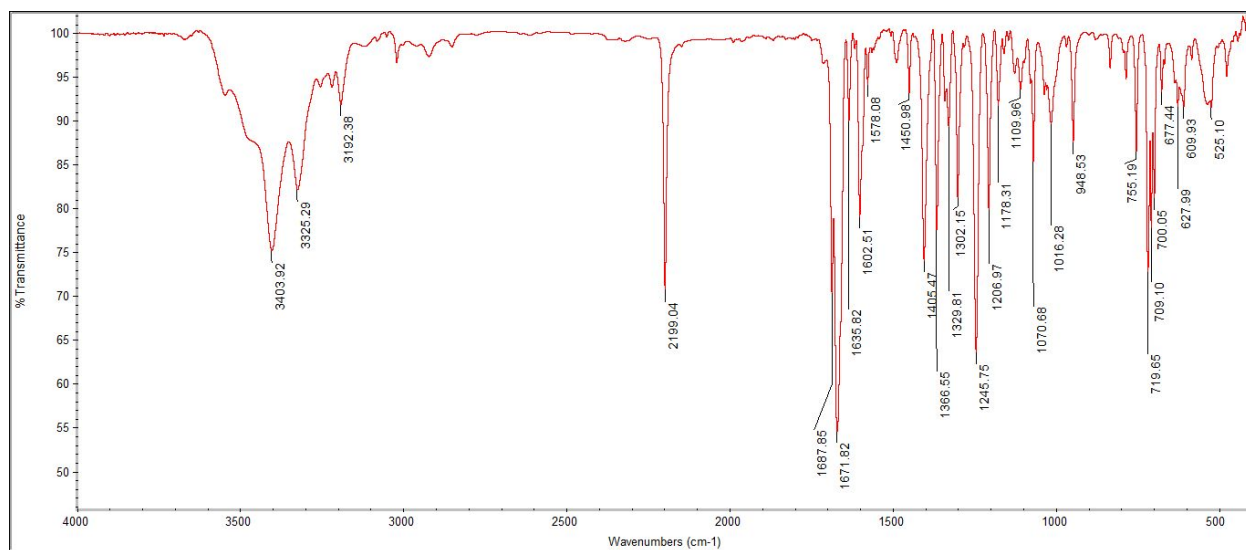
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<b>List of Contents</b>	<b>Page</b>
<b>Figure S1.</b> FT-IR spectrum of 2-amino-4-(phenyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S6
<b>Figure S2.</b> <sup>1</sup> H NMR spectrum of 2-amino-4-(phenyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S7
<b>Figure S3.</b> The expanded <sup>1</sup> H NMR spectrum of 2-amino-4-(phenyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S8
<b>Figure S4.</b> <sup>13</sup> C NMR spectrum of 2-amino-4-(phenyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S9
<b>Figure S5.</b> FT-IR spectrum of 2-amino-4-(4-nitrophenyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S10
<b>Figure S6.</b> <sup>1</sup> H NMR spectrum of 2-amino-4-(4-nitrophenyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S11
<b>Figure S7.</b> The expanded <sup>1</sup> H NMR spectrum of 2-amino-4-(4-nitrophenyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S12
<b>Figure S8.</b> <sup>13</sup> C NMR spectrum of 2-amino-4-(4-nitrophenyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S13
<b>Figure S9.</b> FT-IR spectrum of 2-amino-4-(4-methylphenyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S14
<b>Figure S10.</b> <sup>1</sup> H NMR spectrum of 2-amino-4-(4-methylphenyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S15
<b>Figure S11.</b> The expanded <sup>1</sup> H NMR spectrum of 2-amino-4-(4-methylphenyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S16
<b>Figure S12.</b> <sup>13</sup> C NMR spectrum of 2-amino-4-(4-methylphenyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S17
<b>Figure S13.</b> FT-IR spectrum of 2-amino-4-(4-chloro-3-nitrophenyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S18
<b>Figure S14.</b> <sup>1</sup> H NMR spectrum of 2-amino-4-(4-chloro-3-nitrophenyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S19
<b>Figure S15.</b> The expanded <sup>1</sup> H NMR spectrum of 2-amino-4-(4-chloro-3-nitrophenyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S20

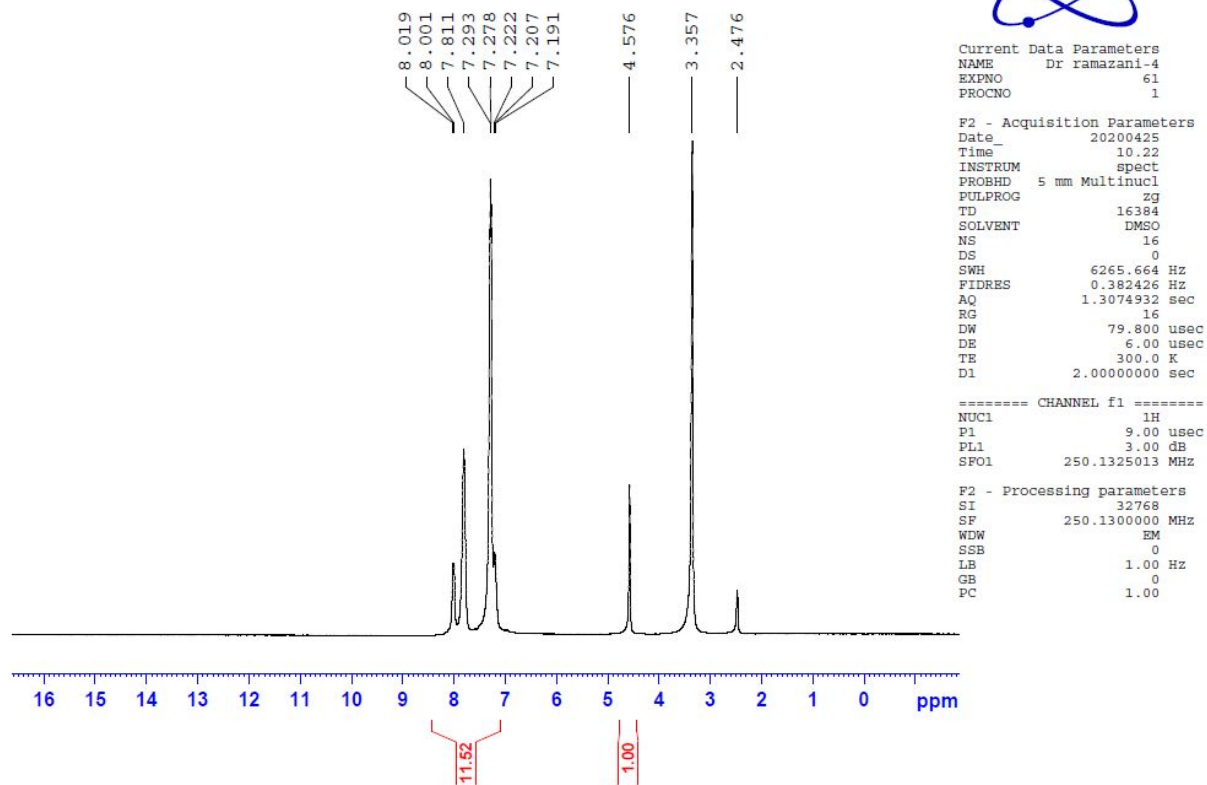
<b>Figure S16.</b> <sup>13</sup> C NMR spectrum of 2-amino-4-(4-chloro-3-nitrophenyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S21
<b>Figure S17.</b> FT-IR spectrum of 2-amino-4-(2,4-dichlorophenyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3 carbonitrile	S22
<b>Figure S18.</b> <sup>1</sup> H NMR spectrum of 2-amino-4-(2,4-dichlorophenyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3 carbonitrile	S23
<b>Figure S19.</b> The expanded <sup>1</sup> H NMR spectrum of 2-amino-4-(2,4-dichlorophenyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3 carbonitrile	S24
<b>Figure S20.</b> <sup>13</sup> C NMR spectrum of 2-amino-4-(2,4-dichlorophenyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3 carbonitrile	S25
<b>Figure S21.</b> FT-IR spectrum of 2-amino-4-(4-(dimethylamino) phenyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> benzo[ <i>g</i> ]chromene-3-carbonitrile	S26
<b>Figure S22.</b> <sup>1</sup> H NMR spectrum of 2-amino-4-(4-(dimethylamino) phenyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> benzo[ <i>g</i> ]chromene-3-carbonitrile	S27
<b>Figure S23.</b> The expanded <sup>1</sup> H NMR of 2-amino-4-(4-(dimethylamino) phenyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> benzo[ <i>g</i> ]chromene-3-carbonitrile	S28
<b>Figure S24.</b> <sup>13</sup> C NMR spectrum of 2-amino-4-(4-(dimethylamino) phenyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> benzo[ <i>g</i> ]chromene-3-carbonitrile	S29
<b>Figure S25.</b> FT-IR spectrum of 2-amino-4-(furan-2-yl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S30
<b>Figure S26.</b> <sup>1</sup> H NMR spectrum of 2-amino-4-(furan-2-yl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S31
<b>Figure S27.</b> The expanded <sup>1</sup> H NMR spectrum of 2-amino-4-(furan-2-yl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S32
<b>Figure S28.</b> <sup>13</sup> C NMR spectrum of 2-amino-4-(furan-2-yl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S33
<b>Figure S29.</b> FT-IR spectrum of 2-amino-4-(4-cyanophenyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S34
<b>Figure S30.</b> <sup>1</sup> H NMR spectrum of 2-amino-4-(4-cyanophenyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S35
<b>Figure S31.</b> <sup>13</sup> C NMR spectrum of 2-amino-4-(4-cyanophenyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S36

<b>Figure S32.</b> FT-IR spectrum of 2-amino-4-(1-naphtyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S37
<b>Figure S33.</b> <sup>1</sup> H NMR spectrum of 2-amino-4-(1-naphtyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S38
<b>Figure S34.</b> The expanded <sup>1</sup> H NMR spectrum of 2-amino-4-(1-naphtyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S39
<b>Figure S35.</b> <sup>13</sup> C NMR spectrum of 2-amino-4-(1-naphtyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S40
<b>Figure S36.</b> FT-IR spectrum of 2-amino-4-(2-naphtyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S41
<b>Figure S37.</b> <sup>1</sup> H NMR spectrum of 2-amino-4-(2-naphtyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S42
<b>Figure S38.</b> The expanded <sup>1</sup> H NMR spectrum of 2-amino-4-(2-naphtyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S43
<b>Figure S39.</b> <sup>13</sup> C NMR spectrum of 2-amino-4-(2-naphtyl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S44
<b>Figure S40.</b> FT-IR spectrum of 2-amino-4-(pyridin-3-yl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S45
<b>Figure S41.</b> <sup>1</sup> H NMR spectrum of 2-amino-4-(pyridin-3-yl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S46
<b>Figure S42.</b> The expanded <sup>1</sup> H NMR spectrum of 2-amino-4-(pyridin-3-yl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S47
<b>Figure S43.</b> <sup>13</sup> C NMR spectrum of 2-amino-4-(pyridin-3-yl)-5,10-dioxo-5,10-dihydro-4 <i>H</i> -benzo[ <i>g</i> ]chromene-3-carbonitrile	S48
<b>Figure S44.</b> FT-IR spectrum of 3-amino-1-phenyl-1 <i>H</i> -benzo[ <i>f</i> ]chromene-2-carbonitrile	S49
<b>Figure S45.</b> <sup>1</sup> H NMR spectrum of 3-amino-1-phenyl-1 <i>H</i> -benzo[ <i>f</i> ]chromene-2-carbonitrile	S50
<b>Figure S46.</b> The expanded <sup>1</sup> H NMR spectrum of 3-amino-1-phenyl-1 <i>H</i> -benzo[ <i>f</i> ]chromene-2-carbonitrile	S51
<b>Figure S47.</b> <sup>13</sup> C NMR spectrum of 3-amino-1-phenyl-1 <i>H</i> -benzo[ <i>f</i> ]chromene-2-carbonitrile	S52

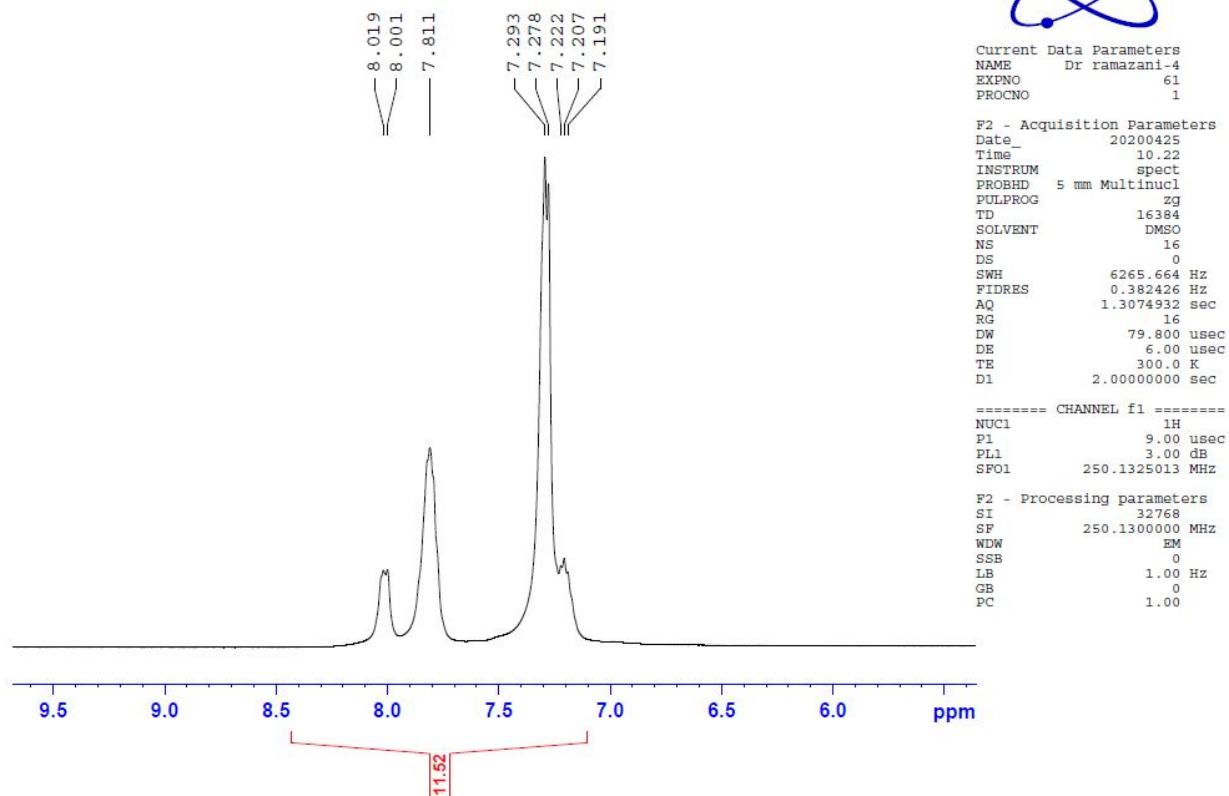
<b>Figure S48.</b> FT-IR spectrum of 3-amino-1-(4-cyanophenyl)-1H-benzo[f]chromene-2-carbonitrile	S53
<b>Figure S49.</b> <sup>1</sup> H NMR spectrum of 3-amino-1-(4-cyanophenyl)-1H-benzo[f]chromene-2-carbonitrile	S54
<b>Figure S50.</b> <sup>13</sup> C NMR spectrum of 3-amino-1-(4-cyanophenyl)-1H-benzo[f]chromene-2-carbonitrile	S55
<b>Figure S51.</b> FT-IR spectrum of 2-amino-7-hydroxy-4-phenyl-4Hchromene-3-carbonitrile	S56
<b>Figure S52.</b> <sup>1</sup> H NMR spectrum of 2-amino-7-hydroxy-4-phenyl-4Hchromene-3-carbonitrile	S57
<b>Figure S53.</b> <sup>1</sup> H NMR expand spectrum of 2-Amino-7-hydroxy-4-phenyl-4Hchromene-3-carbonitrile	S58
<b>Figure S54.</b> <sup>13</sup> C NMR spectrum of 2-amino-7-hydroxy-4-phenyl-4Hchromene-3-carbonitrile	S59
<b>Figure S55.</b> FT-IR spectrum of 2-amino-7-hydroxy-4-(3-nitrophenyl)-4H-chromene-3-carbonitrile	S60
<b>Figure S56.</b> <sup>1</sup> H NMR spectrum of 2-amino-7-hydroxy-4-(3-nitrophenyl)-4H-chromene-3-carbonitrile	S61
<b>Figure S57.</b> The expanded <sup>1</sup> H NMR spectrum of 2-amino-7-hydroxy-4-(3-nitrophenyl)-4H-chromene-3-carbonitrile	S62
<b>Figure S58.</b> <sup>13</sup> C NMR spectrum of 2-amino-7-hydroxy-4-(3-nitrophenyl)-4H-chromene-3-carbonitrile	S63



**Figure S1.** FT-IR spectrum of 2-amino-4-(phenyl)-5,10-dioxo-5,10-dihydro-4H-benzo[g]chromene-3-carbonitrile

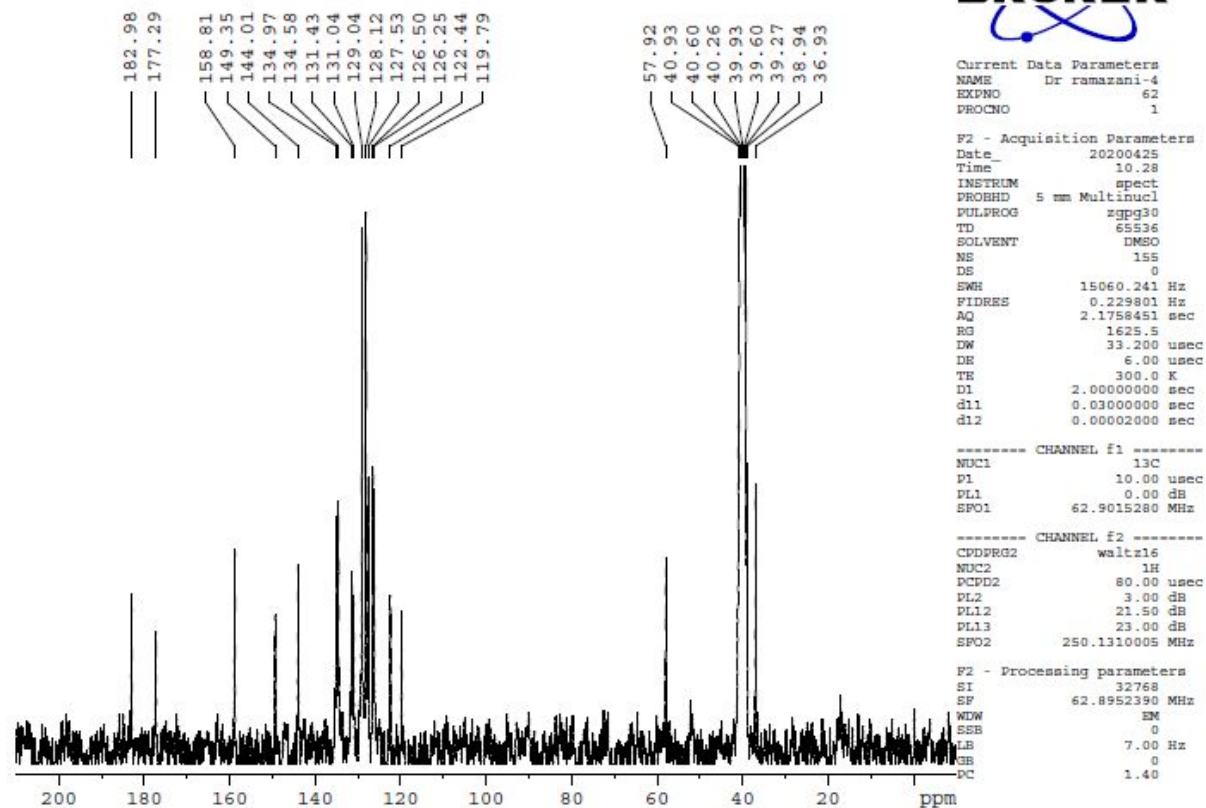


**Figure S2.**  $^1\text{H}$  NMR spectrum of 2-amino-4-(phenyl)-5,10-dioxo-5,10-dihydro-4*H*-benzo[*g*]chromene-3-carbonitrile

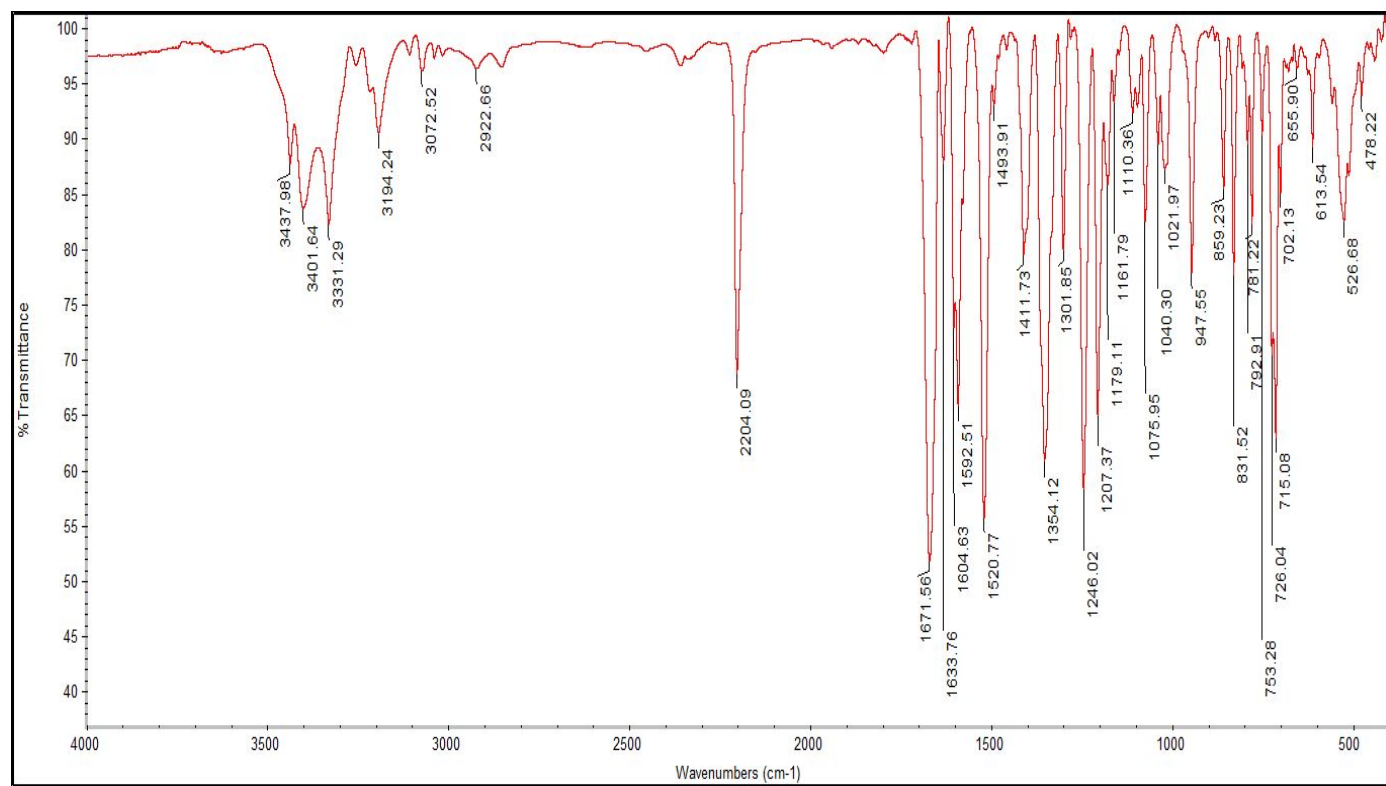


**Figure S3.** The expanded  $^1\text{H}$  NMR spectrum of 2-amino-4-(phenyl)-5,10-dioxo-5,10-dihydro-4H-benzo[g]chromene-3-carbonitrile

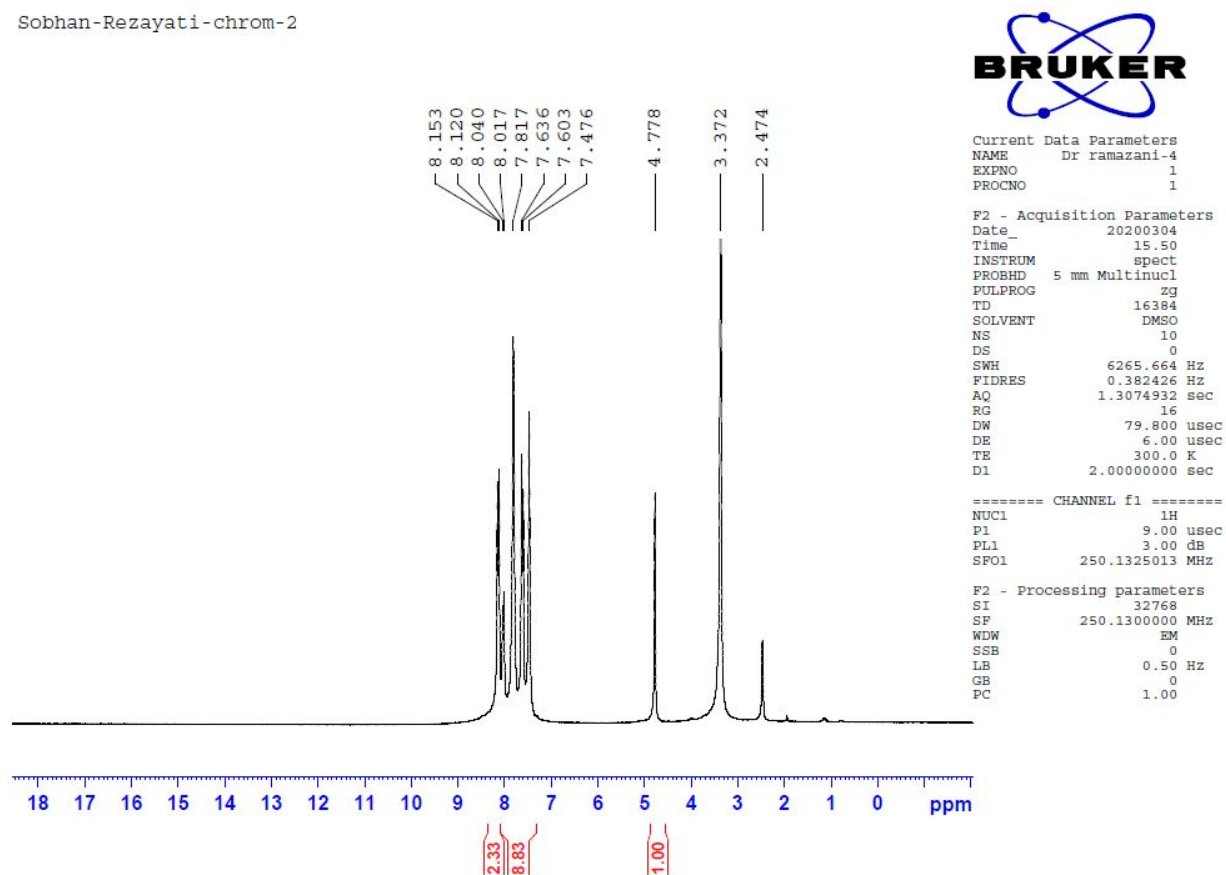




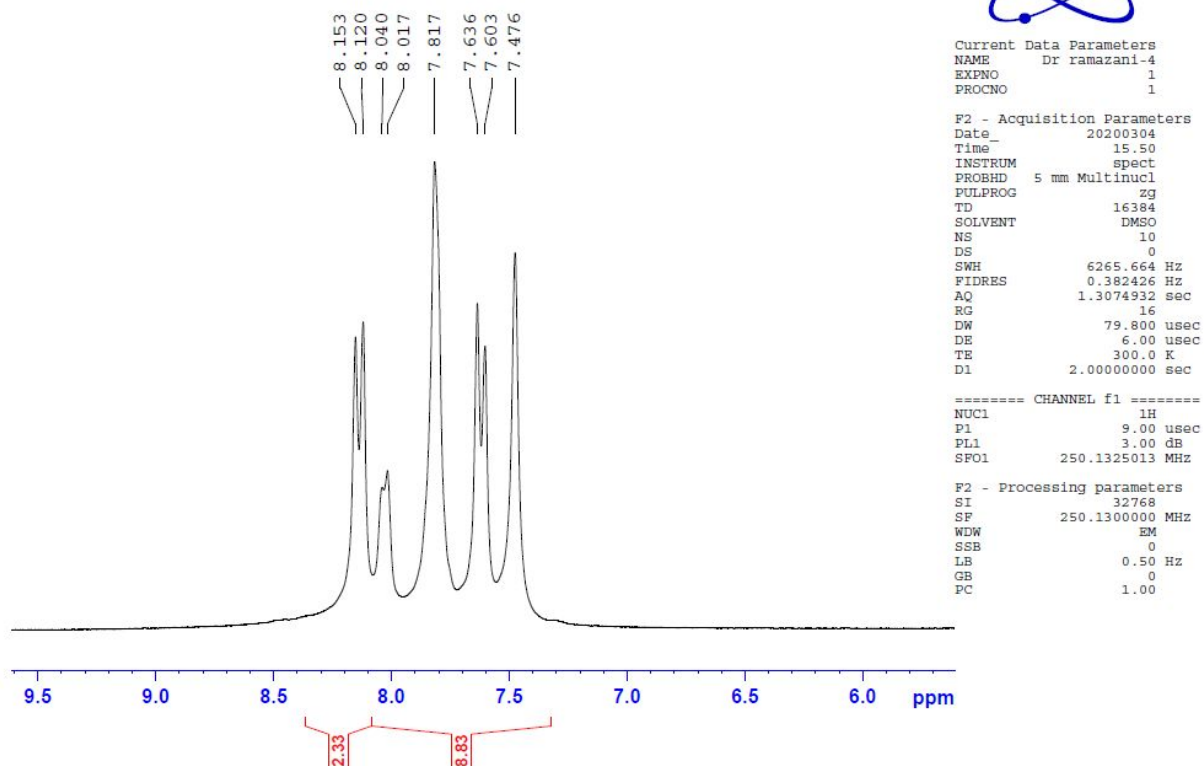
**Figure S4.**  $^{13}\text{C}$  NMR spectrum of 2-amino-4-(phenyl)-5,10-dioxo-5,10-dihydro-4H-benzo[g]chromene-3-carbonitrile



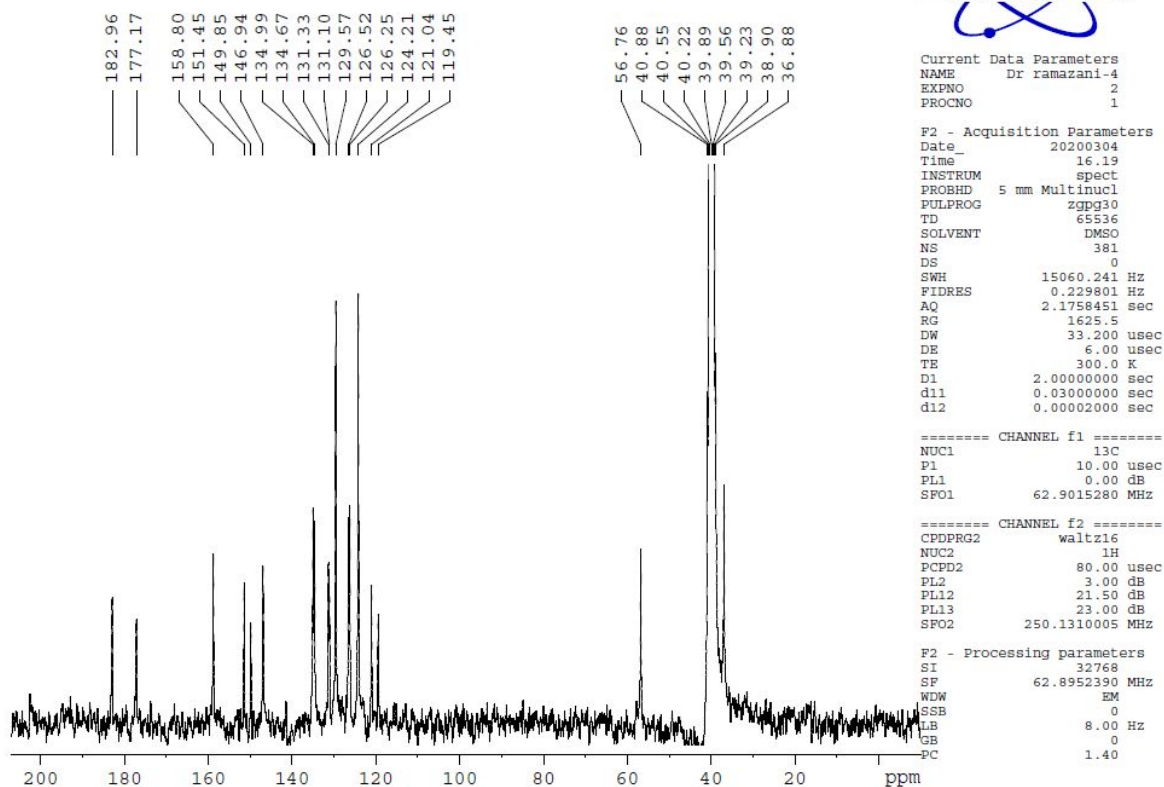
**Figure S5.** FT-IR spectrum of 2-amino-4-(4-nitrophenyl)-5,10-dioxo-5,10-dihydro-4H-benzo[g]chromene-3-carbonitrile



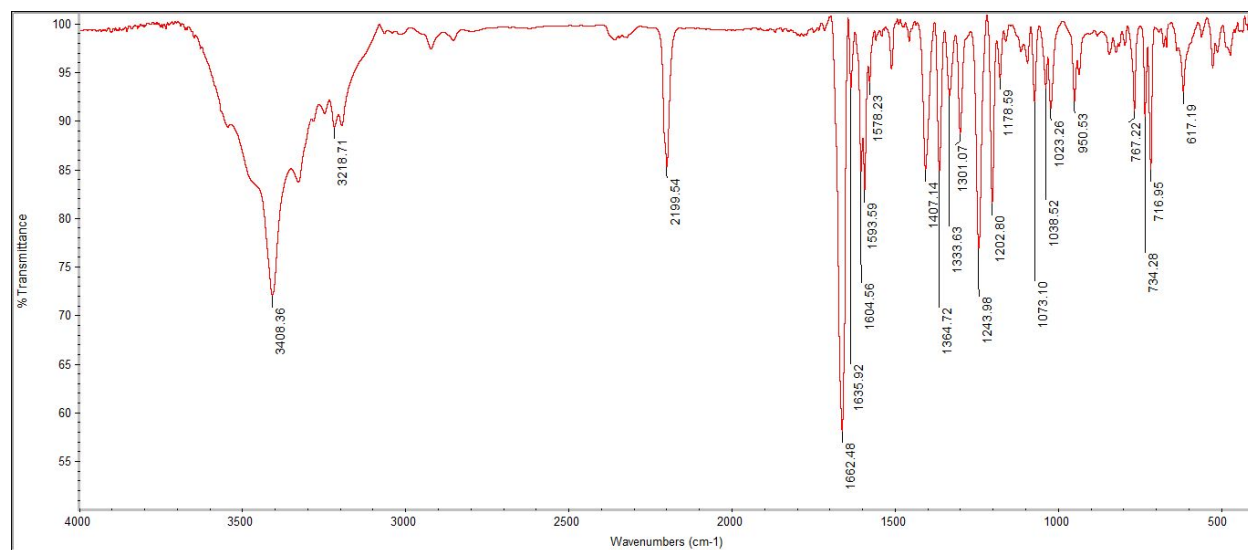
**Figure S6.**  $^1\text{H}$  NMR spectrum of 2-amino-4-(4-nitrophenyl)-5,10-dioxo-5,10-dihydro-4H-benzo[g]chromene-3-carbonitrile



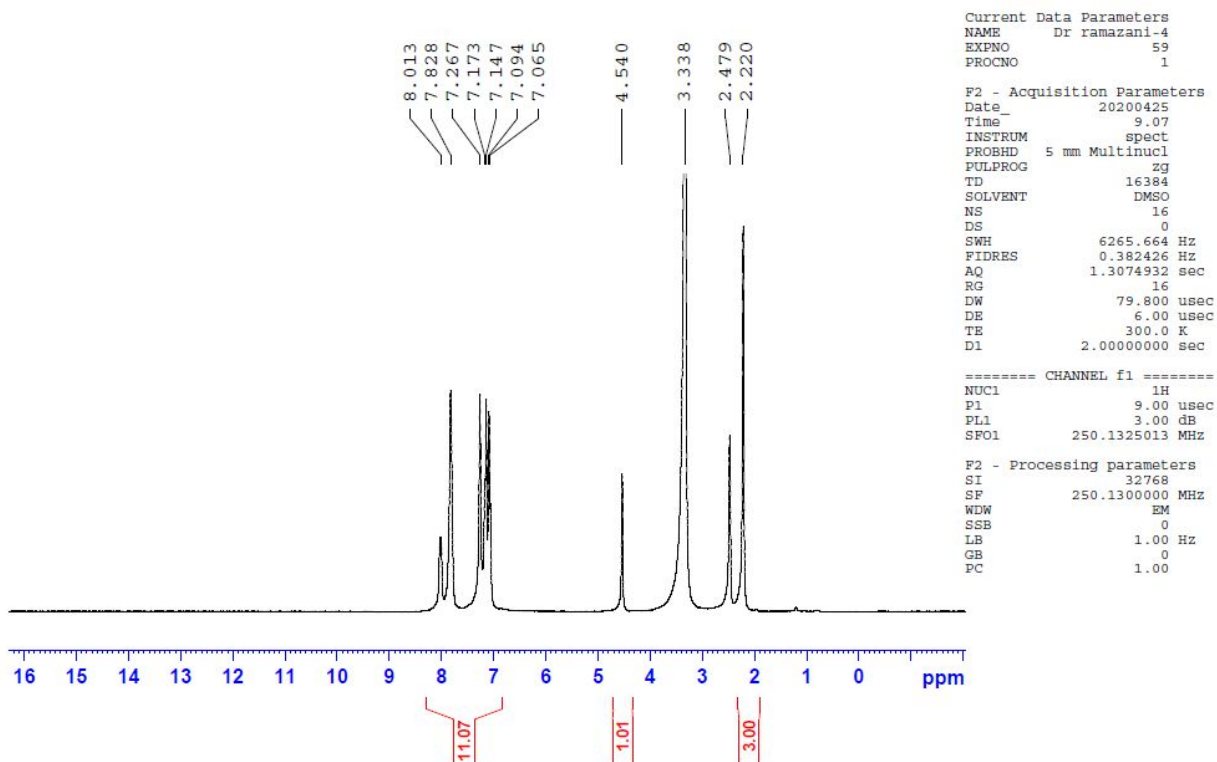
**Figure S7.** The expanded  $^1\text{H}$  NMR spectrum of 2-amino-4-(4-nitrophenyl)-5,10-dioxo-5,10-dihydro-4*H*-benzo[*g*]chromene-3-carbonitrile



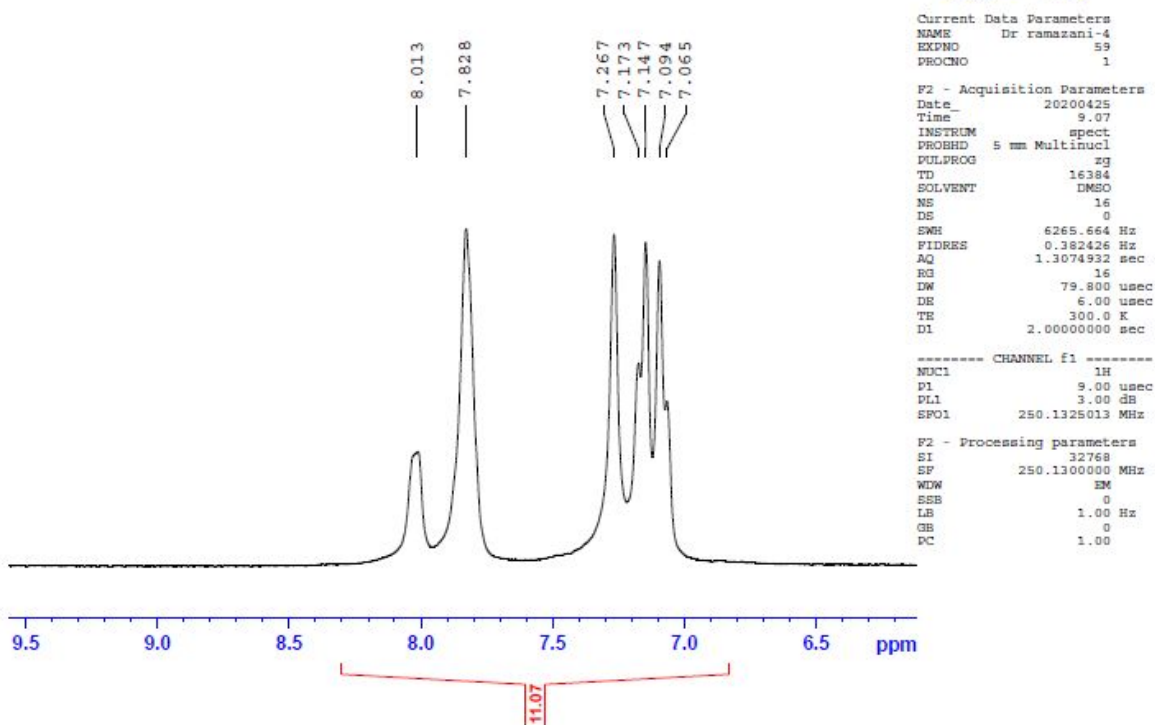
**Figure S8.**  $^{13}\text{C}$  NMR spectrum of 2-amino-4-(4-nitrophenyl)-5,10-dioxo-5,10-dihydro-4H-benzo[g]chromene-3-carbonitrile



**Figure S9.** FT-IR spectrum of 2-amino-4-(4-methylphenyl)-5,10-dioxo-5,10-dihydro-4H-benzo[g]chromene-3-carbonitrile



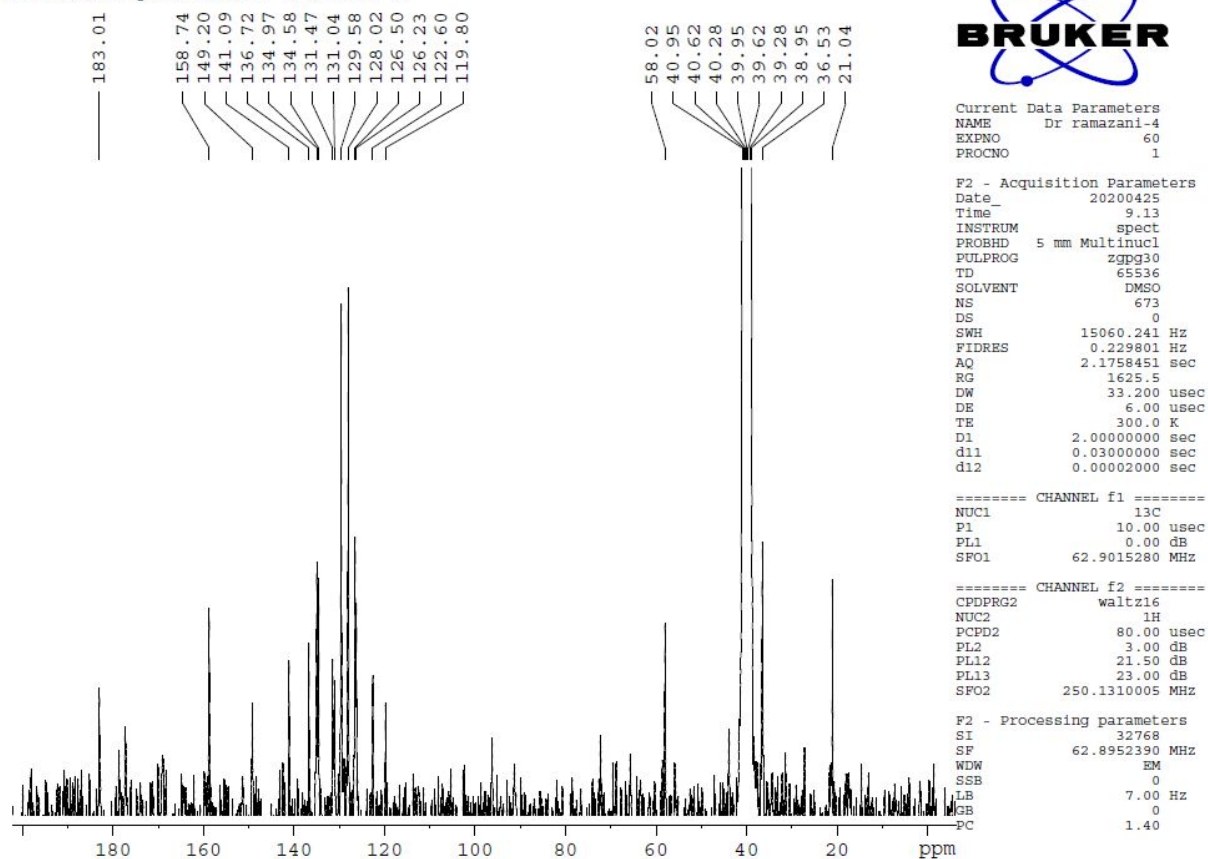
**Figure S10.**  $^1\text{H}$  NMR spectrum of 2-amino-4-(4-methylphenyl)-5,10-dioxo-5,10-dihydro-4H-benzo[g]chromene-3-carbonitrile



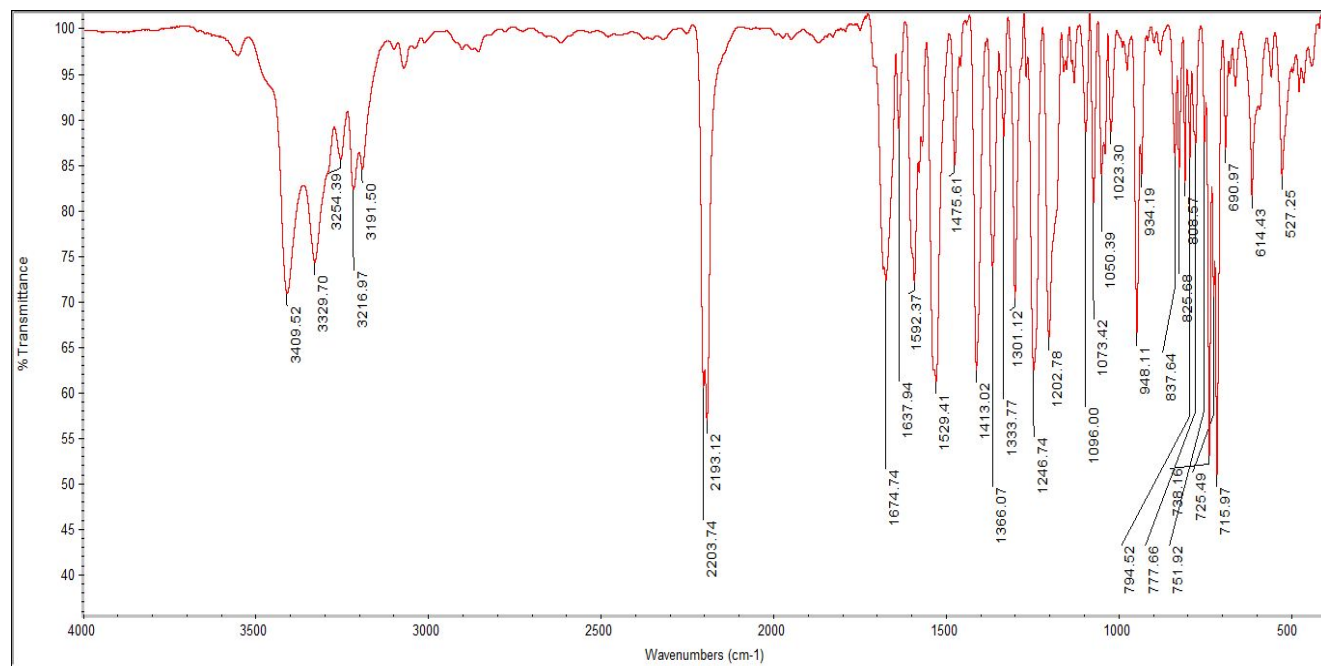
**Figure S11.** The expanded  $^1\text{H}$  NMR spectrum of 2-amino-4-(4-methylphenyl)-5,10-dioxo-5,10-dihydro-4*H*-benzo[*g*]chromene-3-carbonitrile



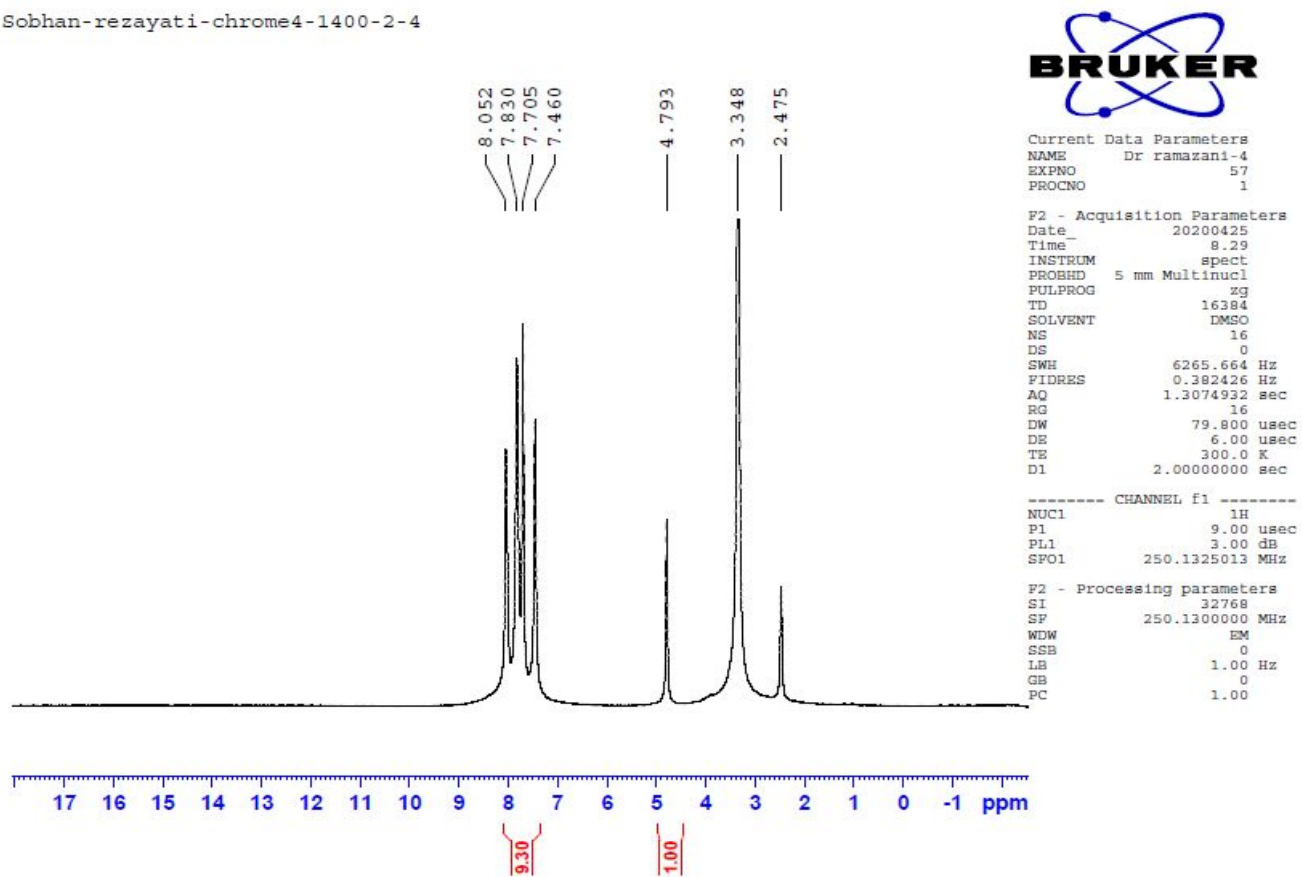
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**Figure S12.**  $^{13}\text{C}$  NMR spectrum of 2-amino-4-(4-methylphenyl)-5,10-dioxo-5,10-dihydro-4H-benzo[g]chromene-3-carbonitrile

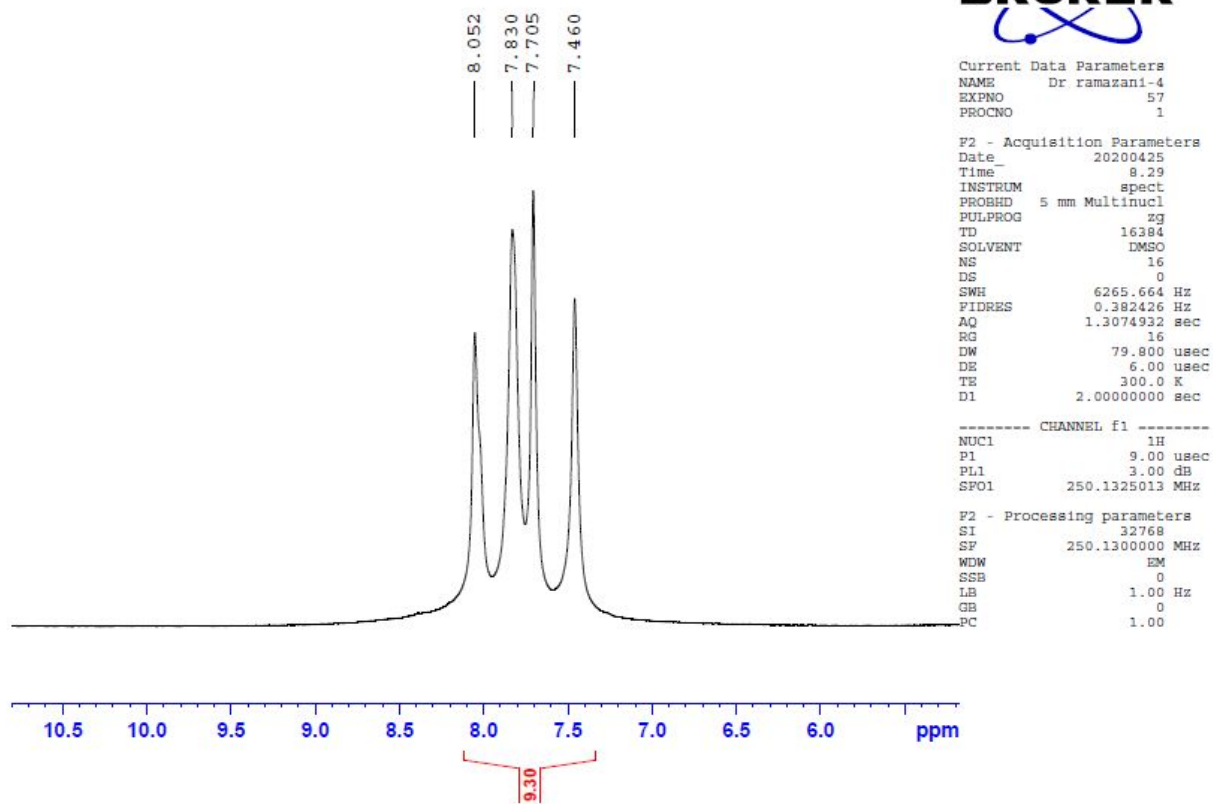


**Figure S13.** FT-IR spectrum of 2-amino-4-(4-chloro-3-nitrophenyl)-5,10-dioxo-5,10-dihydro-4H-benzo[g]chromene-3-carbonitrile



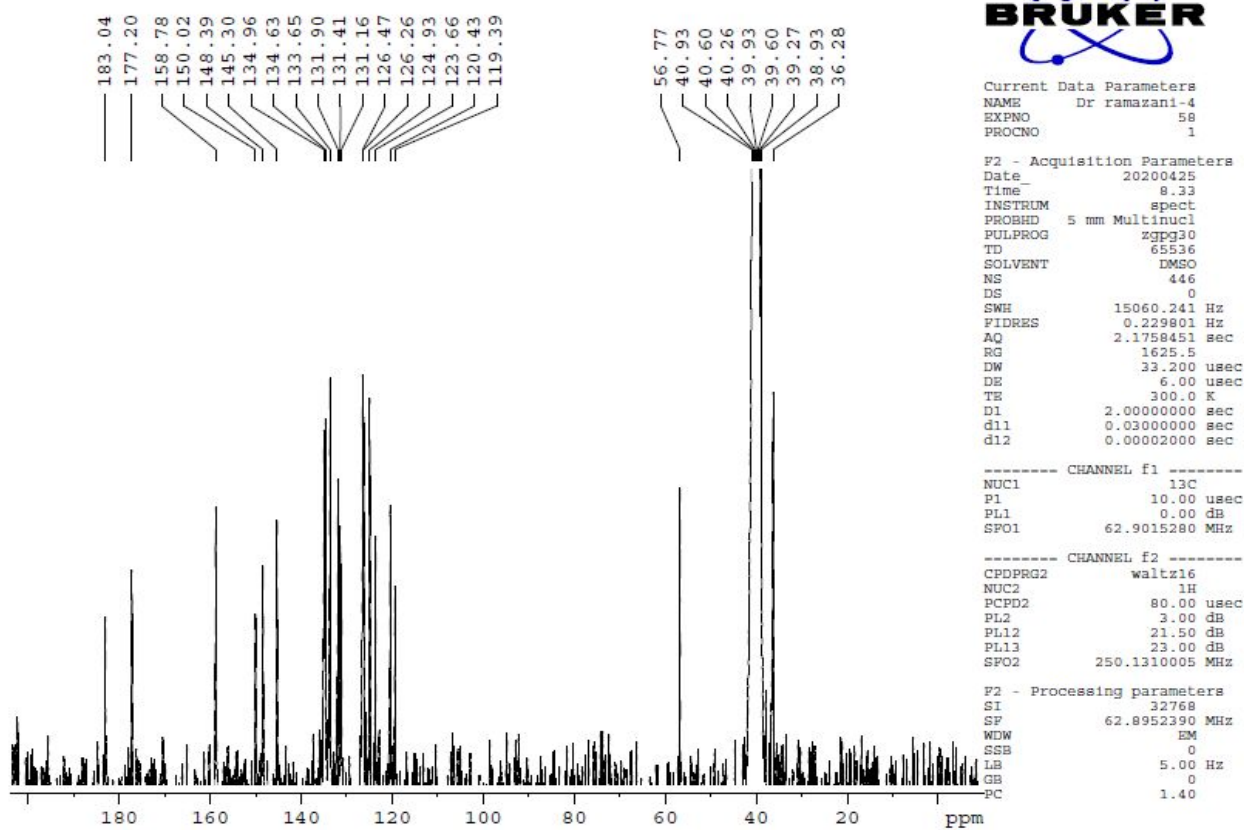
**Figure S14.**  $^1\text{H}$  NMR spectrum of 2-amino-4-(4-chloro-3-nitrophenyl)-5,10-dioxo-5,10-dihydro-4H-benzo[g]chromene-3-carbonitrile

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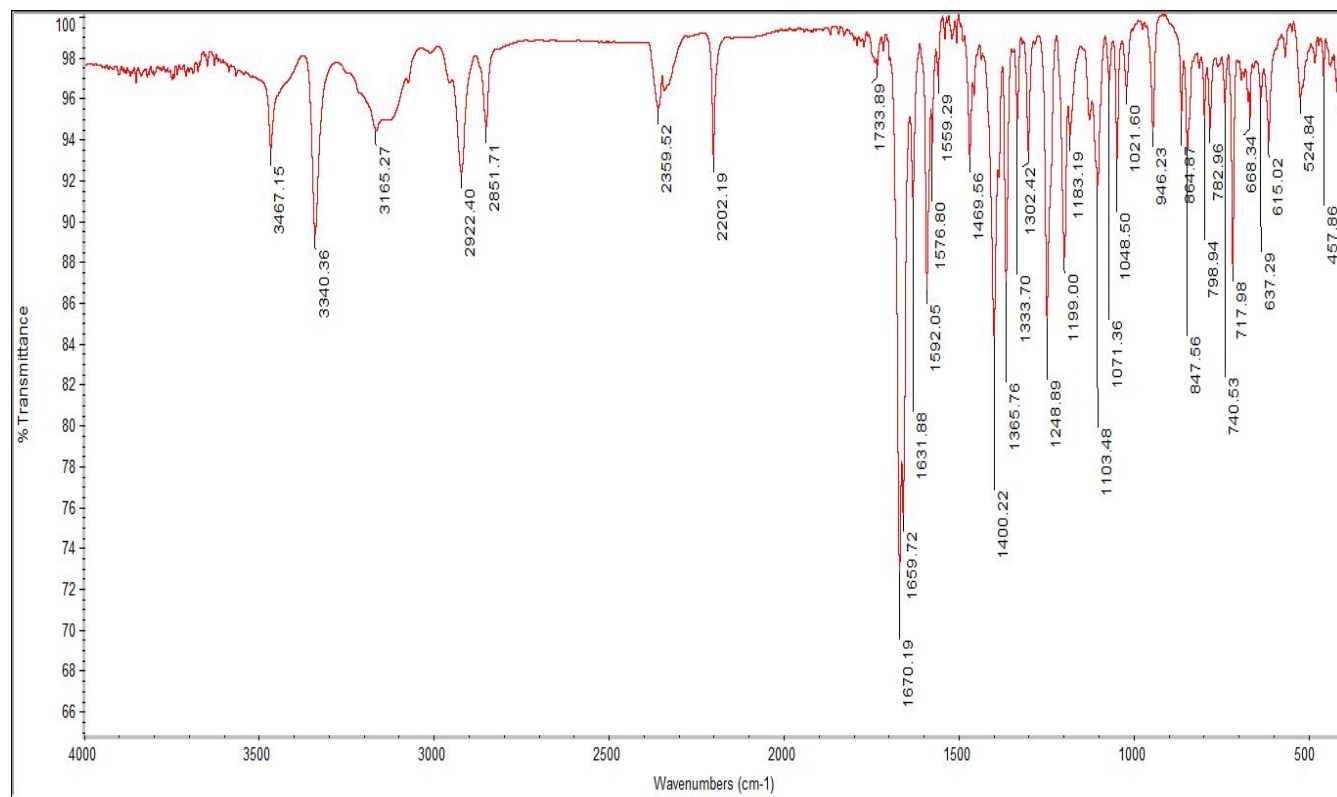


**Figure S15.** The expanded  $^1\text{H}$  NMR spectrum of 2-amino-4-(4-chloro-3-nitrophenyl)-5,10-dioxo-5,10-dihydro-4*H*-benzo[*g*]chromene-3-carbonitrile

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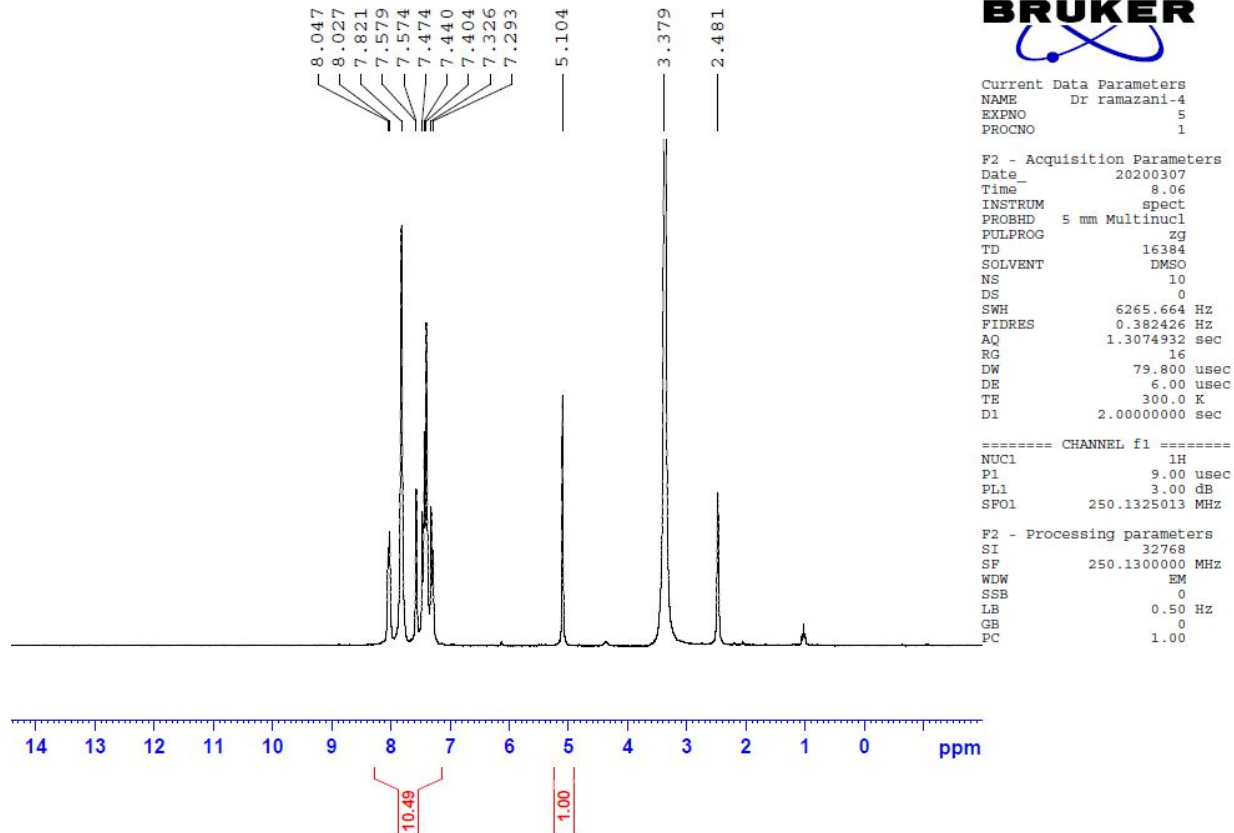


**Figure S16.**  $^{13}\text{C}$  NMR spectrum of 2-amino-4-(4-chloro-3-nitrophenyl)-5,10-dioxo-5,10-dihydro-4H-benzo[g]chromene-3-carbonitrile



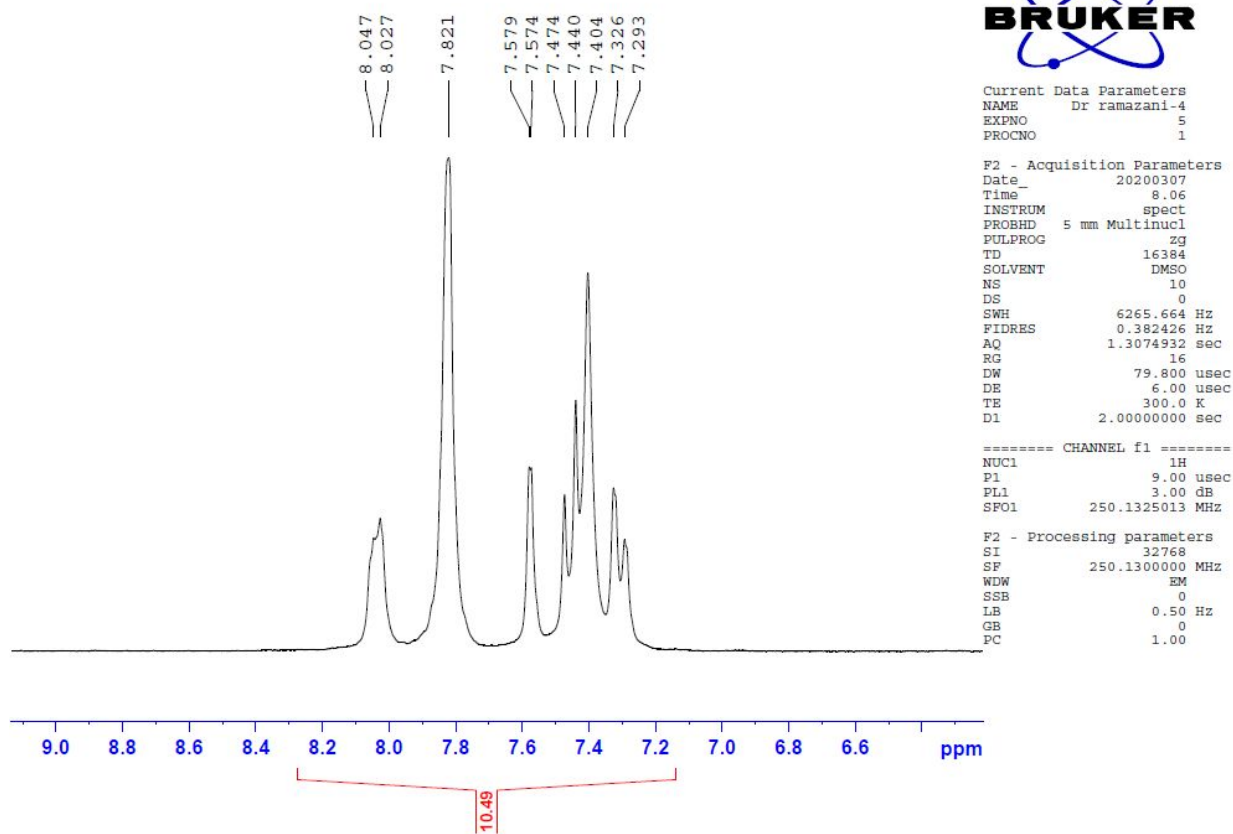
**Figure S17.** FT-IR spectrum of 2-amino-4-(2,4-dichlorophenyl)-5,10-dioxo-5,10-dihydro-4*H*-benzo[*g*]chromene-3 carbonitrile

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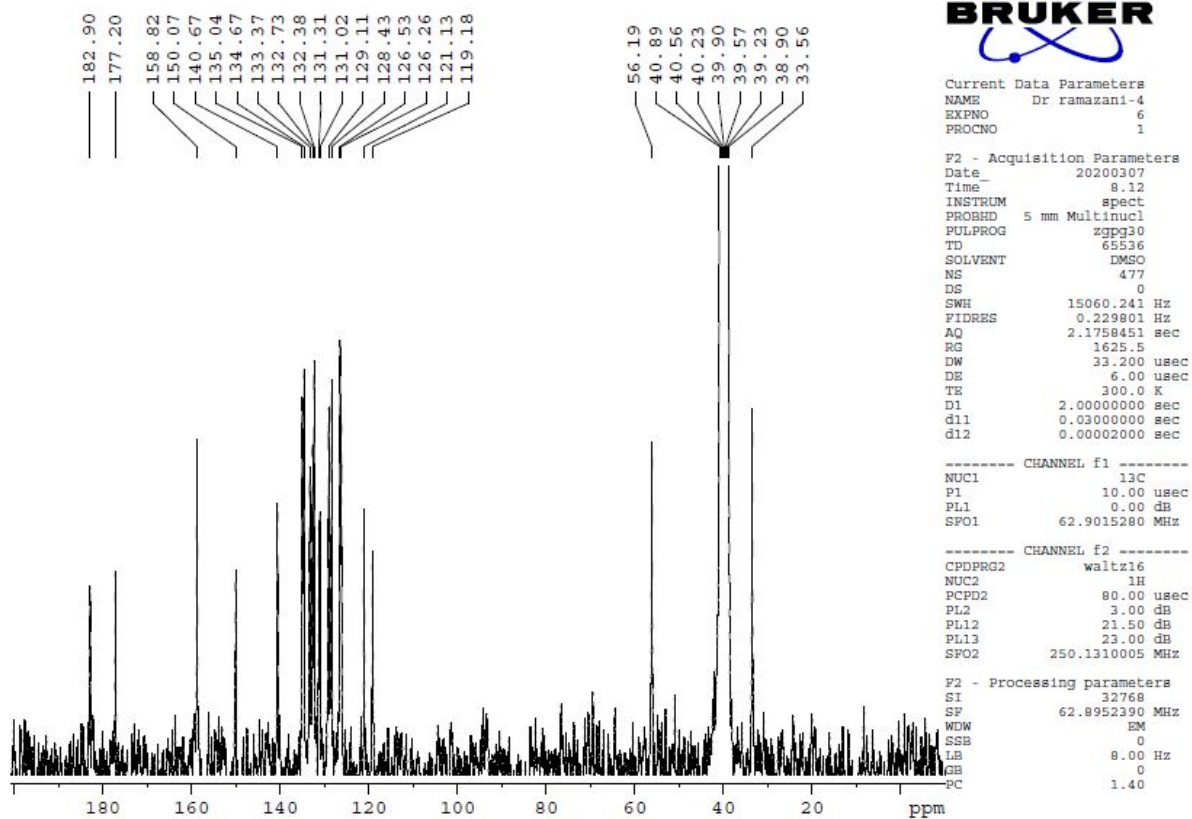
**Figure S18.**  $^1\text{H}$  NMR spectrum of 2-amino-4-(2,4-dichlorophenyl)-5,10-dioxo-5,10-dihydro-4H-benzo[g]chromene-3 carbonitrile

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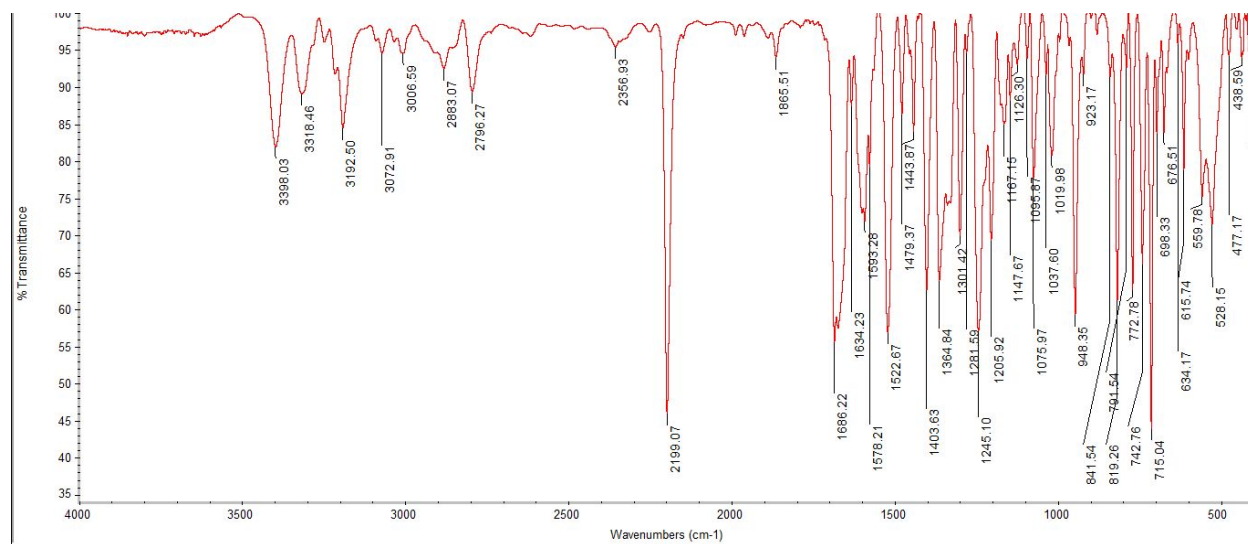


**Figure S19.** The expanded  $^1\text{H}$  NMR spectrum of 2-amino-4-(2,4-dichlorophenyl)-5,10-dioxo-5,10-dihydro-4*H*-benzo[*g*]chromene-3 carbonitrile

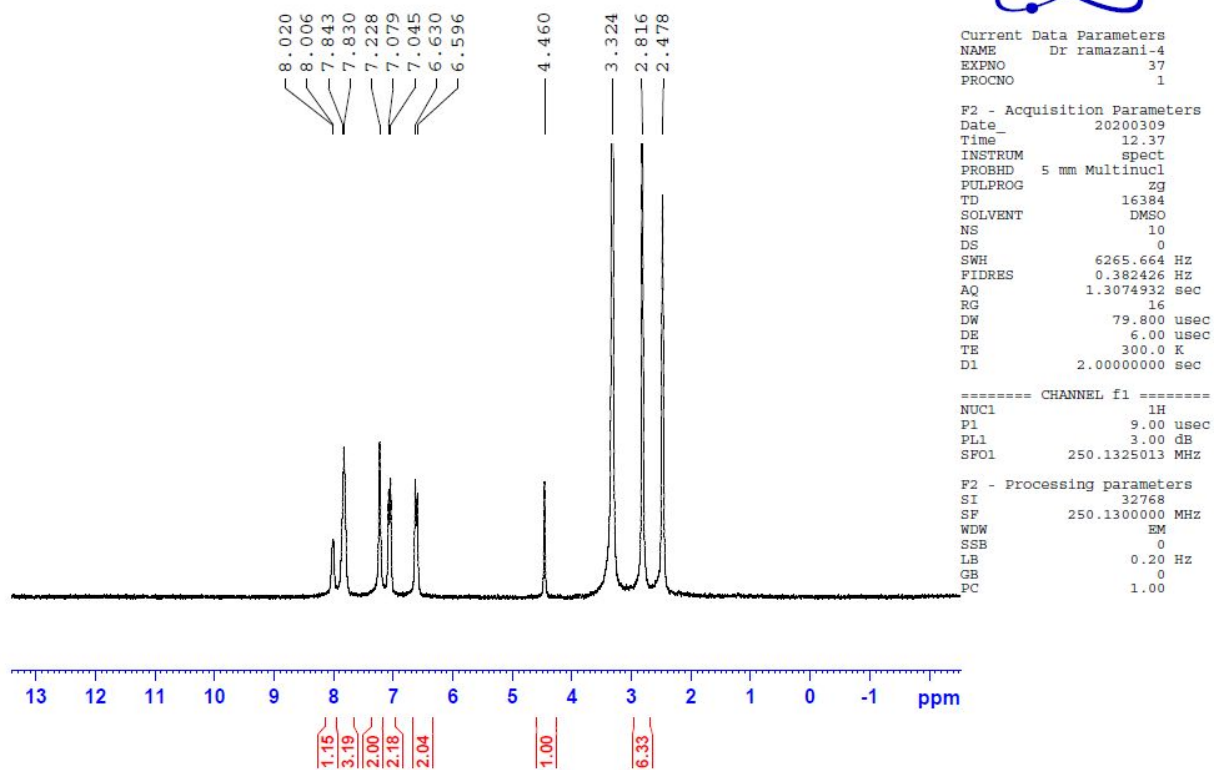




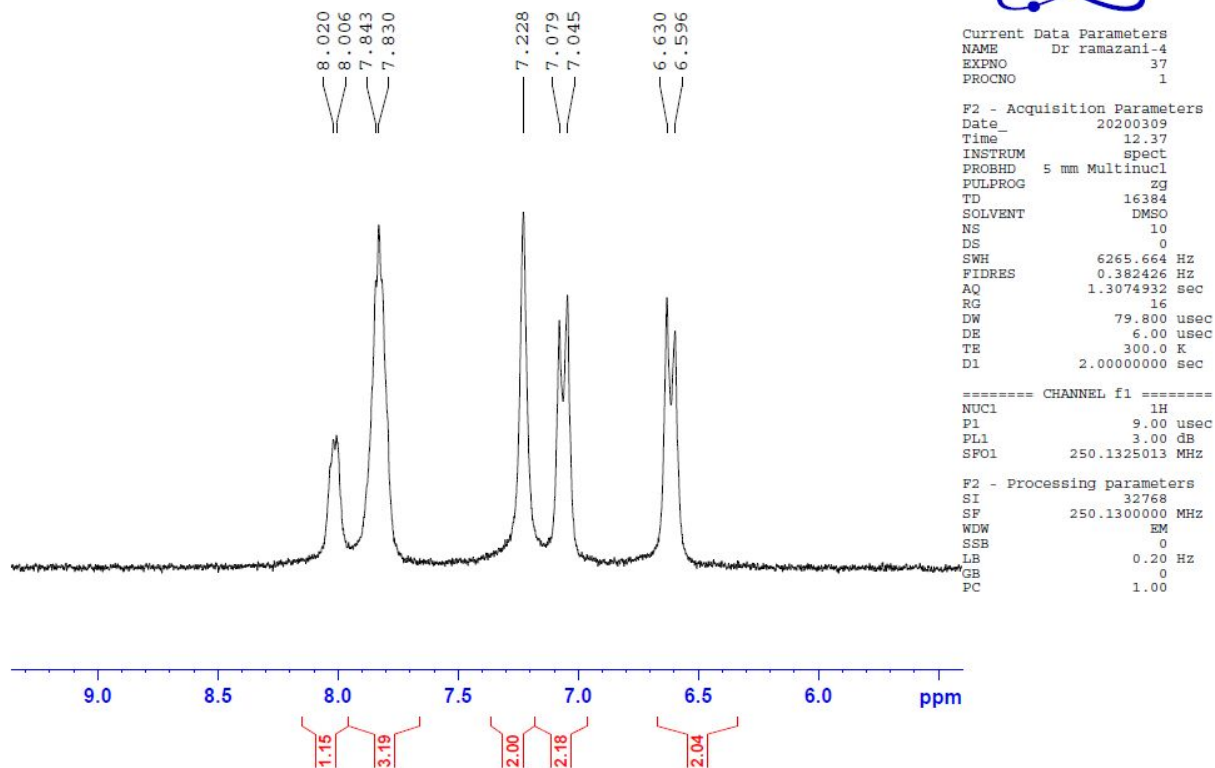
**Figure S20.**  $^{13}\text{C}$  NMR spectrum of 2-amino-4-(2,4-dichlorophenyl)-5,10-dioxo-5,10-dihydro-4H-benzo[g]chromene-3 carbonitrile



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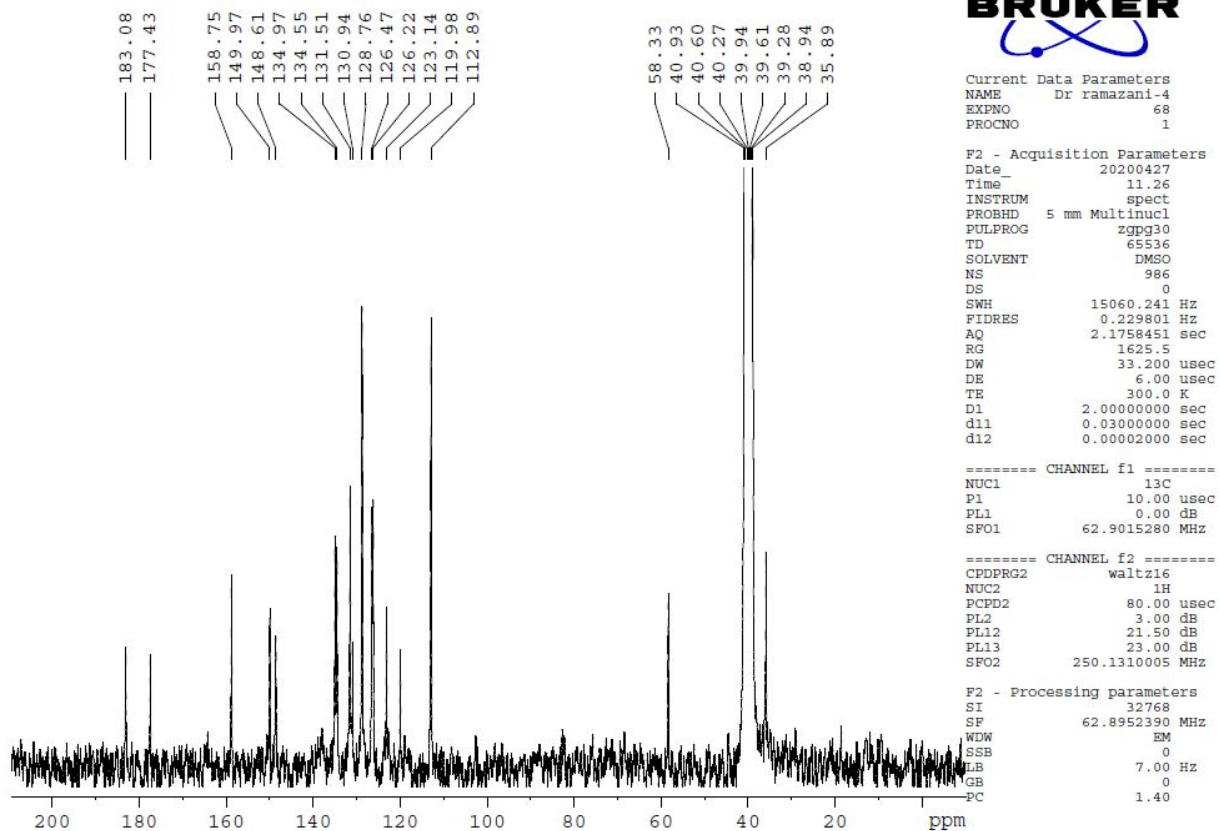


**Figure S22.**  $^1\text{H}$  NMR spectrum of 2-amino-4-(4-(dimethylamino) phenyl)-5,10-dioxo-5,10-dihydro-4*H*benzo[*g*]chromene-3-carbonitrile

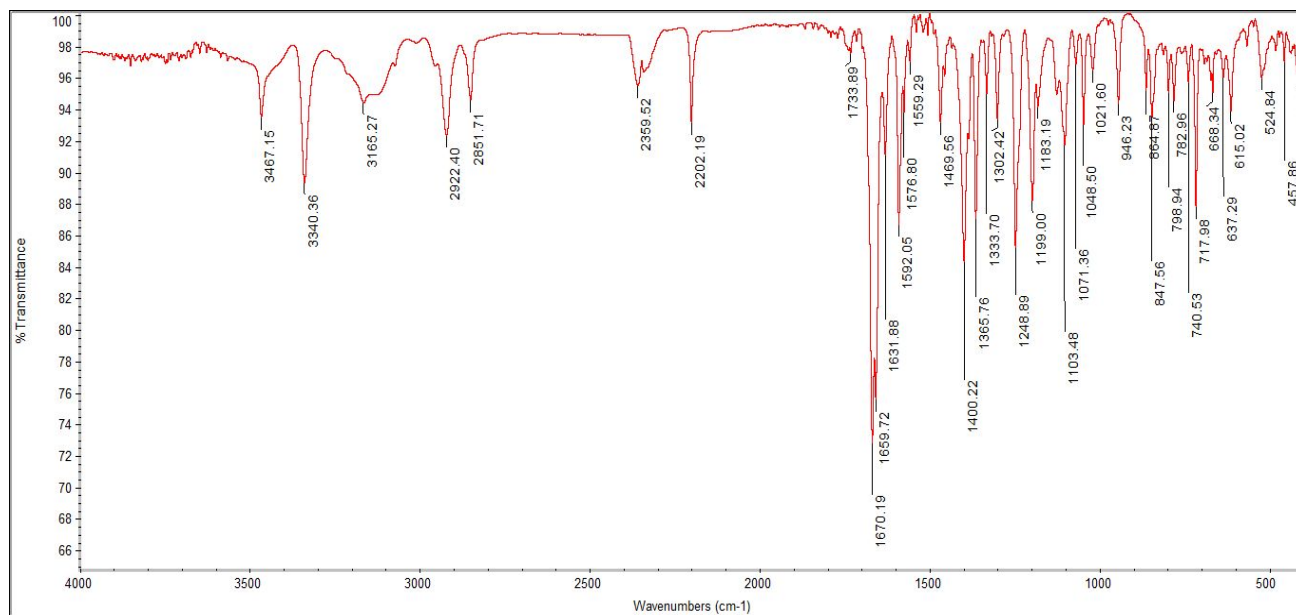


**Figure S23.** The expanded <sup>1</sup>H NMR of 2-amino-4-(4-(dimethylamino) phenyl)-5,10-dioxo-5,10-dihydro-4*H*benzo[*g*]chromene-3-carbonitrile

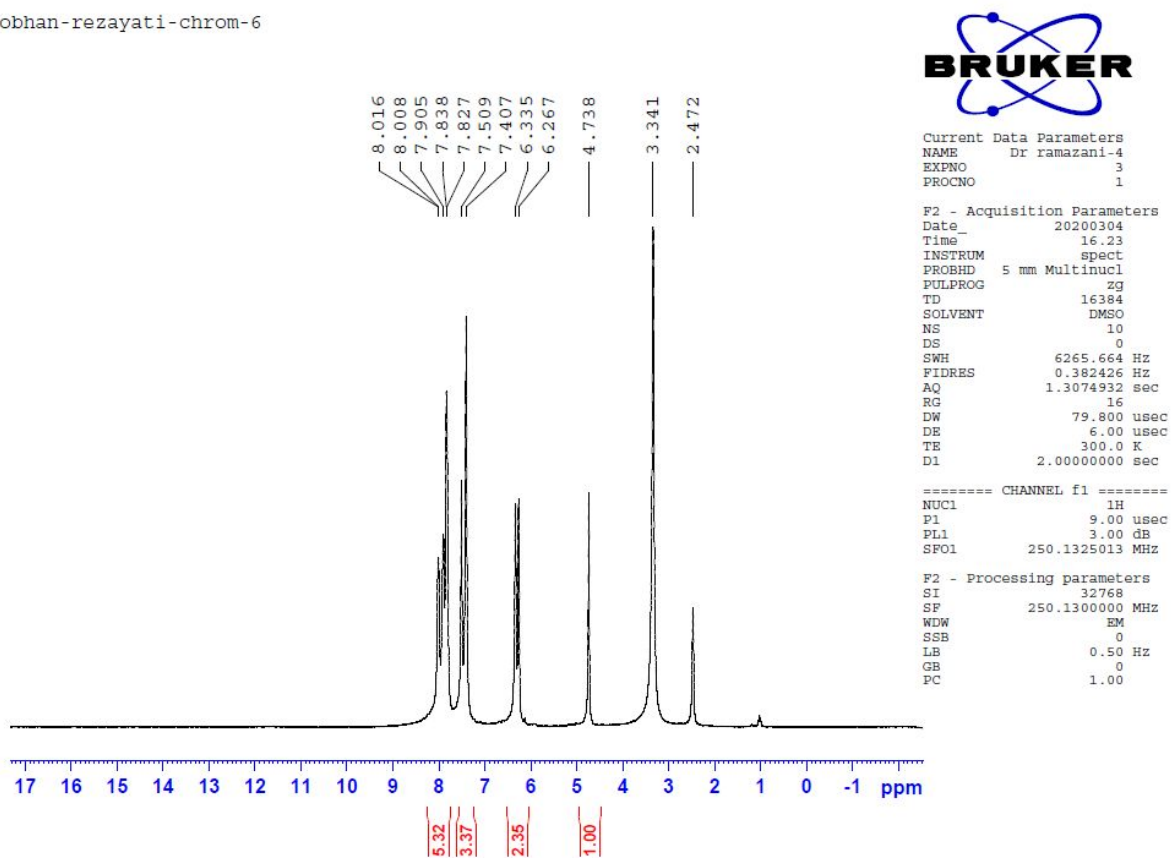
Rezayati-Chrome-7-1400-2-6



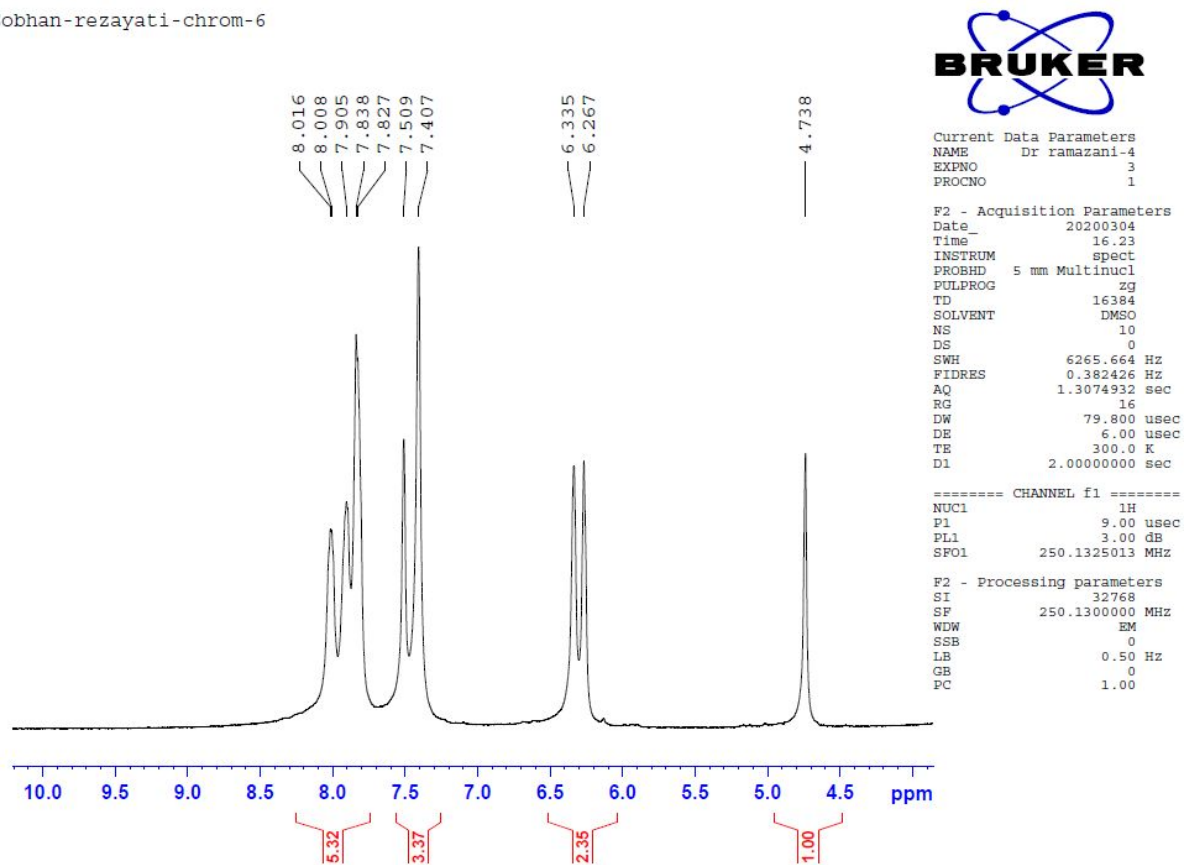
**Figure S24.**  $^{13}\text{C}$  NMR spectrum of 2-amino-4-(4-(dimethylamino) phenyl)-5,10-dioxo-5,10-dihydro-4*H*benzo[*g*]chromene-3-carbonitrile



**Figure S25.** FT-IR spectrum of 2-amino-4-(furan-2-yl)-5,10-dioxo-5,10-dihydro-4H-benzo[g]chromene-3-carbonitrile

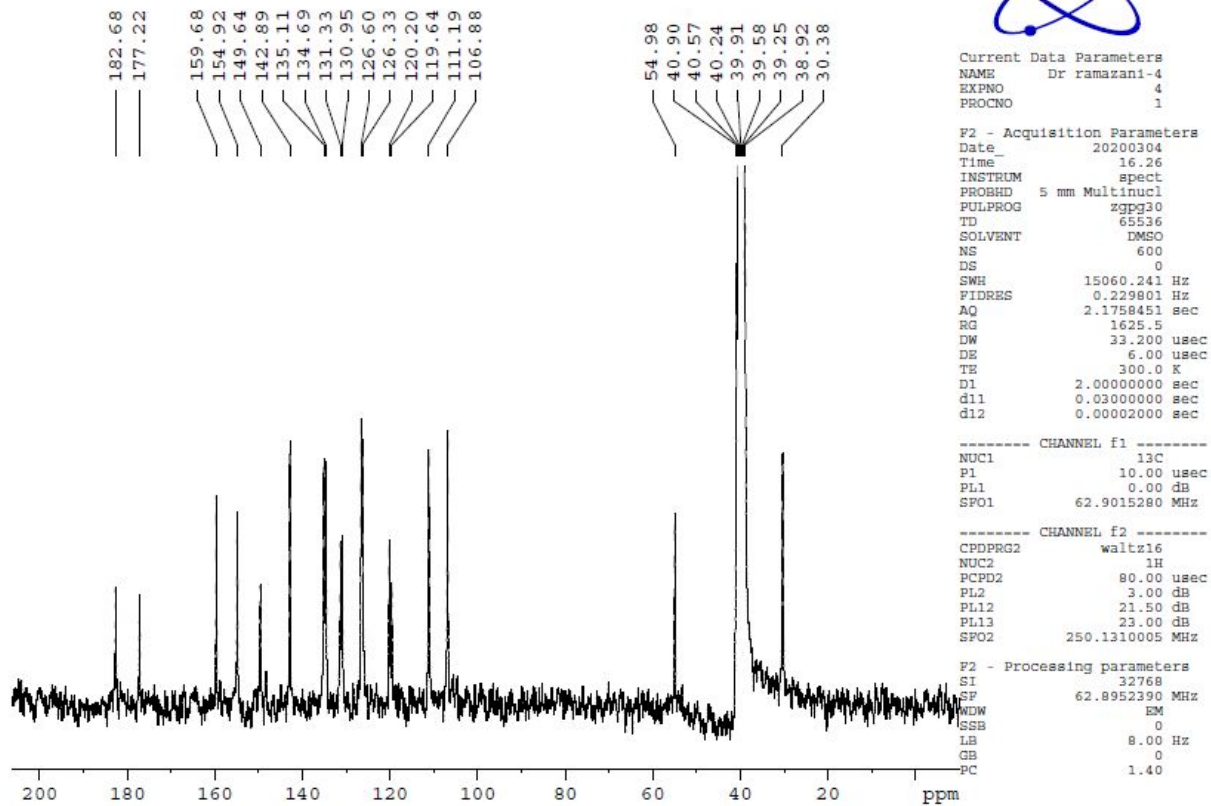


**Figure S26.**  $^1\text{H}$  NMR spectrum of 2-amino-4-(furan-2-yl)-5,10-dioxo-5,10-dihydro-4H-benzo[g]chromene-3-carbonitrile

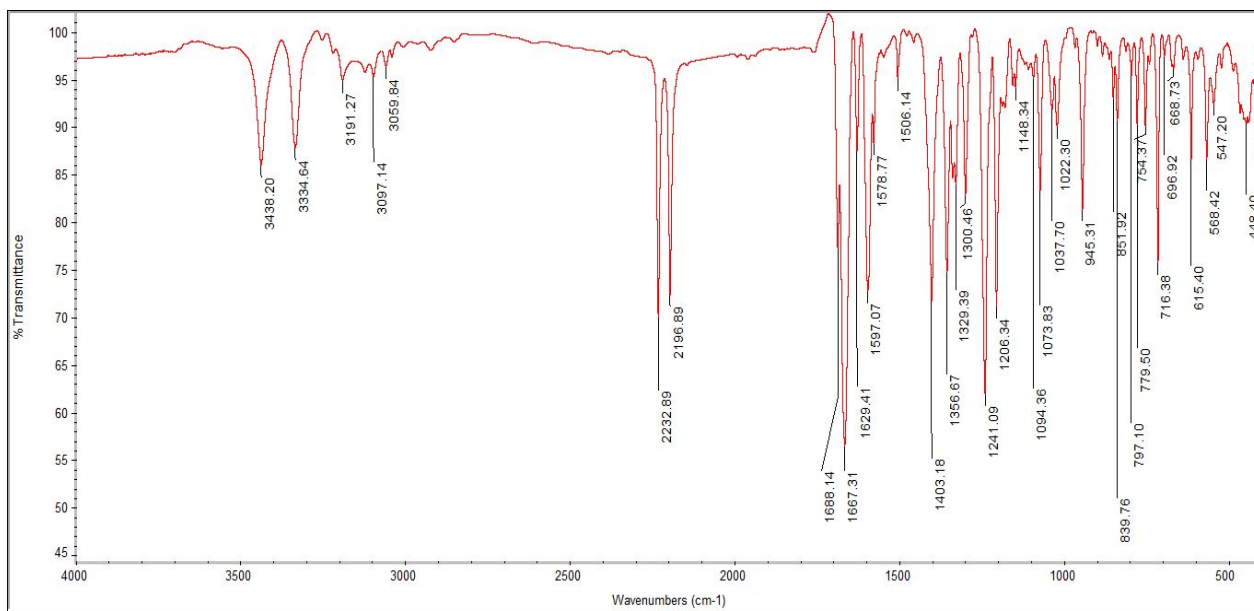


**Figure S27.** The expanded  $^1\text{H}$  NMR spectrum of 2-amino-4-(furan-2-yl)-5,10-dioxo-5,10-dihydro-4*H*-benzo[*g*]chromene-3-carbonitrile

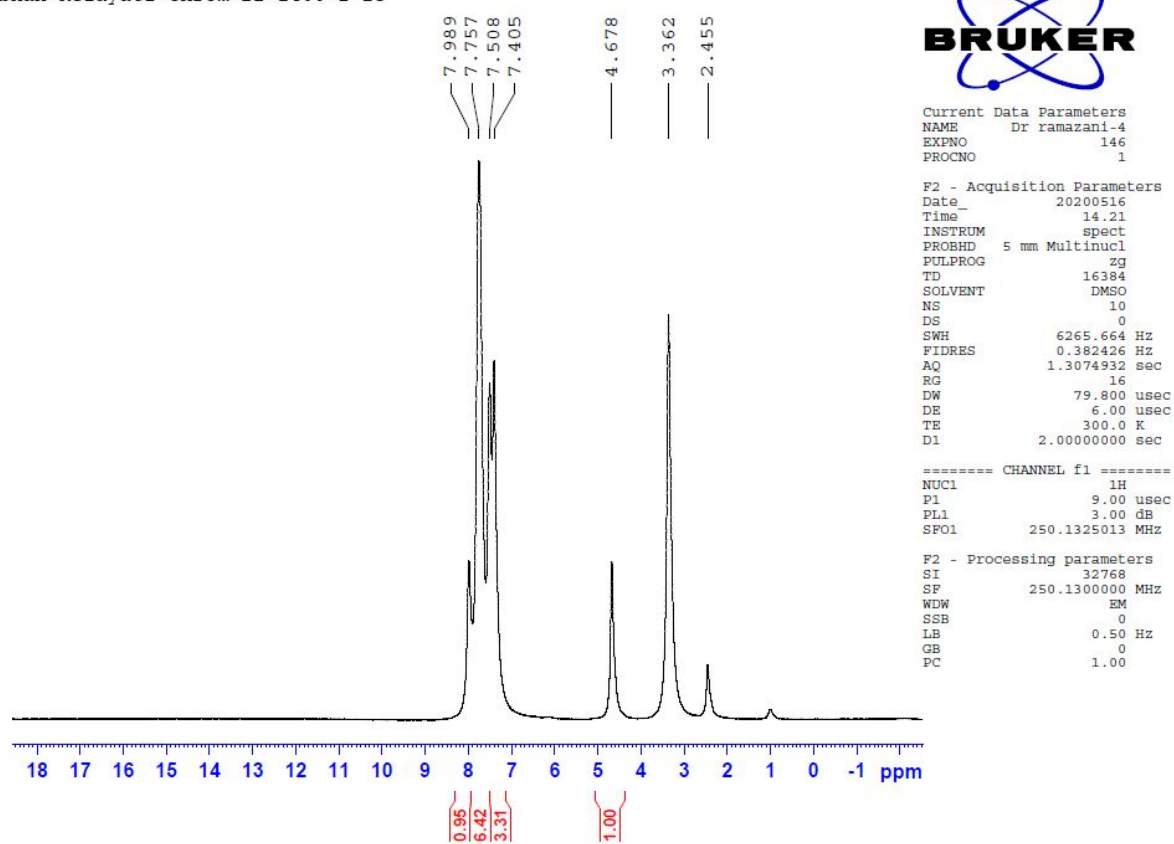




**Figure S28.**  $^{13}\text{C}$  NMR spectrum of 2-amino-4-(furan-2-yl)-5,10-dioxo-5,10-dihydro-4H-benzo[g]chromene-3-carbonitrile

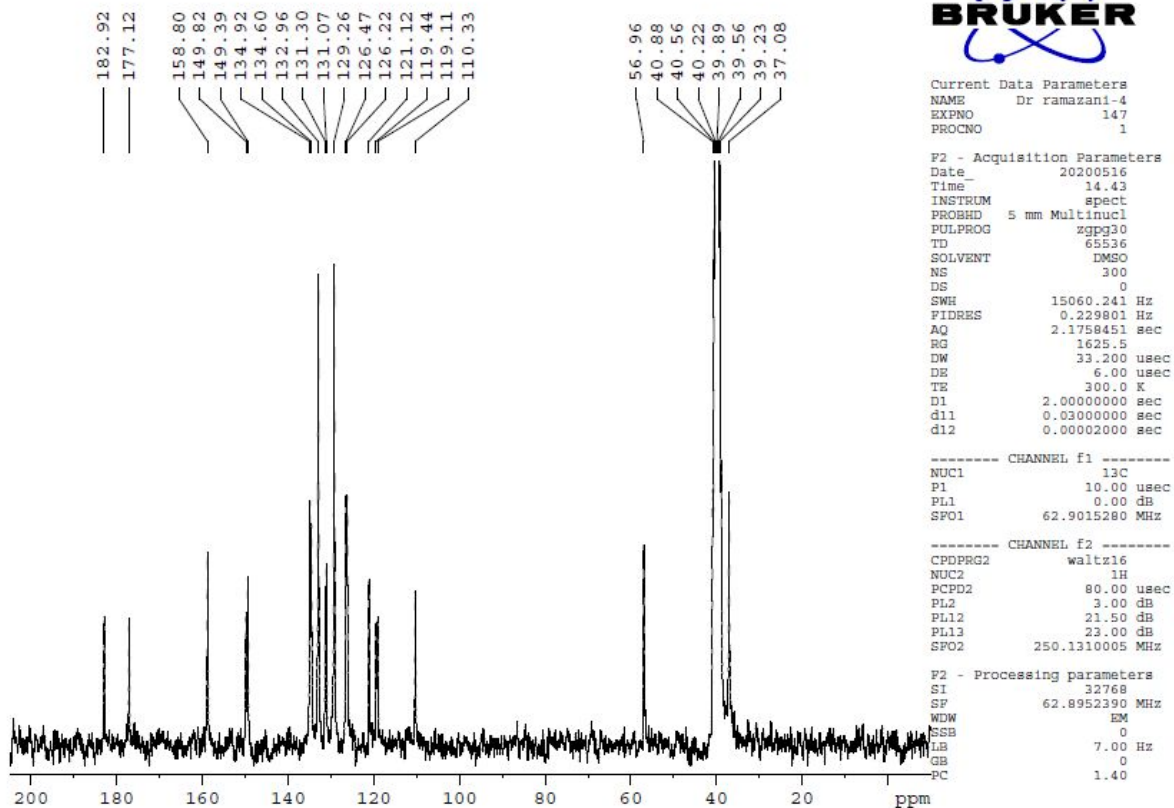


**Figure S29.** FT-IR spectrum of 2-amino-4-(4-cyanophenyl)-5,10-dioxo-5,10-dihydro-4H-benzo[g]chromene-3-carbonitrile

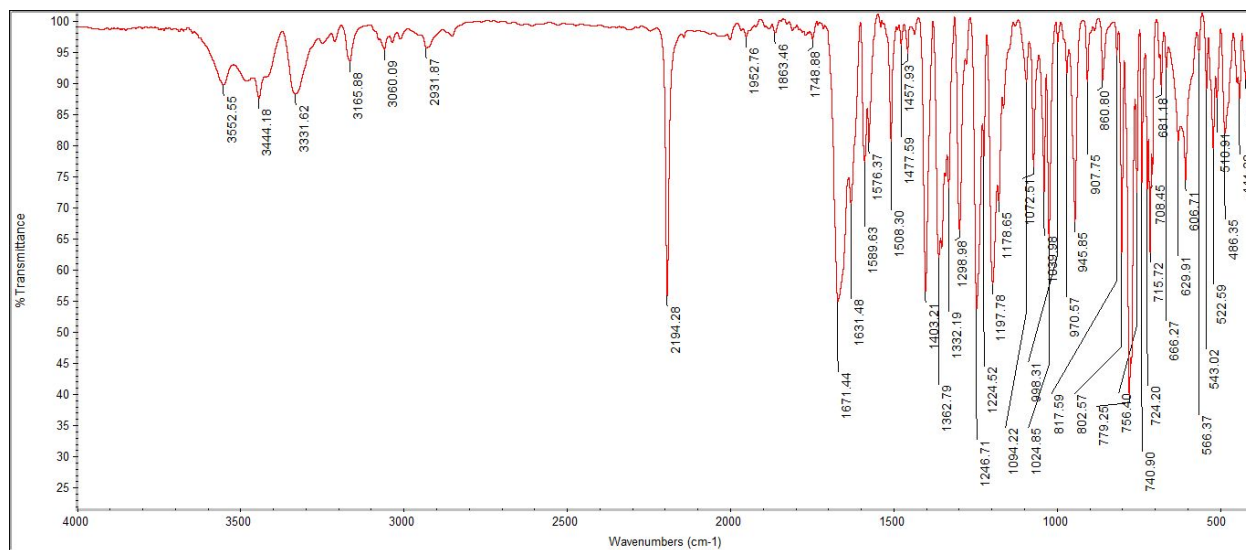


**Figure S30.**  $^1\text{H}$  NMR spectrum of 2-amino-4-(4-cyanophenyl)-5,10-dioxo-5,10-dihydro-4H-benzo[g]chromene-3-carbonitrile

Sobhan-Rezayati-chrom-22-1400-2-25

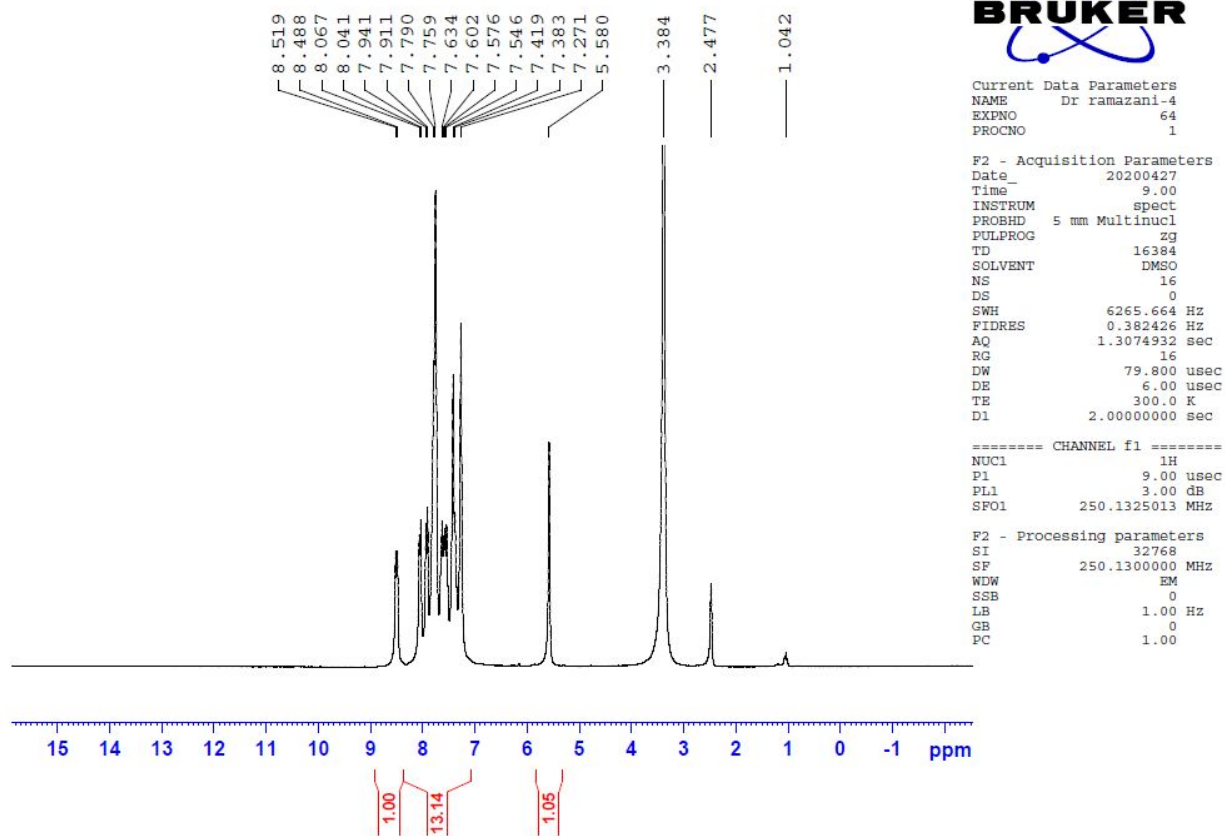


**Figure S31.**  $^{13}\text{C}$  NMR spectrum of 2-amino-4-(4-cyanophenyl)-5,10-dioxo-5,10-dihydro-4H-benzo[g]chromene-3-carbonitrile



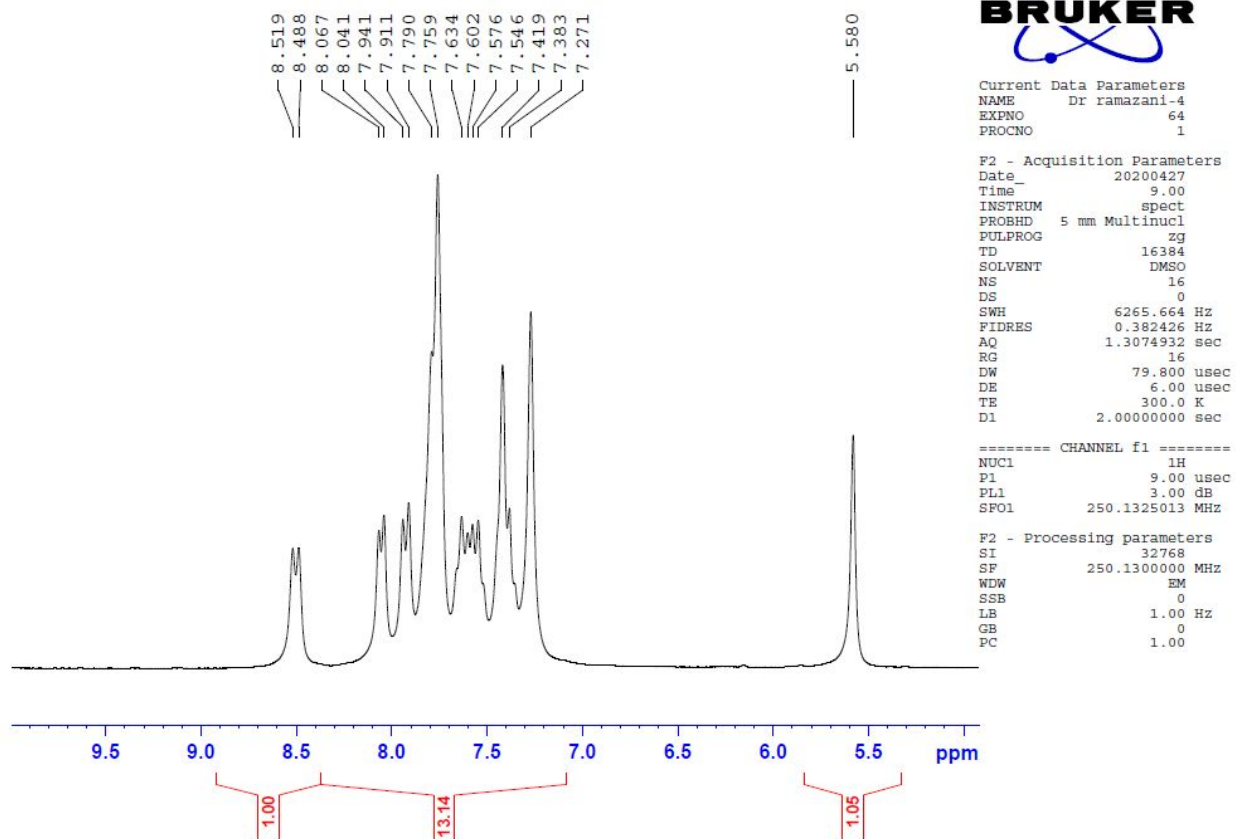
**Figure S32.** FT-IR spectrum of 2-amino-4-(1-naphtyl)-5,10-dioxo-5,10-dihydro-4H-benzo[g]chromene-3-carbonitrile

Rezayati-Chrome-13-1400-2-6

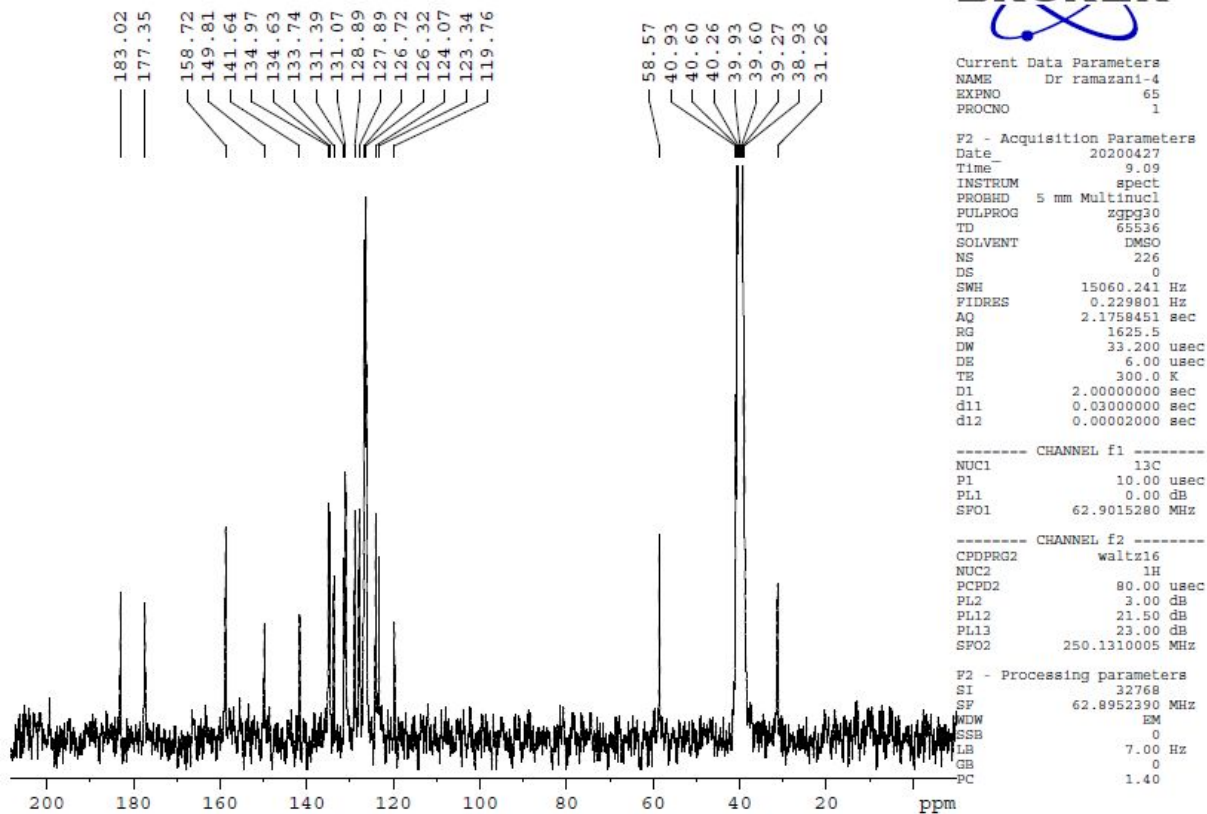


**Figure S33.**  $^1\text{H}$  NMR spectrum of 2-amino-4-(1-naphthyl)-5,10-dioxo-5,10-dihydro-4H-benzo[g]chromene-3-carbonitrile

Rezayati-Chrome-13-1400-2-6

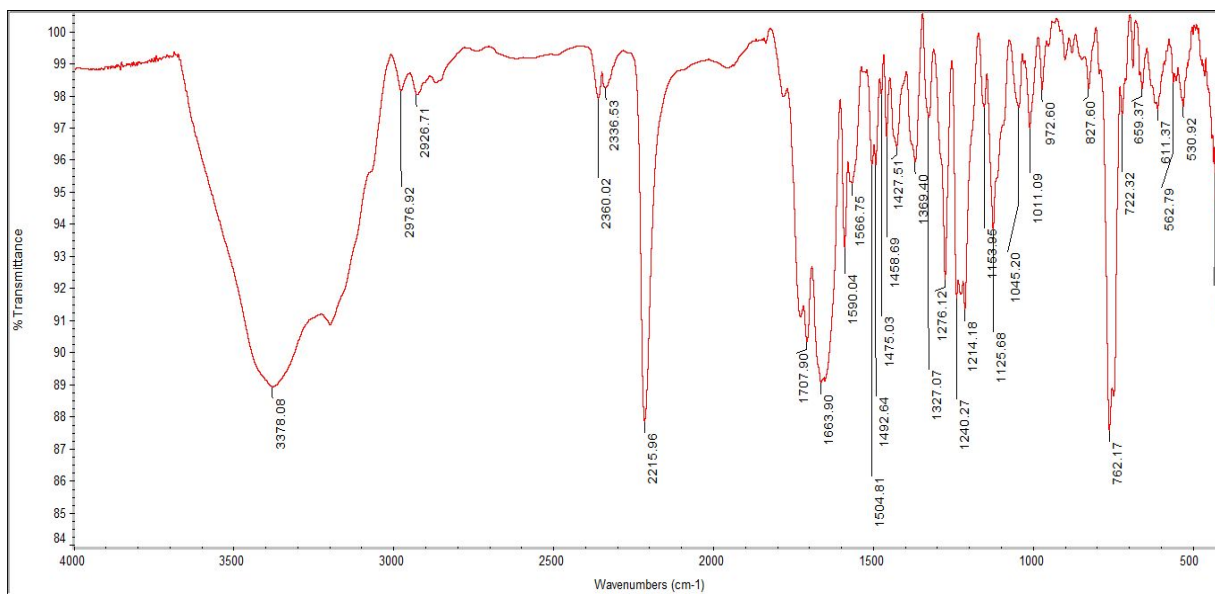


**Figure S34.** The expanded  $^1\text{H}$  NMR spectrum of 2-amino-4-(1-naphthyl)-5,10-dioxo-5,10-dihydro-4*H*-benzo[*g*]chromene-3-carbonitrile



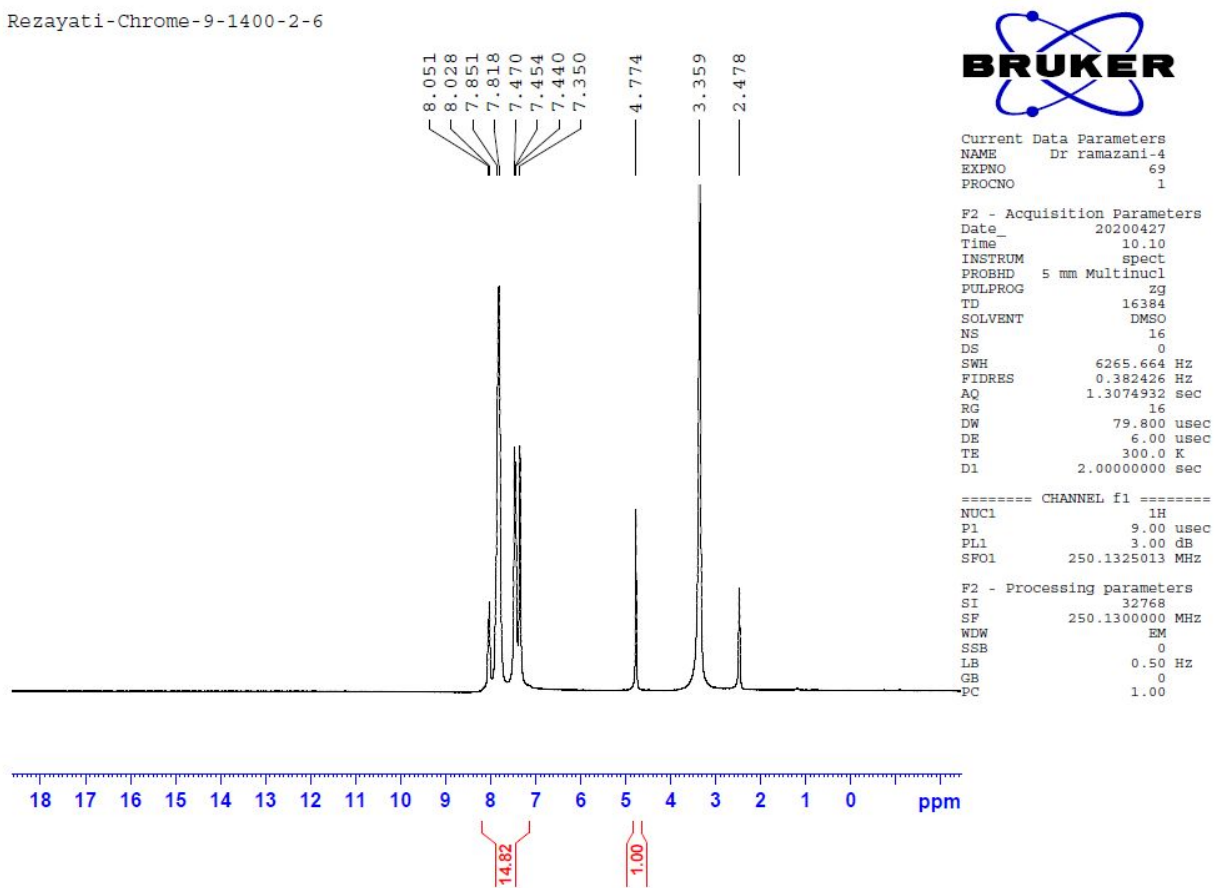
**Figure S35.** <sup>13</sup>C NMR spectrum of 2-amino-4-(1-naphtyl)-5,10-dioxo-5,10-dihydro-4H-benzo[g]chromene-3-carbonitrile





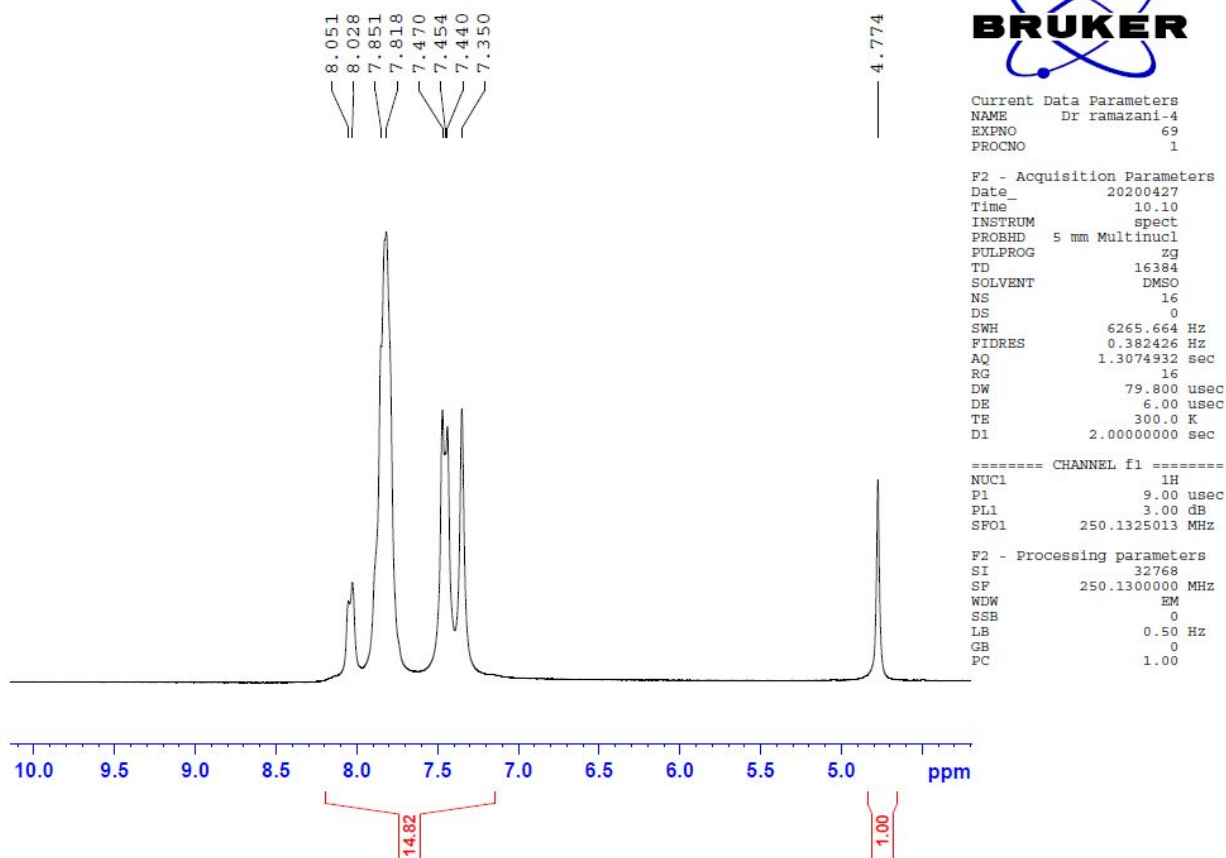
**Figure S36.** FT-IR spectrum of 2-amino-4-(2-naphthyl)-5,10-dioxo-5,10-dihydro-4*H*-benzo[*g*]chromene-3-carbonitrile

Rezayati-Chrome-9-1400-2-6

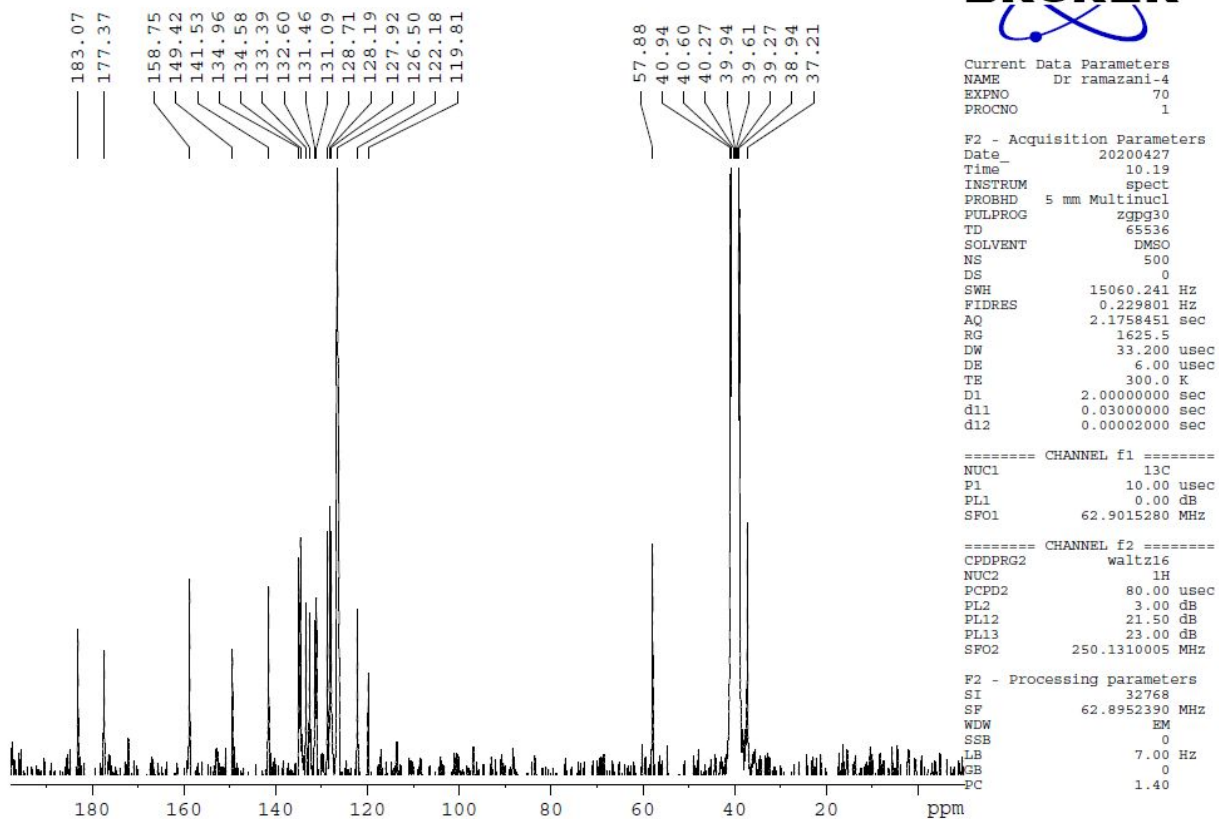


**Figure S37.**  $^1\text{H}$  NMR spectrum of 2-amino-4-(2-naphthyl)-5,10-dioxo-5,10-dihydro-4*H*-benzo[*g*]chromene-3-carbonitrile

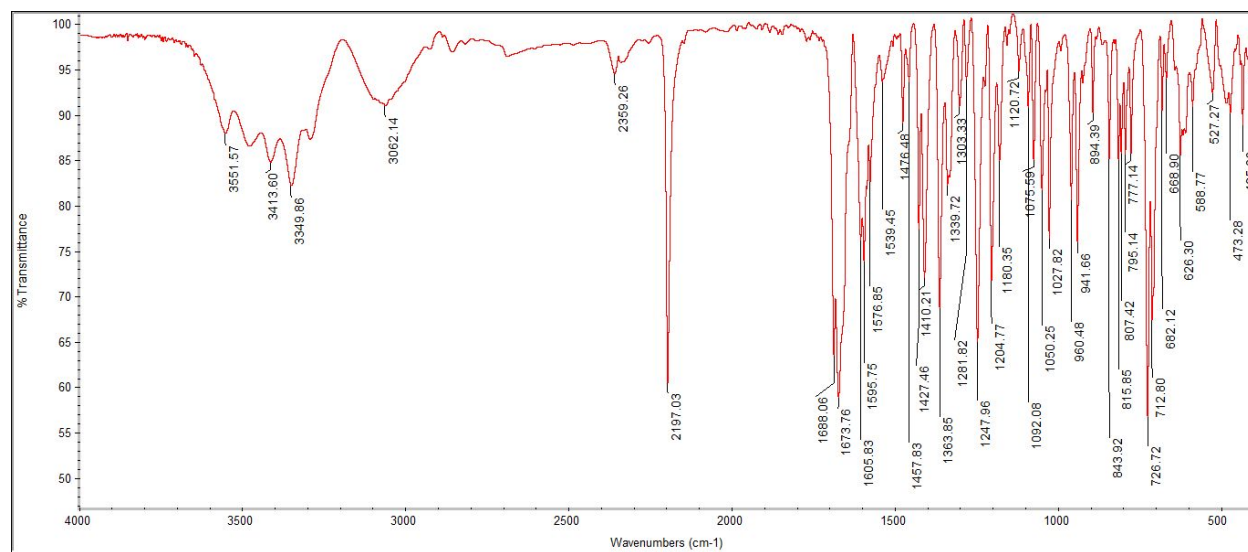
Rezayati-Chrome-9-1400-2-6



**Figure S38.** The expanded  $^1\text{H}$  NMR spectrum of 2-amino-4-(2-naphthyl)-5,10-dioxo-5,10-dihydro-4*H*-benzo[*g*]chromene-3-carbonitrile

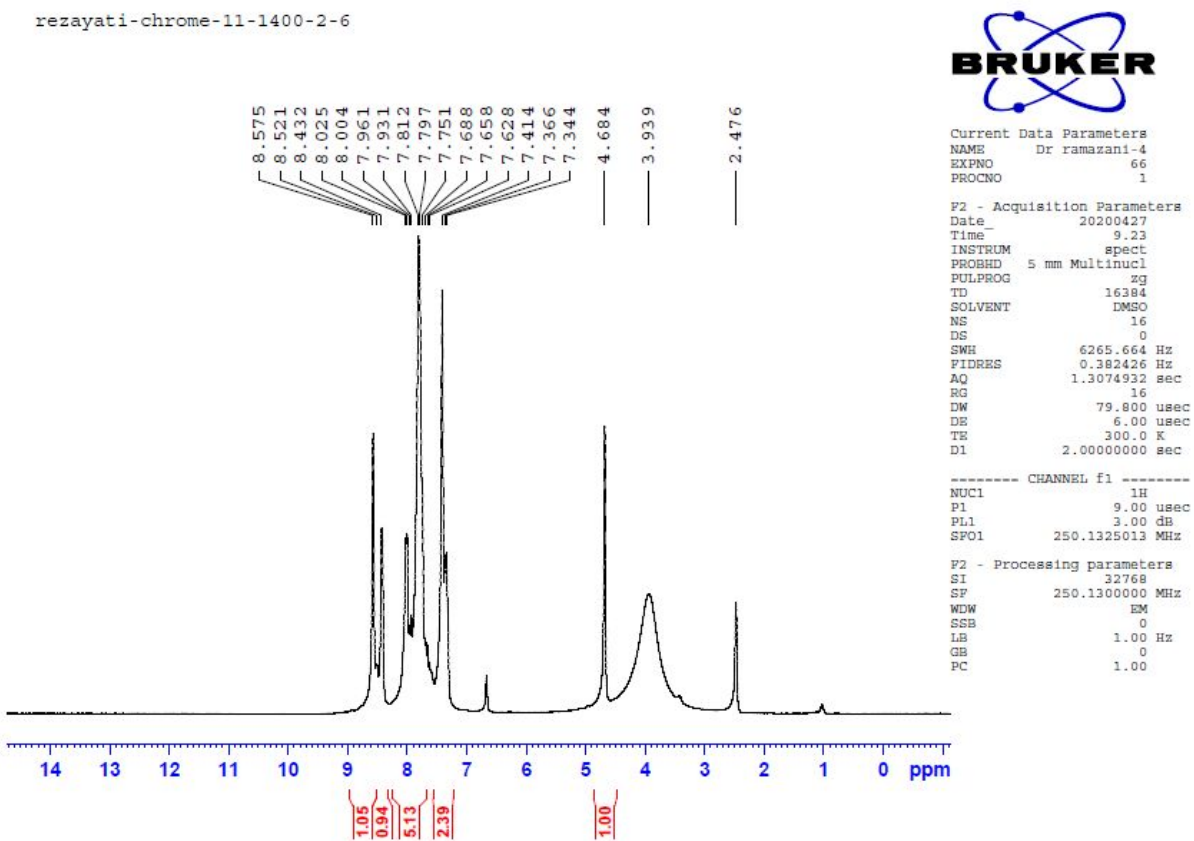


**Figure S39.** <sup>13</sup>C NMR spectrum of 2-amino-4-(2-naphthyl)-5,10-dioxo-5,10-dihydro-4H-benzo[g]chromene-3-carbonitrile



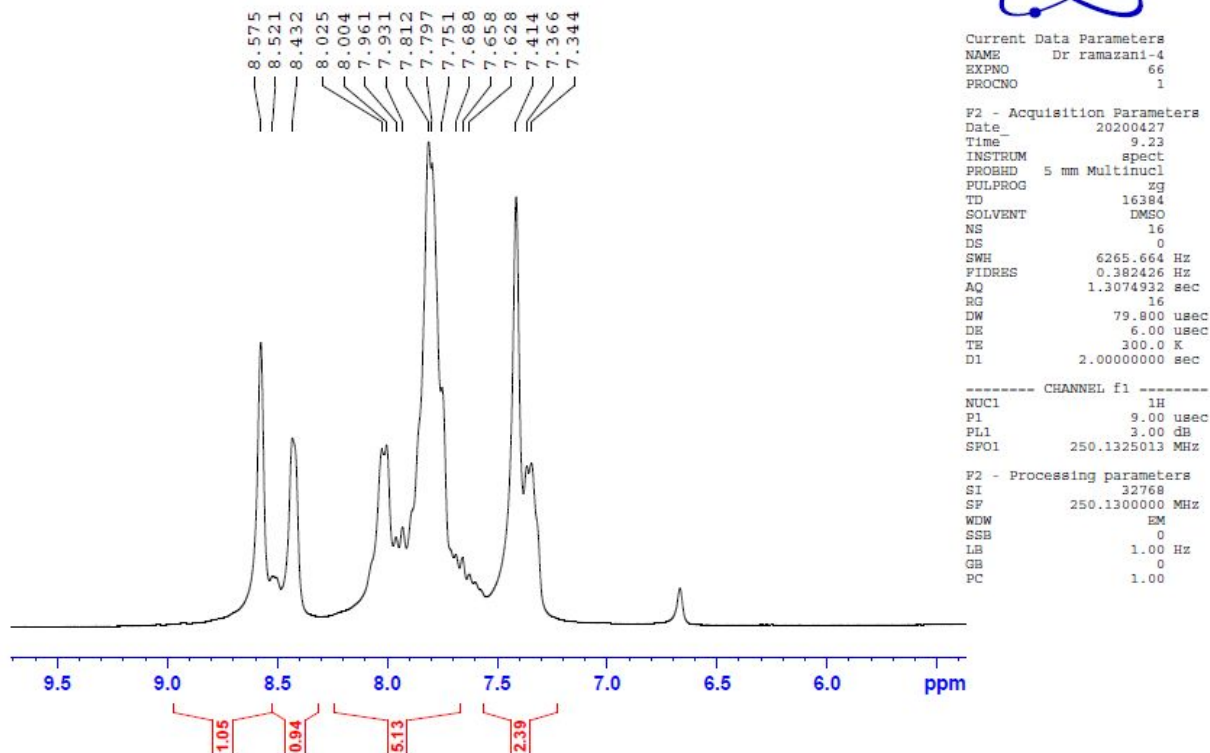
**Figure S40.** FT-IR spectrum of 2-amino-4-(pyridin-3-yl)-5,10-dioxo-5,10-dihydro-4H-benzo[g]chromene-3-carbonitrile

rezayati-chrome-11-1400-2-6

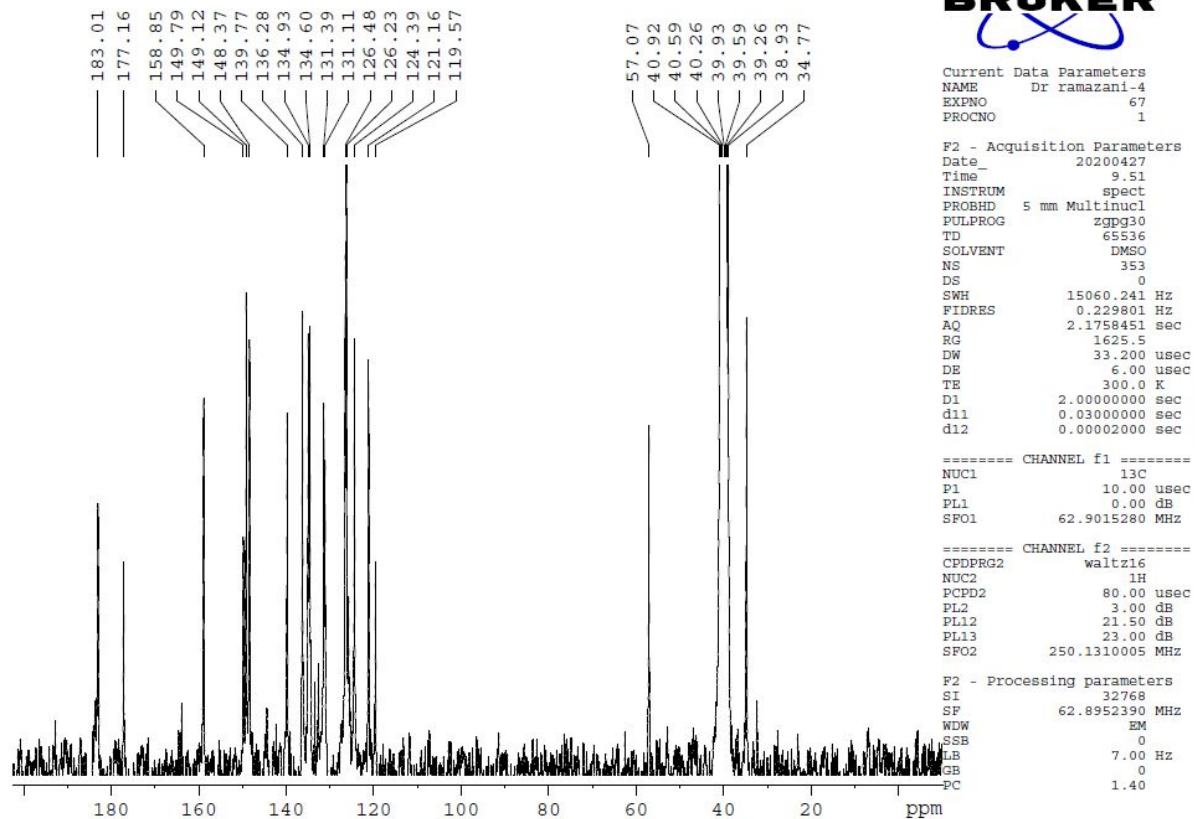


**Figure S41.**  $^1\text{H}$  NMR spectrum of 2-amino-4-(pyridin-3-yl)-5,10-dioxo-5,10-dihydro-4H-benzo[g]chromene-3-carbonitrile

rezayati-chrome-11-1400-2-6

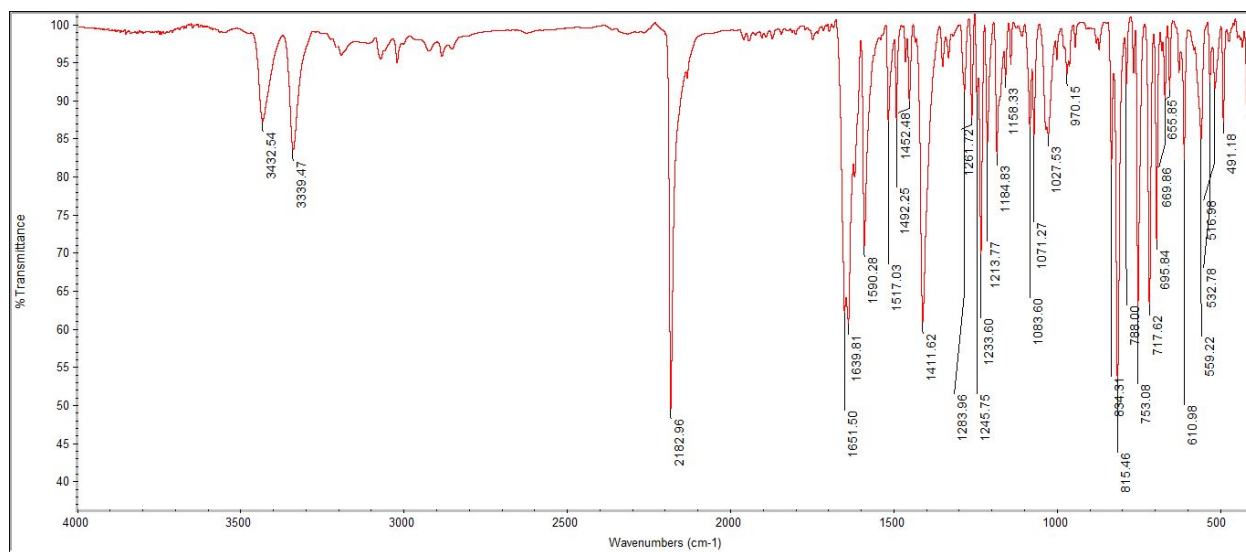


**Figure S42.** The expanded  $^1\text{H}$  NMR spectrum of 2-amino-4-(pyridin-3-yl)-5,10-dioxo-5,10-dihydro-4*H*-benzo[*g*]chromene-3-carbonitrile



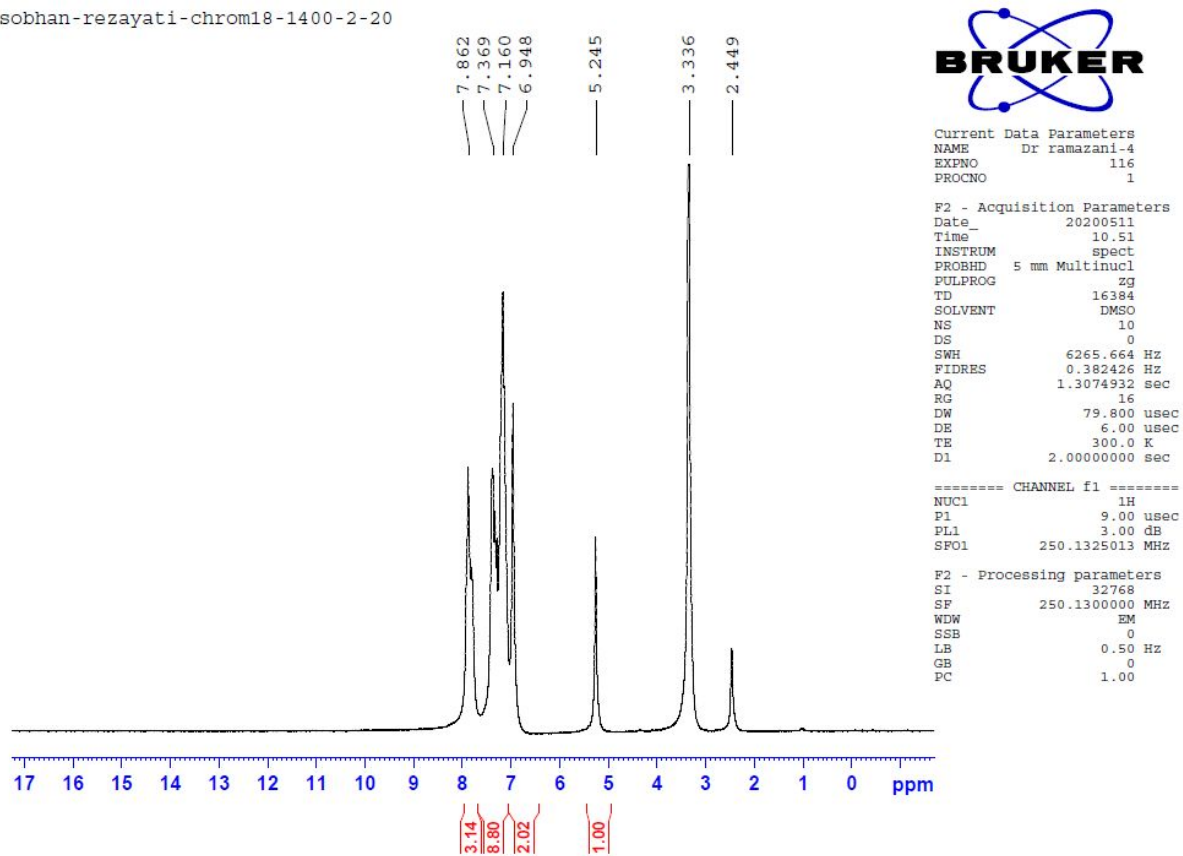
**Figure S43.**  $^{13}\text{C}$  NMR spectrum of 2-amino-4-(pyridin-3-yl)-5,10-dioxo-5,10-dihydro-4H-benzo[g]chromene-3-carbonitrile





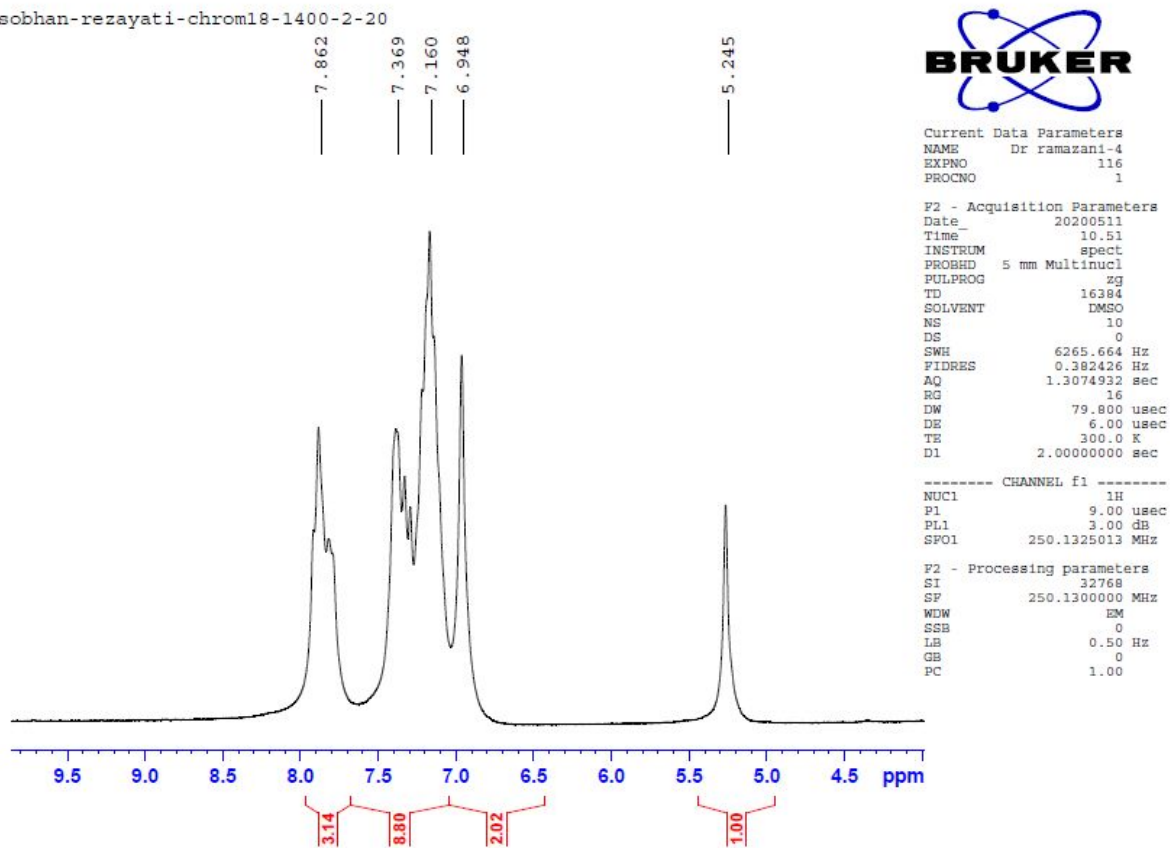
**Figure S44.** FT-IR spectrum of 3-amino-1-phenyl-1H-benzo[f]chromene-2-carbonitrile

sobhan-rezayati-chrom18-1400-2-20



**Figure S45.**  $^1\text{H}$  NMR spectrum of 3-amino-1-phenyl-1H-benzo[f]chromene-2-carbonitrile

sobhan-rezayati-chrom18-1400-2-20



**Figure S46.** The expanded  $^1\text{H}$  NMR spectrum of 3-amino-1-phenyl-1H-benzo[f]chromene-2-carbonitrile

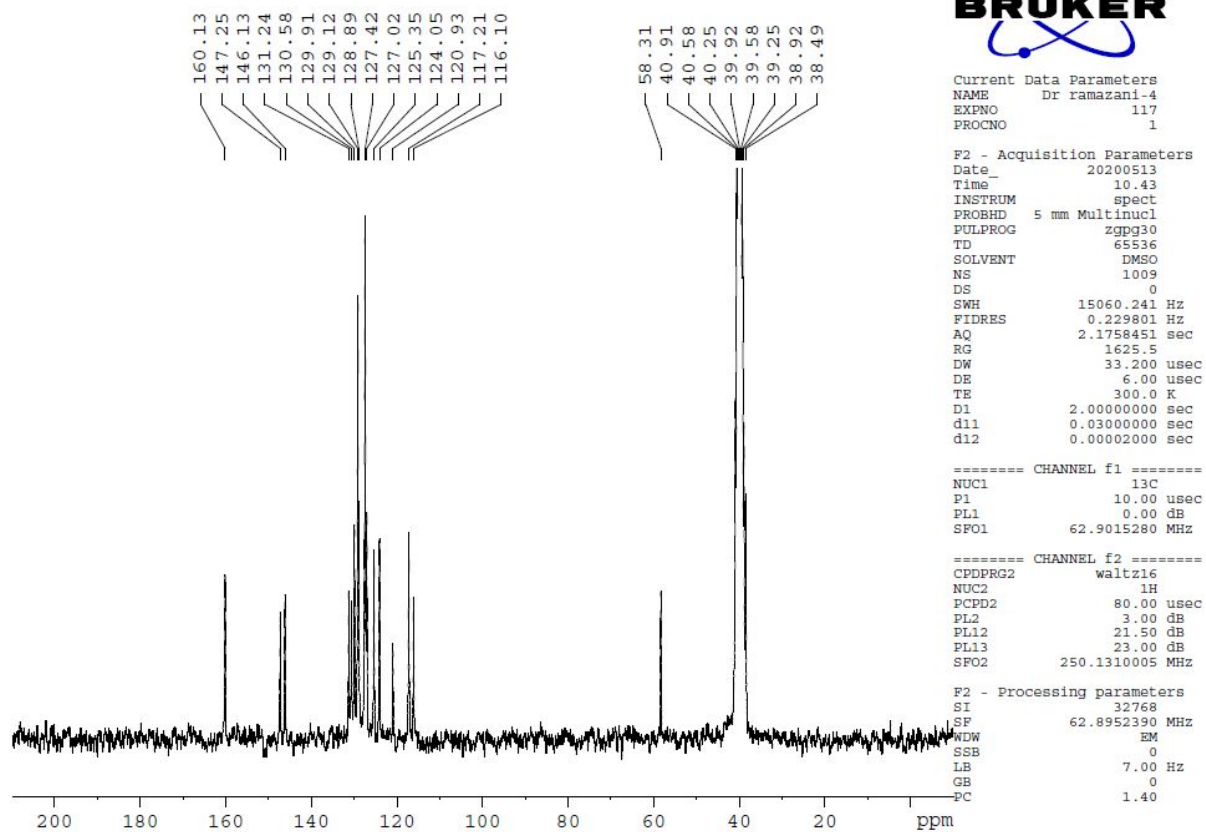
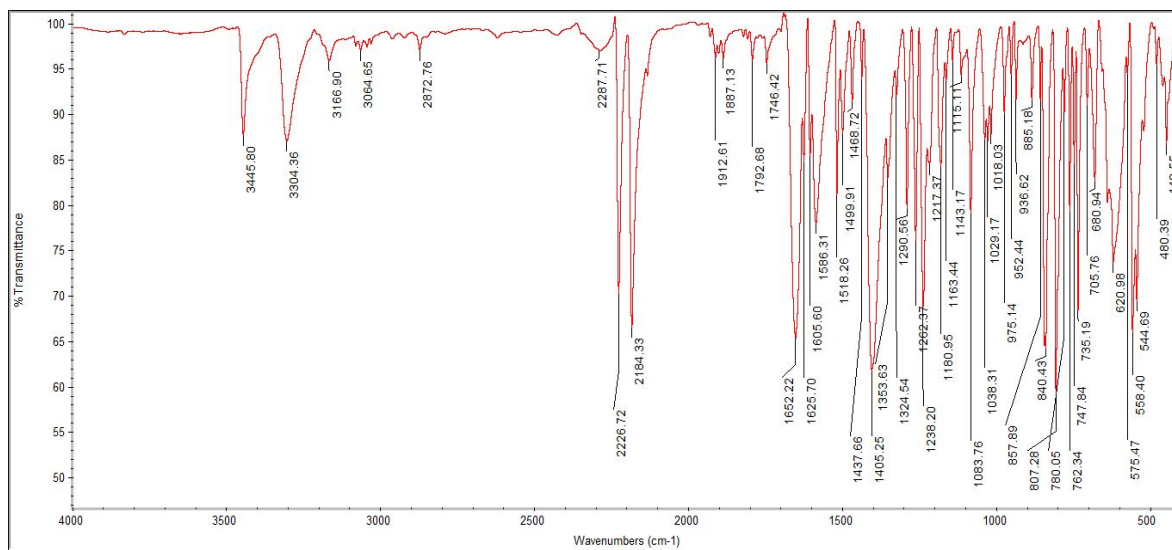
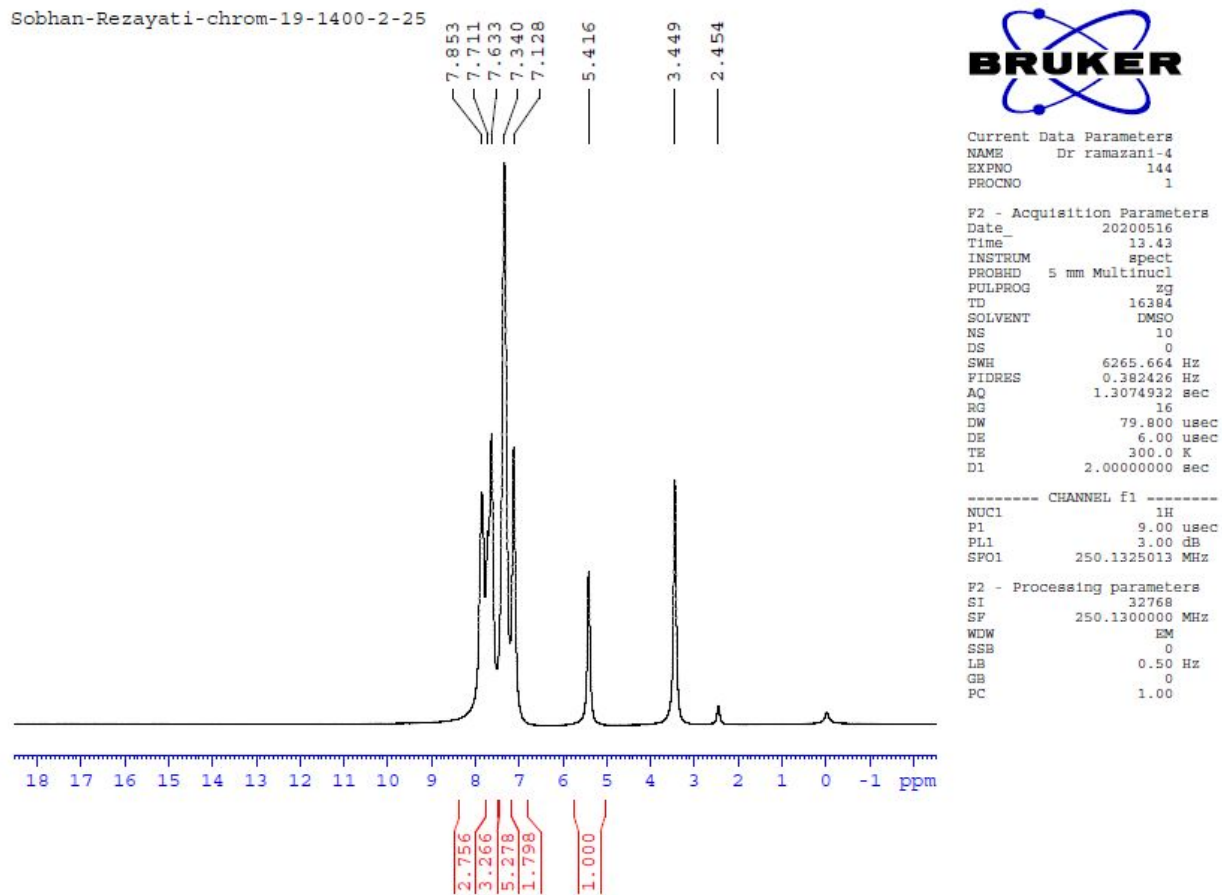


Figure S47. <sup>13</sup>C NMR spectrum of 3-amino-1-phenyl-1H-benzo[f]chromene-2-carbonitrile

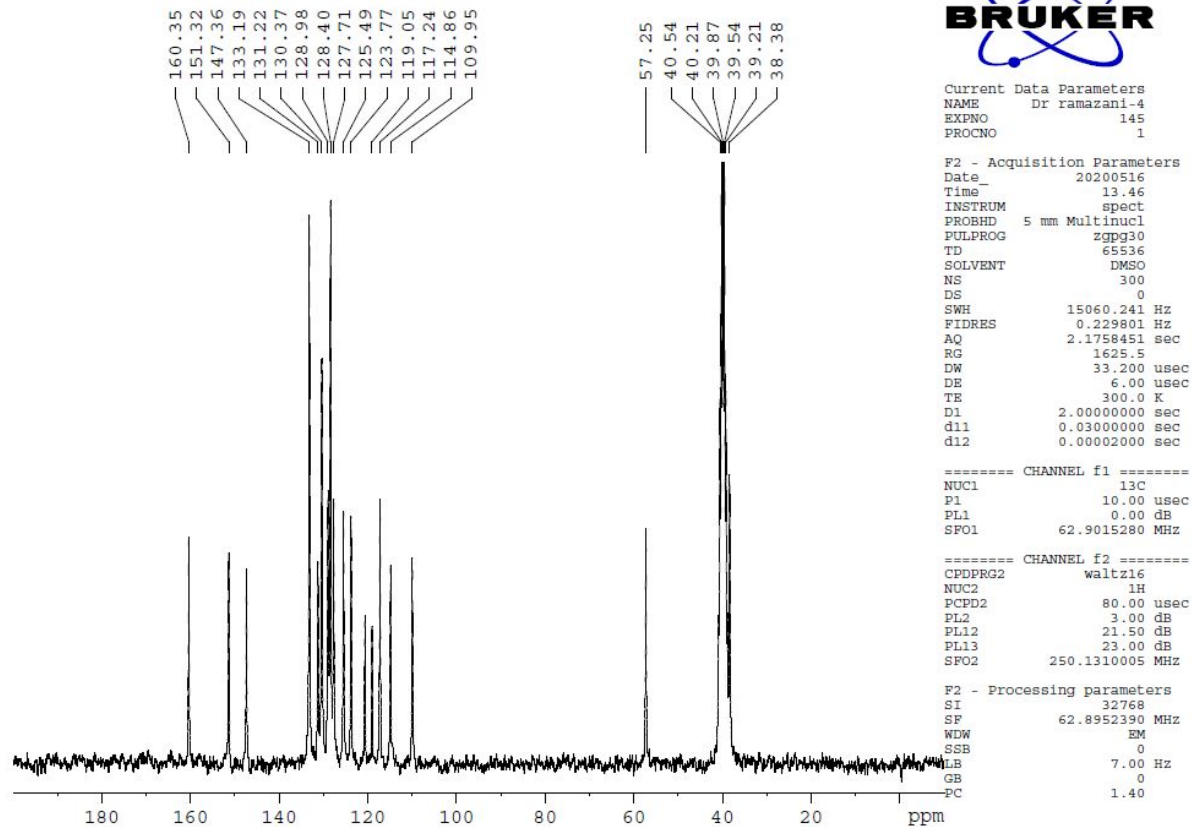


**Figure S48.** FT-IR spectrum of 3-amino-1-(4-cyanophenyl)-1H-benzo[f]chromene-2-carbonitrile (6c)

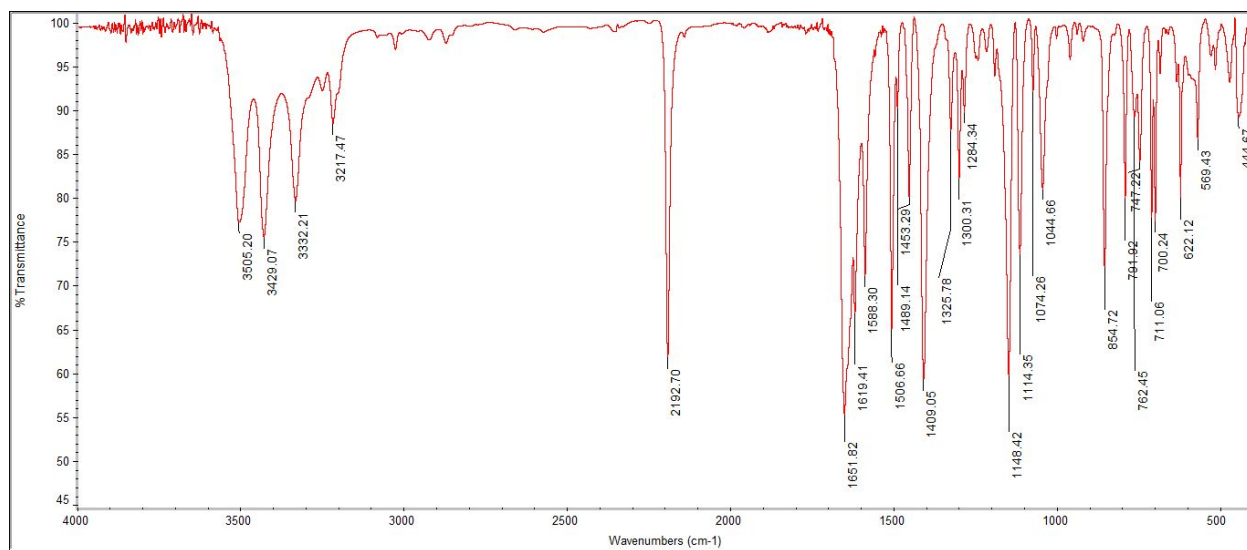
Sobhan-Rezayati-chrom-19-1400-2-25



**Figure S49.**  $^1\text{H}$  NMR spectrum of 3-amino-1-(4-cyanophenyl)-1H-benzo[f]chromene-2-carbonitrile



**Figure S50.** <sup>13</sup>C NMR spectrum of 3-amino-1-(4-cyanophenyl)-1H-benzo[f]chromene-2-carbonitrile



**Figure S51.** FT-IR spectrum of 2-amino-7-hydroxy-4-phenyl-4Hchromene-3-carbonitrile



Sobhan-rezayati-chrom14-1400-2-20

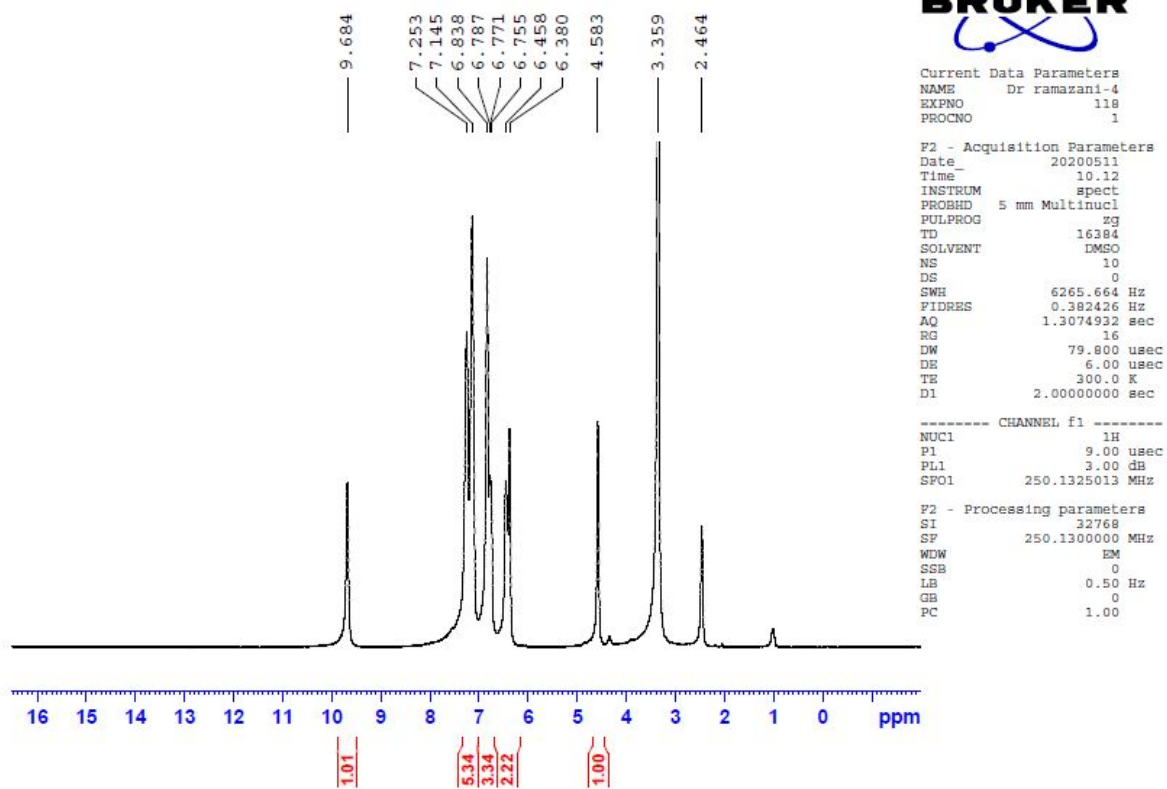
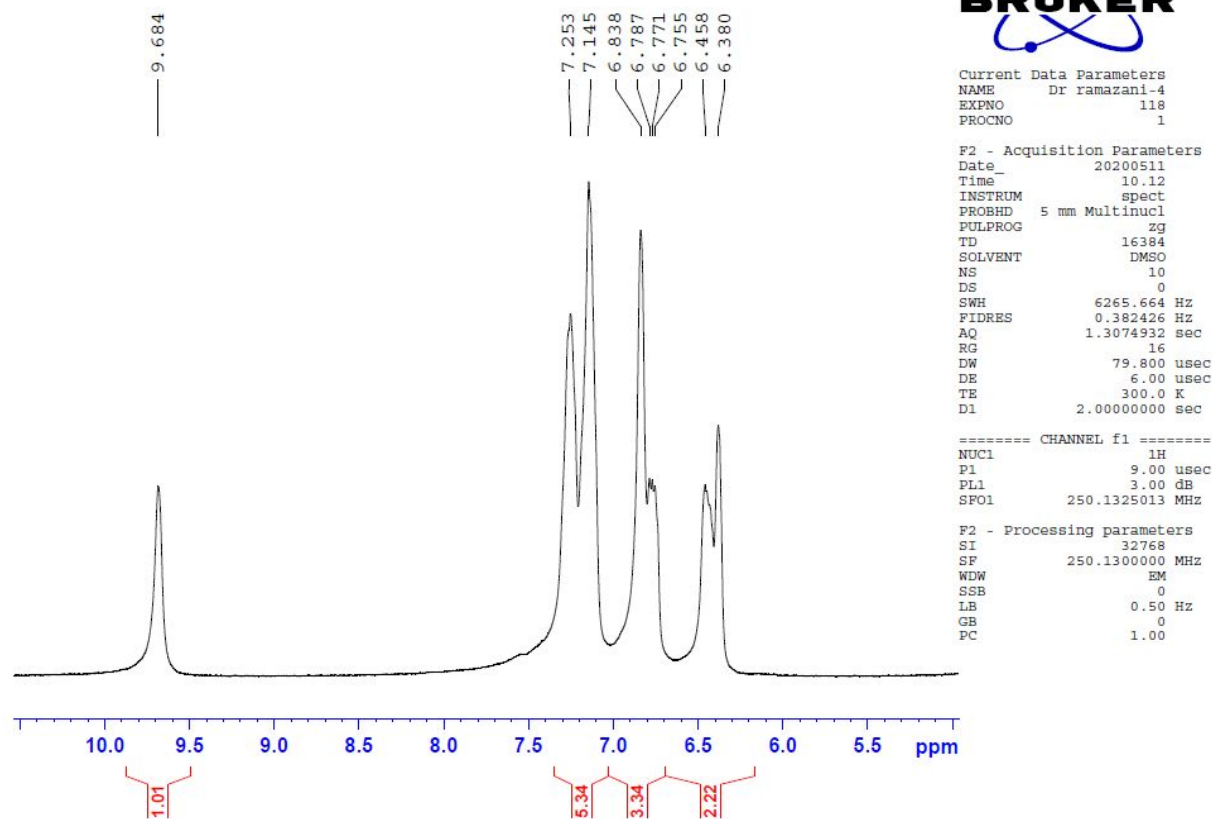


Figure S52. <sup>1</sup>H NMR spectrum of 2-amino-7-hydroxy-4-phenyl-4Hchromene-3-carbonitrile



**Figure S53.** <sup>1</sup>H NMR expand spectrum of 2-Amino-7-hydroxy-4-phenyl-4Hchromene-3-carbonitrile

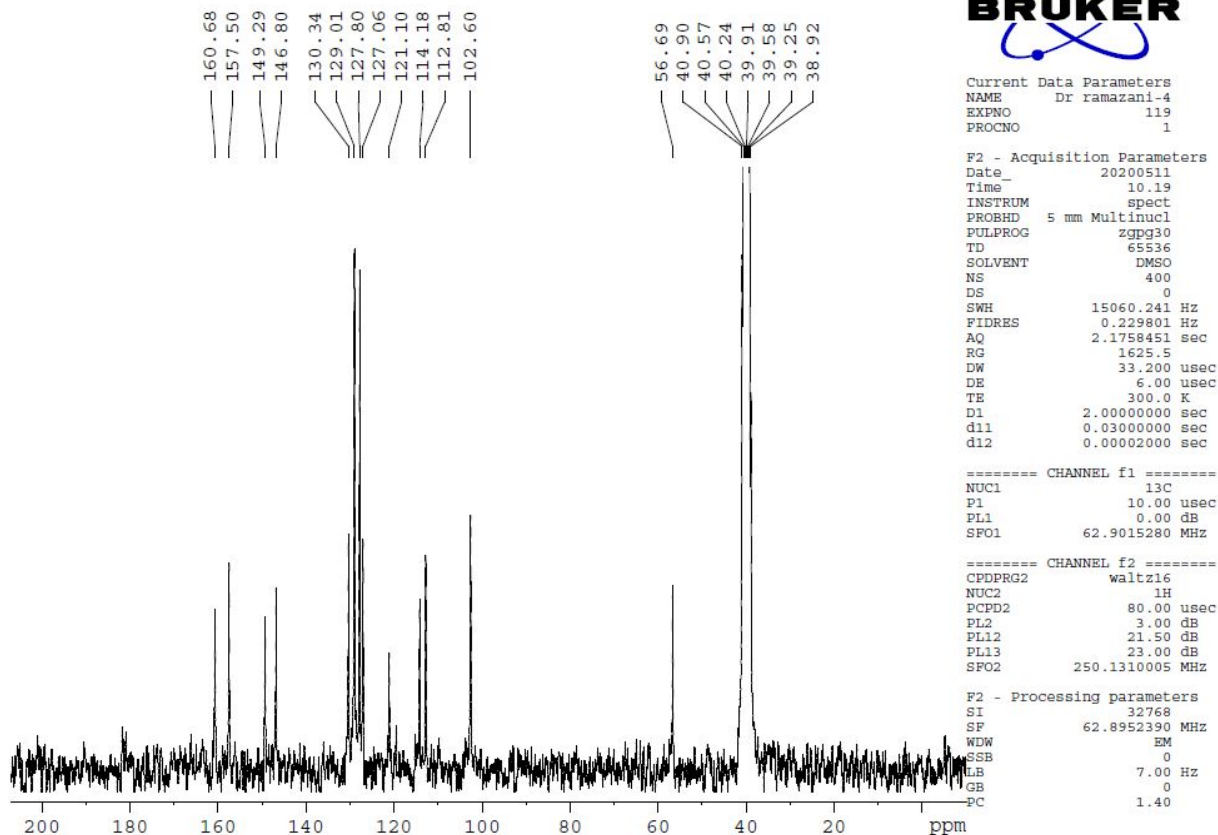
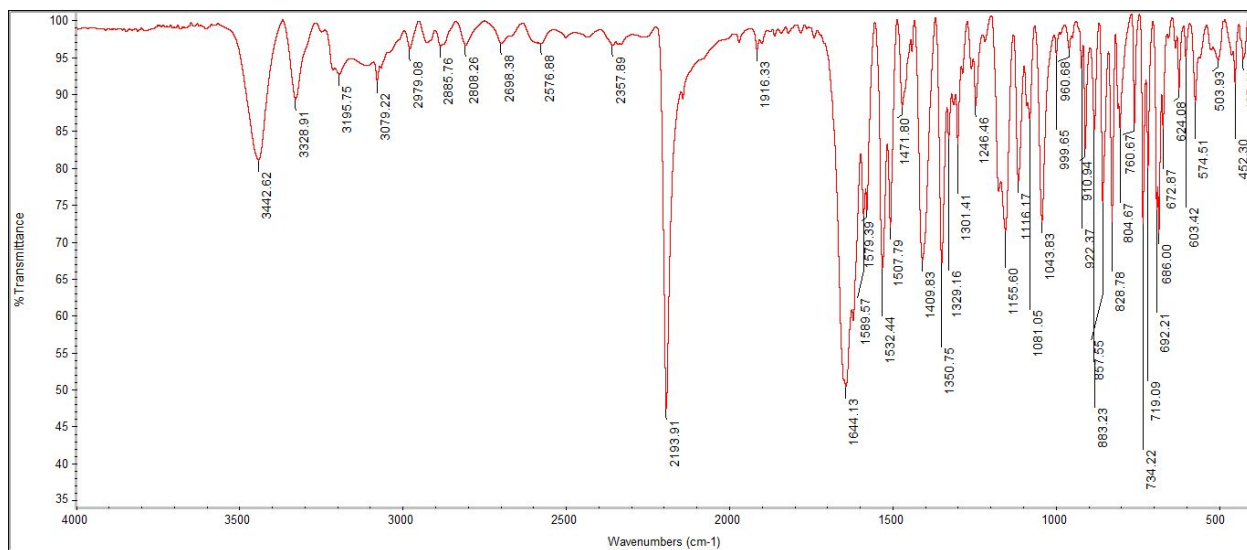
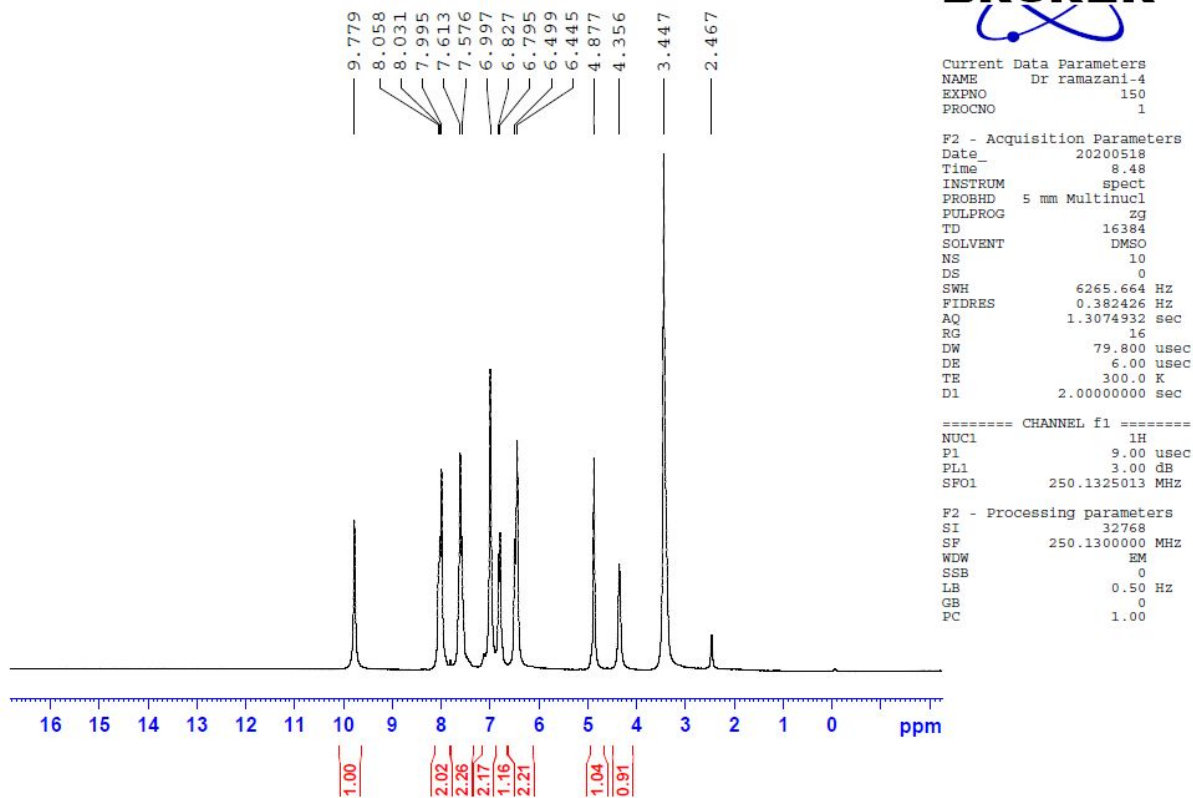


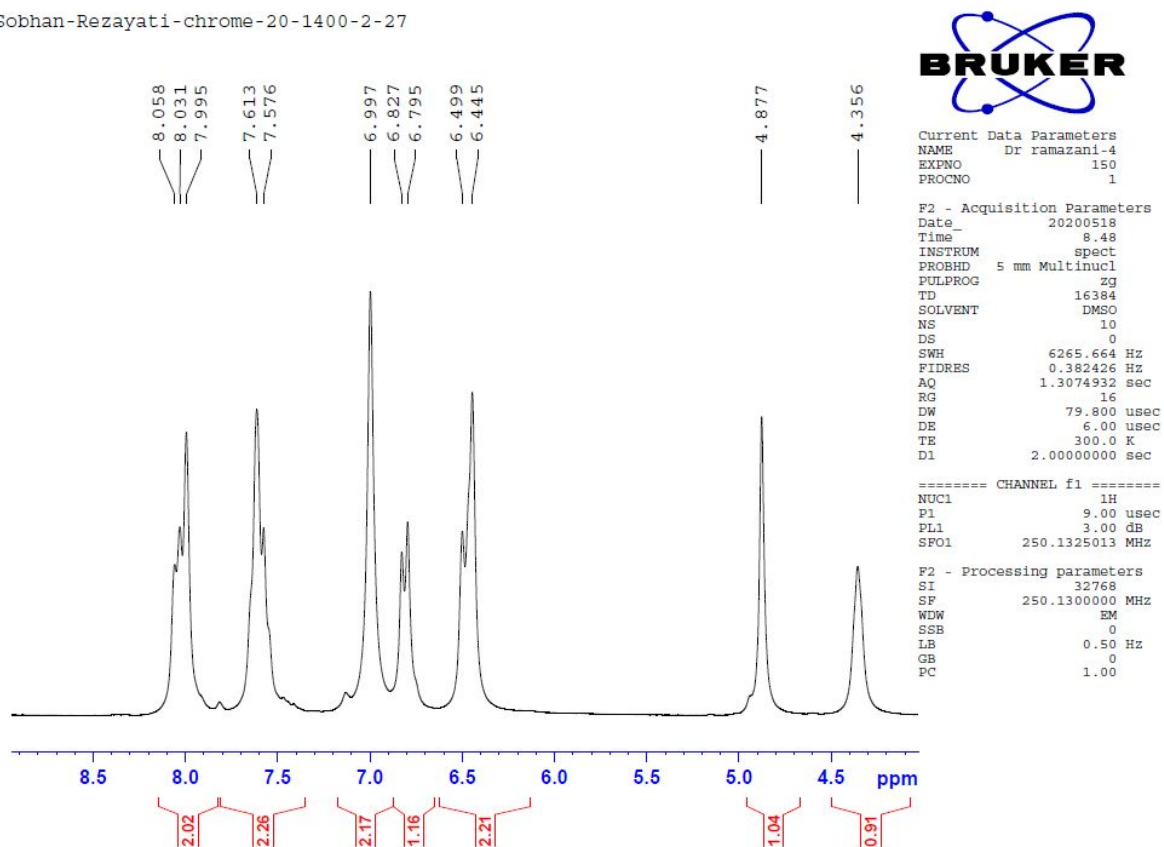
Figure S54. <sup>13</sup>C NMR spectrum of 2-amino-7-hydroxy-4-phenyl-4Hchromene-3-carbonitrile



**Figure S55.** FT-IR spectrum of 2-amino-7-hydroxy-4-(3-nitrophenyl)-4*H*-chromene-3-carbonitrile

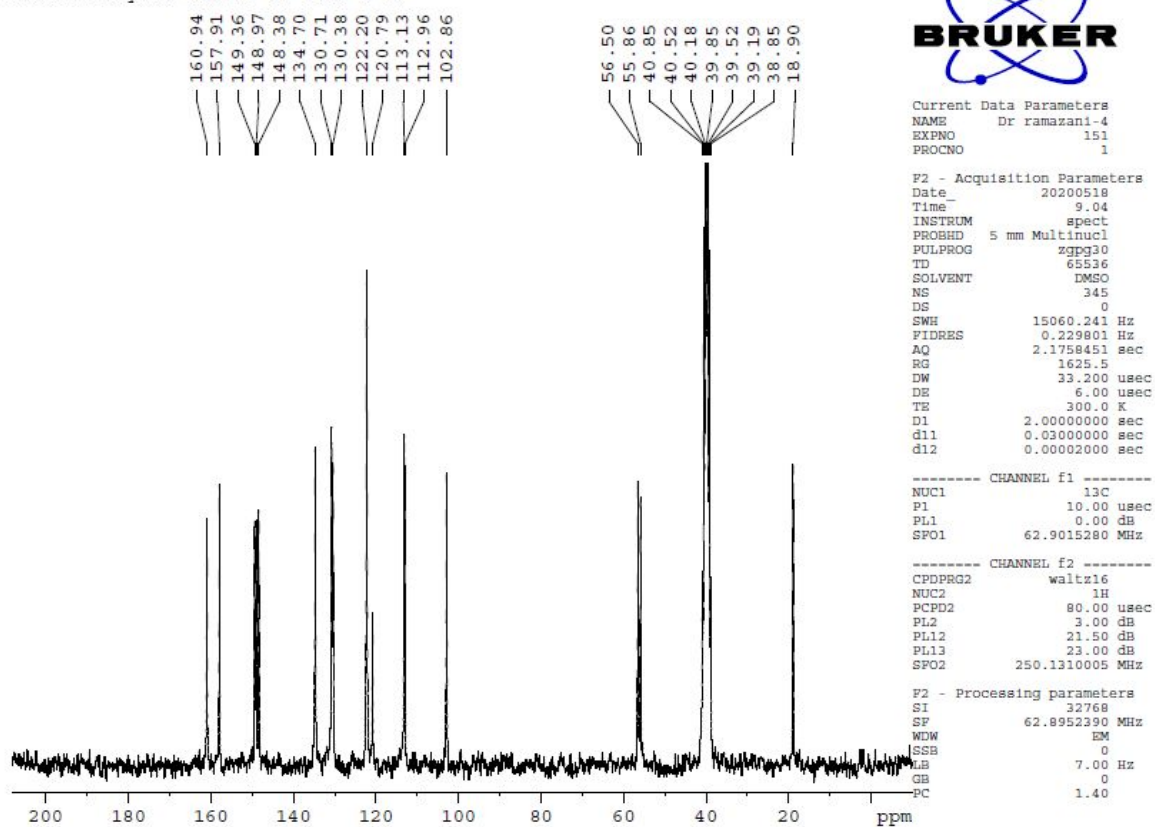


**Figure S56.**  $^1\text{H}$  NMR spectrum of 2-amino-7-hydroxy-4-(3-nitrophenyl)-4*H*-chromene-3-carbonitrile



**Figure S57.** The expanded  $^1\text{H}$  NMR spectrum of 2-amino-7-hydroxy-4-(3-nitrophenyl)-4*H*-chromene-3-carbonitrile

Sobhan-Rezayati-chrome-20-1400-2-27



**Figure S58.**  $^{13}\text{C}$  NMR spectrum of 2-amino-7-hydroxy-4-(3-nitrophenyl)-4*H*-chromene-3-carbonitrile