



“ज्ञान, विज्ञान आणि सुसंस्कार यासाठी शिक्षणप्रसार”

-सिद्धान्तमहर्षी डॉ. वापूजी साळुंगे .



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**VIVEKANAND COLLEGE KOLHAPUR  
(AUTONOMOUS)**

**NAAC Re Accredited 'A'**

**DEPARTMENT OF CHEMISTRY**

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**TITLE: Synthesis of Dihydropyrano[3,2-c]chromenes Using  
DABCO Surfactant in Water**

**Submitted to**

**Department of Chemistry**

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**The Award of M. Sc. Degree in Organic Chemistry**

**By**

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**2022 - 23**



“ज्ञान, विज्ञान आणि युगंकार यासाठी शिक्षणप्रसार”

-शिक्षणमहर्षी डॉ. वापूजी मालुंगे.

Shri. Swami Vivekanand Shikshan Sanstha's



VIVEKANAND COLLEGE KOLHAPUR  
(AUTONOMOUS)

PG DEPARTMENT OF CHEMISTRY

## Certificate

This is to certify that the project report entitled **Synthesis of Dihydropyrano[3,2-c] chromenes Using DABCO Surfactant in Water** submitted by Ms. AARTI ASHOK SAWANT, Mrs. NAMRATA VISHWANATH GHORPADE, Mr. SOURABH SUNIL PATIL in fulfilment of the project work, prescribed by **SHIVAJI UNIVERSITY, KOLHAPUR** for **M. Sc. II** course in **Organic Chemistry** have been completed satisfactorily under my guidance during the academic year 2022-2023. The conclusions drawn are based on the experimental work carried by them.

To the best of my knowledge and belief, the matter presented here is original and has not been submitted earlier.

Place: Kolhapur

Date: 05-07-2023

Prof. (Dr.) A. S. Kumbhar  
(Project guide)

Dr. (Mrs) S. D. Shirke  
Head,  
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Head  
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Examiner

# Declaration

We are Ms. AARTI ASHOK SAWANT, Mrs. NAMRATA VISHWANATH GHORPADE, Mr. SOURABH SUNIL PATIL The student of PG Department of Chemistry, Vivekanand College, Kolhapur (Autonomous) hereby declare that the project entitled **Synthesis of Dihydropyrano[3,2-c]chromenes Using DABCO Surfactant in Water** written and submitted by me under the guidance of **Prof. (Dr). A. S. Kumbhar** is our original work. The empirical findings presented in this report are based on experimental work carried by us during the course of the project work. I, hereby declare that work has been done by us and it has not previously formed the basis for the award of any degree or diploma.

Place: Kolhapur

Date: 05-07-2023

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## Synthesis of Dihydropyrano[3,2-c]chromenes Using DABCO Surfactant in Water

### Abstract

We report DABCO catalyzed one-pot synthesis of 3,4-dihydropyrano[3,2-c]chromenes, from aldehydes, active methylene compounds malononitrile and 4-hydroxycoumarin in water at room temperature. The attractive features of this process are mild reaction conditions, short reaction times, easy isolation of products, and excellent yields.

### Introduction

Multicomponent reactions (MCRs), involving domino processes with more than two reactants, have emerged as an attractive and powerful strategy for organic synthesis. Compared with classical linear multistep reactions, MCRs have the advantages of high atom economy, great synthetic efficiency, low number of reaction and purification steps, the creation of several new bonds in a one-pot procedure [1]. Water is the most readily available and nontoxic reaction medium, which makes it a promising solvent for green chemistry [2]. Thus, the development of MCRs in water is a popular research area in current organic chemistry.

3,4-dihydropyrano[3,2-c]chromene derivatives are important heterocycles with a wide range of biological and pharmacological properties, such as diuretic, spasmolytic, analgesic, anti-cancer, anticoagulant, anti-anaphylactic, anti-tumor [3-6]. In general, 3,4-dihydropyrano[3,2-c]chromenes are accessible through the one-pot three-component reaction of aromatic aldehyde, malononitrile, and 4-hydroxycoumarin in the presence of basic

catalyst in organic solvent. In recent studies, several methods for the preparation of these heterocyclic compounds have been reported with various catalysts such as diammonium hydrogen phosphate (DAHP) [7], high surface area MgO [8], heteropolyacid (HPA) [9], tetrabutylammonium bromide (TBAB) [10], sodium dodecyl sulfate (SDS) [11], 1,8-diazabicyclo[5.4.0] undec-7-ene (DBU) [12], hexamethylenetetramine (HMT) [13], 4-(dimethylamino)pyridine (DMAP) [14], CuO nanoparticles [15], N,N',N',N'-tetrabromobenzene-1,3-disulfonamide [TBBDA] and poly(N,N'-dibromo-N-ethylbenzene-1,3-disulfonamide) [PBBS] [16], trisodium citrate [17], Ru(II) complexes bearing tertiary phosphine ligands [18], (2-aminomethyl)phenol moiety supported on HAp-encapsulated- $\gamma$ -Fe<sub>2</sub>O<sub>3</sub> ([ $\gamma$ -Fe<sub>2</sub>O<sub>3</sub>@HApSi-(CH<sub>2</sub>)<sub>3</sub>-AMP]) [19], amberlyst A21 [20], nano magnetic double-charged diazoniabicyclo[2.2.2]octane dichloride silica hybrid [21], cetyltrimethyl ammonium bromide bentonite (CTMAB-bentonite) [22], titanium dioxide nanowires [23], cellulose-SO<sub>3</sub>H [24], thiourea dioxide [25], potassium sodium tartrate [26]. At the same time, a variety of technologies including the use of microwave irradiation [27], ultrasonic irradiation [28] and electrocatalytic system [29] were found to be efficient to promote them. However, each of the reported methods suffer from one or more disadvantages, such as harsh reaction conditions, long reaction times, low product yields, poor catalyst recyclability, application of special equipment and laborious workup procedures. Based on their extensive application, it is necessary to further develop an efficient and convenient method to construct such valuable heterocyclic compounds.



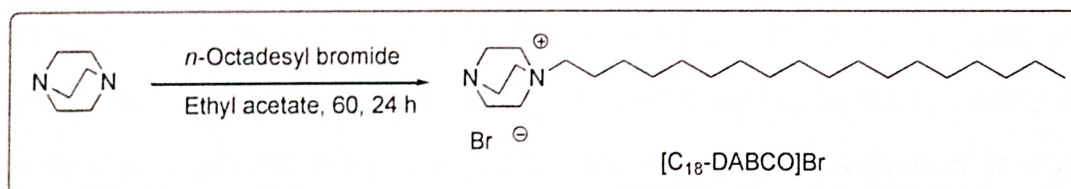
Though all these methodologies have found their importance, some of these methods have displayed fewer drawbacks, such as environmental hazards caused by using toxic solvents, long reaction times, moderate yields, and stoichiometric amounts of catalyst.

### Present Work

In this communication, we would like to report a [C<sub>18</sub>-DABCO]Br (10 mol %) acts as an efficient and reusable basic 'Gemini type surfactant' for the synthesis of dihydropyrano[3,2-c]chromenes in a water medium at RT.

### Results and Discussion

**1. Synthesis of [C<sub>18</sub>-DABCO-C<sub>18</sub>]Br<sub>2</sub>:** It was simply synthesized with 95 % yield by mono quaternization of DABCO with octadecyl bromide in ethyl acetate at 60°C (**Scheme 1**) [16].



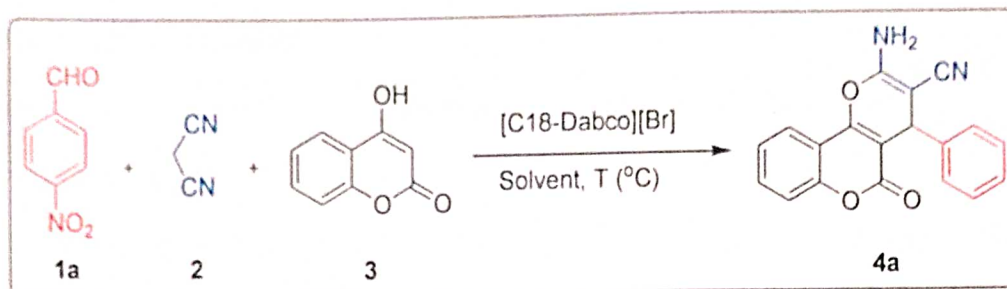
**Scheme 1:** Synthesis of [C<sub>18</sub>-DABCO-C<sub>18</sub>]Br<sub>2</sub> surfactant

**2. Applications of [C<sub>18</sub>-DABCO]Br in the synthesis of dihydropyrano[3,2-c]chromenes:** In view of the good surfactant properties of [C<sub>18</sub>-DABCO]Br and basic properties afforded by DABCO, we planned to study its catalytic properties for the synthesis of dihydropyrano[3,2-c]chromenes under environmentally benign conditions.

Initially, to optimize various reaction parameters the 4-nitrobenzaldehyde (1 mmol), malononitrile (1 mmol), and 4-



hydroxycoumarin (1 mmol) were chosen as model reaction partners in the presence of [DABCO-C<sub>18</sub>]Br in water (**Scheme 2**).



**Scheme 2:** Synthesis of dihydropyrano[3,2-c]chromenes using [C<sub>18</sub>-DABCO]Br surfactants in aqueous solution

To establish the suitable amount of the surfactant, reaction temperature, and nature of the solvent, the model reaction was carried out with varied conditions. No reaction occurred under catalyst-free conditions. However, a 94% product yield was observed in the presence of 5 mg surfactant. Increasing the amount of surfactant from 5-50 mg improved yield from 94-96 % with a slight reduction in the reaction time from 30- 20 min at room temperature. Increasing the temperature of the reaction from RT to 80 °C have an influential effect on the time of the reaction. As surfactant is soluble in solvents, we assessed its catalytic activity in these solvents. It was observed that though the surfactant worked in these solvents its catalytic activity was less as compared to water. Thus, the optimum reaction condition was found to be 5 mg surfactant in water at room temperature.

**Table 1.** Influence of quantity of [C<sub>18</sub>-DABCO]Br, solvent, and temperature on the yield and reaction time of dihydropyrano[3,2-c]chromenes in water <sup>a</sup>

Entry	Amount of [C <sub>18</sub> -DABCO]Br (mg)	Solvent	Temperature (°C)	Time (min)	Yield <sup>b</sup> (%)
1	0	H <sub>2</sub> O	RT	60	Trace
2	5	H <sub>2</sub> O	RT	30	94
3	10	H <sub>2</sub> O	RT	30	95
<b>4</b>	<b>20</b>	<b>H<sub>2</sub>O</b>	<b>RT</b>	<b>30</b>	<b>96</b>
5	30	H <sub>2</sub> O	RT	25	95
6	40	H <sub>2</sub> O	RT	25	96
7	50	H <sub>2</sub> O	RT	25	96
8	5	H <sub>2</sub> O	40	20	91
9	5	H <sub>2</sub> O	80	30	90
10	5	H <sub>2</sub> O	100	35	90
11	5	EtOH	RT	40	89
12	5	EtOH:H <sub>2</sub> O(1:1)	RT	40	88
13	5	DMF	RT	50	87
14	5	DCM	RT	60	85
15	5	CH <sub>3</sub> CN	RT	90	89
16	5	Toluene	RT	120	86

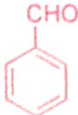
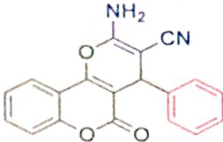
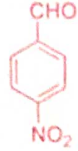
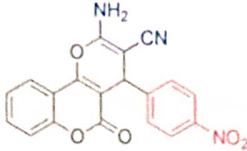

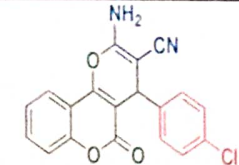
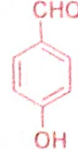
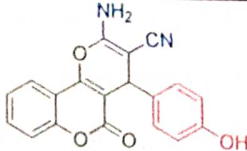
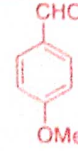
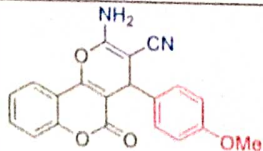
<sup>a</sup>Reaction conditions: 4-Nitrobenzaldehyde (1 mmol), malononitrile (1 mmol), 4-hydroxycoumarin (1 mmol), [C<sub>18</sub>-DABCO]Br (20 mg), solvent (5 mL), Room Temperature stirring.

<sup>b</sup>Isolated yields.

To study the generality of this process, variety of examples were illustrated for the synthesis of dihydropyrano[3,2-c] chromenes and

the results are summarized in Table 4. The reaction is compatible for various substituents such as -CH<sub>3</sub>, -OCH<sub>3</sub>, -OH, -N(CH<sub>3</sub>)<sub>2</sub>, and -Cl. The formation of desired product has been confirmed by <sup>1</sup>H NMR and IR spectroscopic analysis techniques and compared with the corresponding literature data.

**Table 2: Synthesis of dihydropyrano[3,2-c] chromenes using [C<sub>18</sub>-DABCO]Br**

Entry	Aldehyde	Product	Time (min)	Yield (%)	Melting Point (oC)
1			35	92	260-261
2			30	95	258-260
3			30	94	260-262
4			40	94	264-266
5			39	93	234-236



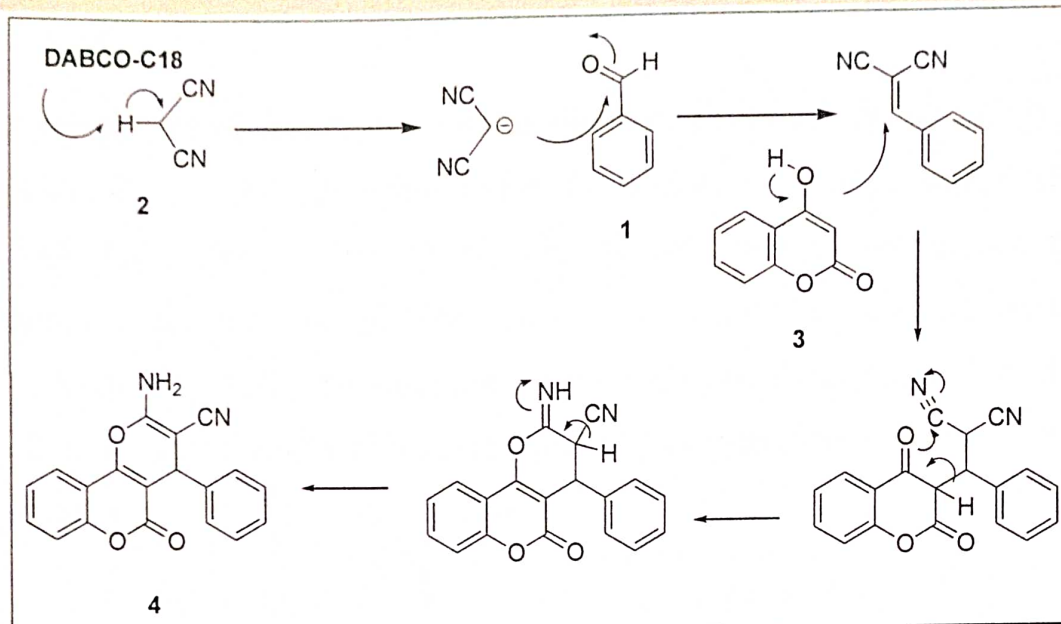
**Table 3. Comparison of present method with reported methods**

Entry	Catalyst	Catalyst Conc.	Solvent Medium	Temp (c)	Time (Min)	Yield (%)	Reference
1	DAHP	(10 mol %)	Ethanol-Water	25	240	85	16
2	H <sub>6</sub> P <sub>2</sub> W <sub>18</sub> O <sub>62</sub> .18H <sub>2</sub> O	(10 mol %)	Ethanol	Reflux	30-85	80	17
3	TBAB	(10 mol %)	Water	Reflux	45-60	93	18
4	(CH <sub>2</sub> ) <sub>6</sub> N <sub>4</sub>	(10 mol %)	Ethanol	Reflux	40	95	19
5	SDS	(20 mol %)	Water	60	150	88	21
6	[TETA]TFA	(10 mol %)	Ethanol-Water	Reflux	30	95	22
7	α-Fe <sub>2</sub> O <sub>3</sub>	(10 Wt %)	Ethanol	Reflux	30	93	23
8	DMAP	(20 mol %)	Ethanol	Reflux	4	94	24
9	CuO nanoparticles	(15 mol %)	Water	100	6	93	25
10	[C <sub>18</sub> -DABCO]Br	(20 mg)	Water	RT	30	96	Present Method

### Conclusion

In conclusion, we have developed an exceedingly simple, mild and clean synthetic protocol for the synthesis of **dihydropyrano[3,2-c] chromenes** derivatives using [C18-Dabco][Br] as a cationic surfactant in water under ultrasonication. The present procedure has advantages, such as good yields, mild reaction conditions, easy operation procedures, and environmentally friendly. Considering the presence of a spiro moiety in these products, this type of molecule has great potential in medicinal chemistry.

## Mechanism



Scheme 3: Plausible mechanism of synthesis of dihydropyrano[3,2-c]chromenes

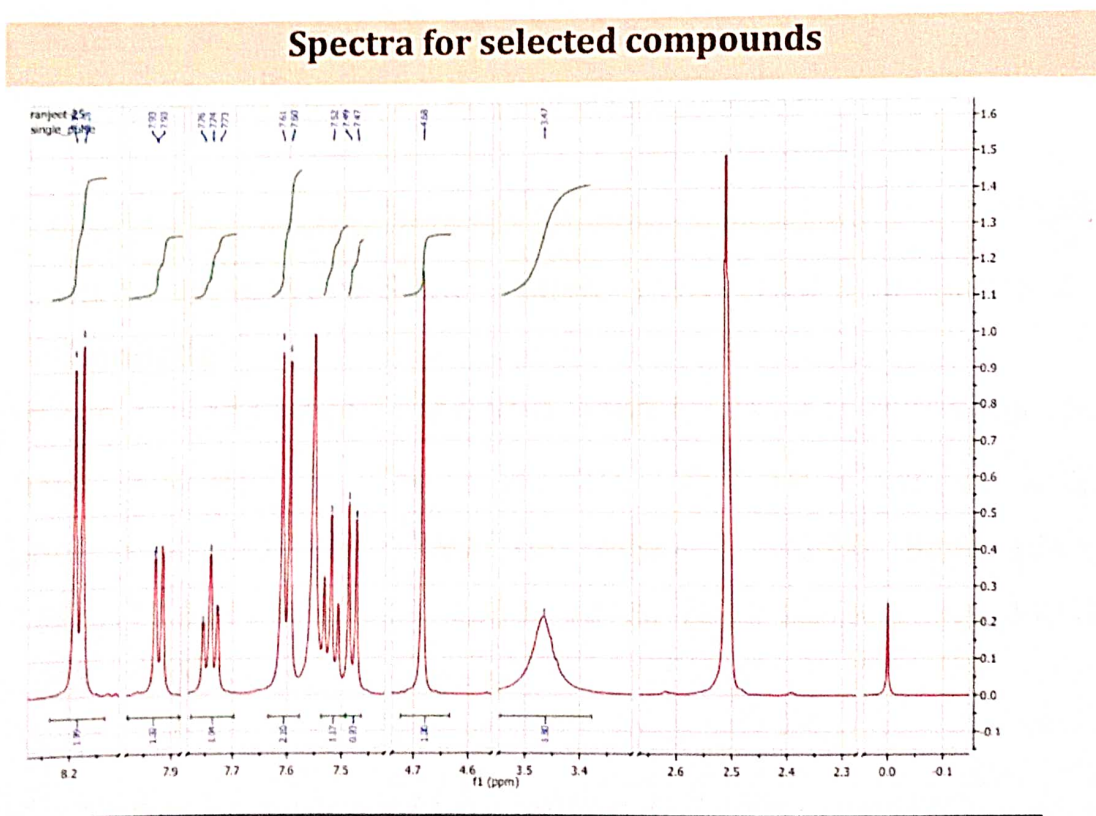
## Experimental Work

## I. Materials and Methods

Chemicals were purchased from Spectrochem and Aldrich chemical companies. All yields refer to isolated products unless otherwise stated. Melting points were determined in an open capillary.  $^1\text{H}$  nuclear magnetic resonance (NMR) (500 MHz) with tetramethylsilane as internal standard and dimethylsulfoxide DMSO- $d_6$  as solvent. Fourier transform infrared (IR) spectra were obtained as KBr discs on a Shimadzu spectrometer. Mass spectra (MS) were determined on a Varion-Saturn 2000 GC/MS instrument.

## II. General procedure for the synthesis of substituted of 3,4-dihydropyrano[c]chromenes.

A mixture of substituted aromatic aldehyde (1mmol), malononitrile (1mmol) and 4-Hydroxycoumarin (1 mmol) in the presence of [C18- Dabco][Br] (1 mol%) in water (5 mL) was stirred at room temperature for the 60 min. The progress of the reaction was monitored by TLC. After completion, the solid precipitate was filtered off and washed with water and purified by recrystallization from hot ethanol.



**Fig. 1.** Proton NMR Spectrum of Dihydropyrano[3,2-c]chromenes



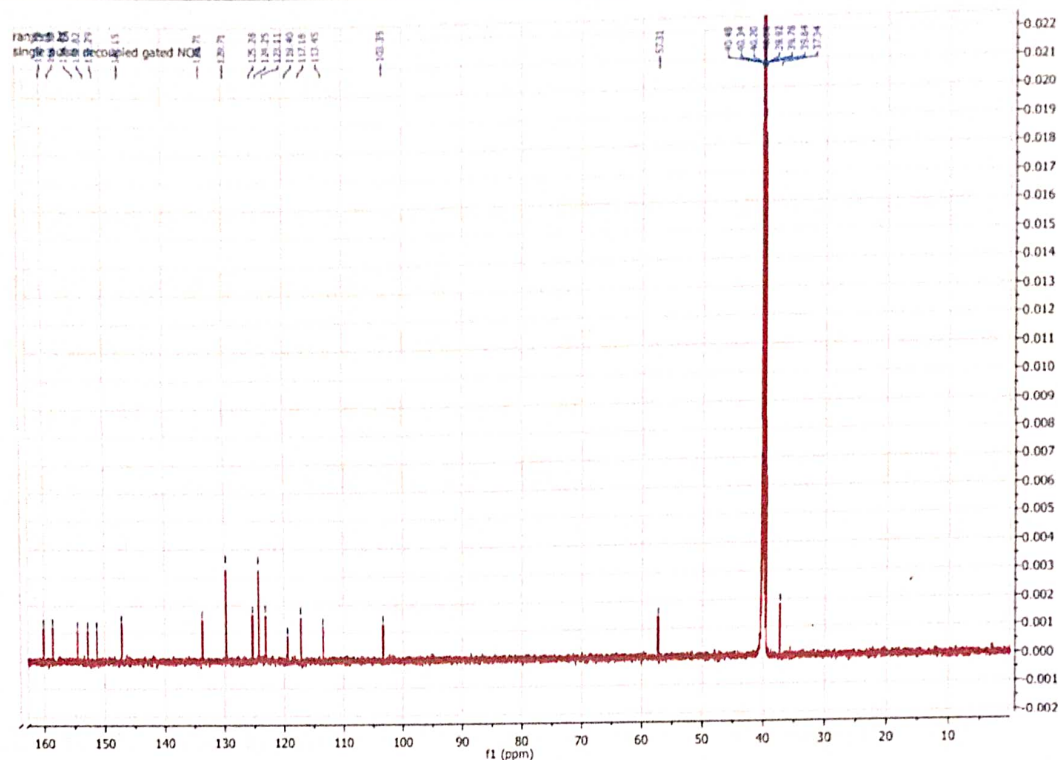


Fig. 2.  $^{13}\text{C}$  NMR spectrum of Dihydropyrano[3,2-c]chromenes

### Spectral Data for Selected Compounds

#### 2-amino-4,5-dihydro-5-oxo-4-phenylpyrano[3,2-c]chromene-3-carbonitrile

IR (KBr) : 3376 (NH<sub>2</sub>), 2195 (CN), 1703 (C=O) cm<sup>-1</sup>; <sup>1</sup>H NMR (d<sub>6</sub>-DMSO, 400 MHz)  $\delta$  : 4.46 (s, 1H, CH), 7.23–7.91(m, 11H, Ar, NH<sub>2</sub>) ppm; <sup>13</sup>C NMR (d<sub>6</sub>-DMSO, 100 MHz),  $\delta$  : 37.4, 58.5, 104.5, 113.4, 117.0, 119.6, 122.9, 125.1, 127.6, 128.1, 128.9, 133.4, 143.8, 152.6, 153.9, 158.4, 159.9 ppm.

#### 2-amino-4,5-dihydro-4-(4-nitrophenyl)-5-oxopyrano[3,2-c]chromene-3-carbonitrile

IR (KBr) : 3367 (NH<sub>2</sub>), 2171 (CN), 1709 (C=O) cm<sup>-1</sup>; <sup>1</sup>H NMR (d<sub>6</sub>-DMSO, 400 MHz)  $\delta$  : 4.43 (s, 1H, CH), 7.23–8.51(m, 10H, Ar, NH<sub>2</sub>) ppm; <sup>13</sup>C NMR (d<sub>6</sub>-DMSO, 100 MHz),  $\delta$  : 57.2, 103.2, 113.3, 117.3,

119.4, 123.2, 124.2, 125.3, 129.7, 133.3, 147.3, 151.4, 152.4, 154.4, 158.5, 158.7, 160.1 ppm

**2-amino-4-(4-chlorophenyl)-4,5-dihydro-5-oxopyrano[3,2-c]chromene-3-carbonitrile**

IR (KBr): 3281 (NH<sub>2</sub>), 2185 (CN), 1701 (C=O) cm<sup>-1</sup>; <sup>1</sup>H NMR (d<sub>6</sub>-DMSO 400 MHz) δ : 4.68 (s, 1H, CH), 7.47–8.19 (m, 10H, Ar, NH<sub>2</sub>) ppm. <sup>13</sup>C NMR (d<sub>6</sub>-DMSO, 100 MHz), δ : 57.2, 103.2, 113.3, 117.0, 119.3, 123.0, 124.1, 124.7, 125.1, 129.6, 129.7, 133.6, 147.0, 151.2, 152.7, 154.4, 158.5, 160.0 ppm.

**2-amino-4,5-dihydro-4-(4-hydroxyphenyl)-5-oxopyrano[3,2-c]chromene-3-carbonitrile**

IR (KBr) : 3353 (NH<sub>2</sub>), 2157 (CN), 1712(C=O) cm<sup>-1</sup>; <sup>1</sup>H NMR (d<sub>6</sub>-DMSO 400 MHz) δ : 4.51 (s, 1H, CH), 7.47–8.05 (m, 10H, Ar, NH<sub>2</sub>) 9.03 (s, OH) ppm. <sup>13</sup>C NMR (d<sub>6</sub>-DMSO, 100 MHz), δ : 58.8, 104.5, 112.8, 115.6, 115.9, 119.8, 122.5, 125.0, 128.9, 133.2, 133.8, 152.4, 154.1, 156.8, 158.3, 160.2 ppm.

**2-amino-4,5-dihydro-4-(4-methoxyphenyl)-5-oxopyrano[3,2-c]chromene-3-carbonitrile**

IR (KBr) : 3367 (NH<sub>2</sub>), 2887 (CH<sub>3</sub>), 2162 (CN), 1707 (C=O) cm<sup>-1</sup>; <sup>1</sup>H NMR (d<sub>6</sub>-DMSO, 400 MHz) δ : 3.75 (s CH<sub>3</sub>) 4.42 (s, 1H, CH), 7.33–8.22(m, 10H, Ar, NH<sub>2</sub>) ppm; <sup>13</sup>C NMR (d<sub>6</sub>-DMSO, 100 MHz), δ : 52.9, 57.6, 104.1, 113.1, 115.7, 116.9, 119.2, 122.9, 124.2, 124.2, 125.2, 126.7, 134.1, 138.1, 152.1, 152.5, 158.2, 159.5 ppm

## References

1. B.B. Touré, D.G. Hall, *Chem. Rev.* 109 (2009) 4439–4486.
2. S. Minakata, M. Komatsu, *Chem. Rev.* 109 (2009) 711–724.
3. F.M.A. Galil, B.Y. Riad, S.M. Sherif, M.H. Elnagdi, *Chem. Lett.* (1982) 1123–1126.
4. E.A. Hafez, M.H. Elnagdi, A.G.A. Elagamey, F.M.A.A. El Taweel, *Heterocycles* 26(1987) 903–907.
5. M.A. Sofan, F.M.A.A. El-Taweel, M.H. Elnagdi, *Liebigs Ann. Chem.* (1989) 935–936.
6. L. Bonsignore, G. Loy, D. Secci, A. Calignano, *Eur. J. Med. Chem.* 28 (1993) 517–520.
7. S. Abdolmohammadi, S. Balalaie, *Tetrahedron Lett.* 48 (2007) 3299–3303.
8. M. Seifi, H. Sheibani, *Catal. Lett.* 126 (2008) 275–279.
9. M.M. Heravi, B.A. Jani, F. Derikvand, F.F. Bamoharram, H.A. Oskooie, *Catal. Commun.* 10 (2008) 272–275.
10. J.M. Khurana, S. Kumar, *Tetrahedron Lett.* 50 (2009) 4125–4127.
11. H. Mehrabi, H. Abusaidi, *J. Iran. Chem. Soc.* 7 (2010) 890–894.
12. J.M. Khurana, B. Nand, P. Saluja, *Tetrahedron* 66 (2010) 5637–5641.
13. H. J. Wang, J. Lu, Z.H. Zhang, *Monatsh. Chem.* 141 (2010) 1107–1112.
14. A.T. Khan, M. Lal, S. Ali, M.M. Khan, *Tetrahedron Lett.* 52 (2011) 5327–5332.
15. H. Mehrabi, M.K. Mireki, *Chin. Chem. Lett.* 22 (2011) 1419–1422.