Ionic Liquid Catalyzed One-Pot Synthesis of 2*H*-Pyridazino[1,2-*a*] indazole-1,6,9(11*H*)-triones Via Three-Component Reaction under Solvent-Free Conditions

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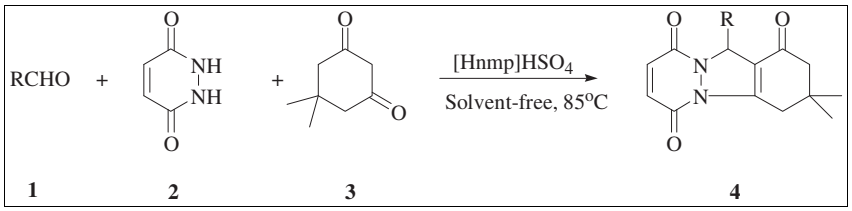

2*H*-Pyridazino[1,2-*a*]indazole-1,6,9(11*H*)-triones were synthesized through one-pot, three-component condesation of aldehydes, maleic hydrazide, and dimedone using a green and inexpensive Brönsted acidic ionic liquid 1-methyl-2-pyrrolidinone hydrosulfate ([Hnmp]HSO_4) as catalyst under solvent-free conditions. The method provided several advantages such as milder conditions, shorter reaction time, high yields, and environmentally benign procedure.

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INTRODUCTION

Multicomponent reactions (MCRs) have been designed to produce elaborate biologically active compounds and have become an important area of research in organic, combinatorial, and medicinal chemistry [1]. The MCR strategy offers significant advantages over conventional linear-type synthesis because of its flexible, convergent, and atom efficient nature [2]. In recent years, the synthesis of combinatorial small-molecule heterocyclic libraries has emerged as a valuable tool in the search for novel lead structures [3]. Thus, the success of combinatorial chemistry in the drug discovery process considerably depends on further advances in the heterocyclic MCR methodology and also the environmentally benign multicomponent procedures.

The indazole nucleus is a pharmaceutically important and emerging heterocycle with a broad spectrum of activities, including anti-inflammatory [4], antitumor [5], anti-HIV [6], antimicrobial [7], contraceptive [8], and have also been used as nNOS inhibitors [9]. Therefore, a number of methods have been reported for the synthesis of indazole derivatives [10–12]. Nevertheless, the development of new synthetic methods for the efficient preparation of heterocycles containing indazole ring fragment is therefore an interesting challenge.

In recent years, the room temperature ionic liquids are attracting increasing interest as a "green" recyclable alternative to classical molecular solvents for synthetic organic chemistry [13–15]. To date, some important reactions have been carried out and investigated. Meanwhile, ionic liquids are able to generate an internal pressure and promote the association of reactants in the solvent cavity during the activation process [16,17].

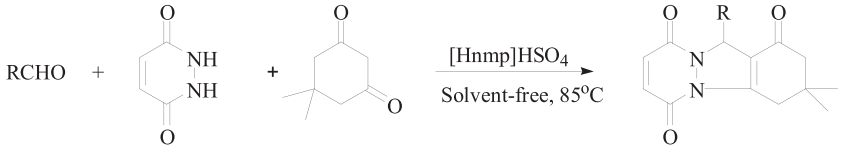
Recently the synthesis of 2*H*-pyridazino[1,2-*a*]indazole-1,6,9(11*H*)-triones has been reported by Bazgir and Teimouri using *p*-TSA as catalyst [18,19]. However, the method has various drawbacks: low yields, the use of expensive catalyst and non-recyclability. Now we reported an efficient method for the preparation of 2*H*-pyridazino[1,2-*a*]indazole-1,6,9(11*H*)-trione derivatives using task-specific Brönsted acidic ionic liquid [Hnmp]HSO_4 as recyclable catalyst under solvent-free conditions (Scheme 1).

RESULTS AND DISCUSSION

Initially, the three-component reaction of benzaldehyde (**1a**, 1 mmol), maleic hydrazide (**2**, 1 mmol), and dimedone (**3**, 1 mmol) was carried out in different solvents in the presence of [Hnmp]HSO_4 and the influence of the amount of ionic liquid. As shown in Table 1, different solvents affected the efficiency of the reaction. Organic solvents and water were used; no expected product was obtained. Especially, when the reaction was carried out under solvent-free condition, the reaction proceeded fast and excellent yield was obtained. In addition, no expected product could be detected in the absence of ionic liquid [Hnmp]HSO_4. Therefore, the best results were obtained with 10% mol catalyst amount of ionic liquid under solvent-free conditions.

The reaction temperature has a great influence on the model reaction. The reactions were carried out at different temperatures ranging from 70 to 100°C under solvent-free conditions. The results are presented in Table 2. The yield of product **4a** was increased, and the reaction time was shortened as the temperature was increased from 70 to

Scheme 1. Synthesis of 2*H*-pyridazino[1,2-*a*]indazole-1,6,9(11*H*)-trione derivatives catalyzed by ionic liquid [Hnmp]HSO_4.



1 **2** **3** **4**

Table 1

Solvent effect and amount of catalyst on the reaction of benzaldehyde, maleic hydrazide, and dimedone catalyzed by ionic liquid [Hnmp]HSO_4.

Entry	Solvent[a]	Temperature	Catalyst (mol%)	Time (h)	Yield of **4a** (%)[b]
1	EtOH	Reflux	10	12	Trace
2	CH_3CN	Reflux	10	12	Trace
3	DMF	100°C	10	12	Trace
4	THF	Reflux	10	12	Trace
5	Water	Reflux	10	12	Trace
6	Solvent-free	80°C	10	0.2	90
7	Solvent-free	80°C	0	12	Trace
8	Solvent-free	80°C	5	0.5	82
9	Solvent-free	80°C	15	0.5	88

[a]Solvent (5 mL) was used.
[b]Isolated yield.

Table 2

Effect of temperature on the solvent-free synthesis of **4a**.

Entry	Temperature (°C)	Time (min)	Yield of **4a** (%)[a]
1	70	30	75
2	80	12	90
3	85	6	91
4	90	6	85
5	95	6	81
6	100	6	78

All reaction were run with benzaldehyde (1 mmol), maleic hydrazide (1 mmol), and dimedone (1 mmol) and [Hnmp]HSO_4 (0.1 mmol).
[a]Isolated yield.

85°C (Table 2, entries 1–3). However, further increase of the temperature to 90−100°C failed to improve the yield of product **4a** (Table 2, entries 4–6). Therefore, the best temperature for the reaction was 85°C.

On the basis of the optimized reaction conditions, a series of 2*H*-pyridazino[1,2-*a*]indazole-1,6,9-(11*H*)-triones were synthesized. The results summarized in Table 3 show that the three-component reaction in the presence of 10 mol % [Hnmp]HSO_4 at 85°C gave the corresponding products in moderate to good yields. It is obvious that protocol could be applied to various aldehydes. Besides, the results suggest that the aromatic aldehydes bearing electron-withdrawing groups have higher reactivity (higher yields and shorter reaction time) than those bearing electron-donating groups. So, it is concluded that the electronic nature of the substituents on aromatic aldehydes has some effect on this reaction. However, when the aliphatic ketones or aromatic ketones were applied to this reaction, no expected product was obtained. In this study, all the products were characterized by mp, IR, ^{1}H NMR, and elemental analyses.

As a green solvent or catalyst, the recovery and reuse of ionic liquids are very important in green synthetic process. Therefore, we also studied on the reuse of [Hnmp]HSO_4. As shown in Table 4, the ionic liquid [Hnmp]HSO_4 could be successively reused in subsequent reactions and had not decreased obviously in its catalytic activity. The corresponding product still could be obtained in good yield when [Hnmp]HSO_4 was reused in the fourth round.

A reasonable mechanism for the formation of the product **4** is outlined in Scheme 2. The reaction occurs via initial formation of intermediate **5** in quantitative yield by the Knoevenagel addition of dimedone **3** to the aldehyde **1** and followed by loss of water molecules. Subsequently, Michael-type addition of the maleic hydrazide **2** to the intermediate **5**, followed by cyclization and tautomerization affords the corresponding products **4**.

CONCLUSION

In conclusion, we have successfully developed a green and highly efficient procedure for one-pot three-component synthesis of 2*H*-pyridazino[1,2-*a*]indazole-1,6,9(11*H*)-trione derivatives by using a novel Brönsted acidic ionic liquid [Hnmp]HSO_4 under solvent-free conditions. The reasonable reaction times, very good yields, simple work-up procedure, and environmentally friendly conditions are the merits of this method.

EXPERIMENTAL

Melting points were determined with an X-4 microscopic melting-point apparatus (Tech, Peking, China) and were uncorrected. IR spectra were recorded on a NEXUS 670 spectrometer (ThermoNicolet, WI) in KBr. ^{1}H NMR spectra were measured on a BRUKER AVANCE-II 500 MHz spectrometer (Bruker, Fällanden, Switzerland) using TMS as internal standard and DMSO-d_6 as solvent. Elemental analyses were performed on FLASH EA 1112 elemental analyzer (Thermo Electron SpA, Milan, Italy).

Table 3

Synthesis of 2*H*-pyridazino[1,2-*a*]indazole-1,6,9(11*H*)-trione derivatives **4**.

Entry	R	Products	Time (min)	Yield (%)[a]	Mp (°C) [Ref]
1	C_6H_5	**4a**	6	91	230–231 [18]
2	4-Cl-C_6H_4	**4b**	5	93	214–216 [18]
3	4-MeO-C_6H_4	**4c**	10	88	192–194
4	4-F-C_6H_4	**4d**	3	94	186–188
5	4-CH_3-C_6H_4	**4e**	10	86	248–250 [18]
6	4-NO_2-C_6H_4	**4f**	3	93	210–212 [18]
7	3-Br-C_6H_4	**4g**	6	91	180–181 [18]
8	2-NO_2-C_6H_4	**4h**	5	92	207–209
9	2-Cl-C_6H_4	**4i**	5	92	220–222 [18]
10	2-Naphthyl	**4j**	6	90	234–235
11	$–CH_2CH_3$	**4k**	10	77	169–171
12	$–CH_2CH_2CH_3$	**4l**	10	82	171–173 [19]

[a]Isolated yield.

Table 4

Studies on the reuse of [Hnmp]HSO_4 in the preparation of **4a**.

Round	1	2	3	4	5
Yield (%)[a]	91	89	90	88	75

[a]Isolated yield.

The synthesis of this task-specific ionic liquid has been carried out from a similar method in the literature [20]. The ionic liquid was formed quantitatively and in high purity as assessed by ^{1}H NMR. All other chemicals (AR grade) were commercially available and used without further purification.

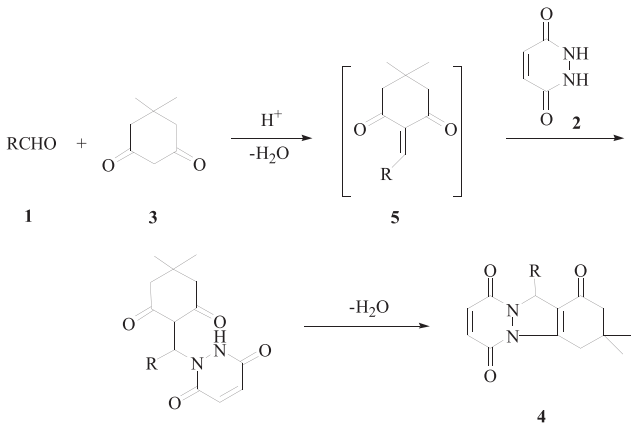
General procedure for the synthesis of 2*H*-pyridazino[1,2-*a*] indazole-1,6,9(11*H*)-trione derivatives 4. The mixture of the aldehyde **1** (1 mmol), maleic hydrazide **2** (1 mmol), dimedone **3** (1 mmol), [Hnmp]HSO_4 (0.1 mmol) was stirred at 85°C for the appropriate time (monitored by thin-layer chromatography [TLC]). After completion of the reaction, the result mixture was cooled to room temperature and poured into 10 mL of water. The solid product was collected by filtration and recrystallized from ethanol to give the pure compound **4**. The filtrate was extracted with diethyl ether several times to remove unreacted starting materials and other organic contaminations. Then the water was evaporated under reduced pressure and dried to recover the ionic liquid for subsequent use.

3,4-dihydro-3,3-dimethyl-11-phenyl-2H-pyridazino[1,2-a]indazole-1,6,9(11H)-trione(4a). This compound was obtained as yellow powder. ^{1}H NMR (500 MHz, DMSO-d_6): δ=1.07 (s, 3H, CH_3), 1.10 (s, 3H, CH_3), 2.23 (s, 2H, CH_2), 3.05 (dd, J_1 = 2.5 Hz, J_2 = 16.5 Hz, 1H, CH_2), 3.18 (dd, J_1 = 1.5 Hz, J_2 = 17.5 Hz, 1H, CH_2), 6.15 (s, 1H, CH), 6.99 (d, J = 10.5 Hz, 1H, CHCO), 7.06 (d, J = 10.0 Hz, 1H, CHCO), 7.25–7.38 (m, 5H, Ar-H); IR (KBr): 3045, 2966, 1664, 1649, 1586, 1442, 1362, 1316, 1274 cm^{-1}; *Anal.* Calcd for $C_{19}H_{18}N_2O_3$: C, 70.79; H, 5.63; N, 8.69. Found: C, 70.68; H, 5.59; N, 8.73.

11-(4-chlorophenyl)-3,4-dihydro-3,3-dimethyl-2H-pyridazino [1,2-a]indazole-1,6,9(11H)-trione (4b). This compound was obtained as yellow powder. ^{1}H NMR (500 MHz, DMSO-d_6): δ=1.06 (s, 3H, CH_3), 1.09 (s, 3H, CH_3), 2.22 (s, 2H, CH_2), 3.04 (dd, J_1 = 2.5 Hz, J_2 = 16.5 Hz, 1H, CH_2), 3.16 (dd, J_1 = 1.5 Hz, J_2 = 17.5 Hz, 1H, CH_2), 6.16 (s, 1H, CH), 6.98 (d, J = 10.0 Hz, 1H, CHCO), 7.06 (d, J = 10.0 Hz, 1H, CHCO), 7.36–7.43 (m, 4H, Ar-H); IR (KBr): 3054, 2962, 1659, 1624, 1589, 1439, 1363, 1312, 1269 cm^{-1}; *Anal*. Calcd for $C_{19}H_{17}ClN_2O_3$: C, 63.96; H, 4.80; N, 7.85. Found: C, 63.80; H, 4.75; N, 7.88.

3,4-dihydro-11-(4-methoxyphenyl)-3,3-dimethyl-2H-pyridazino [1,2-a]indazole-1,6,9(11H)-trione (4c). This compound was

Scheme 2. The possible mechanism for the synthesis of 2*H*-pyridazino[1,2-*a*]indazole-1,6,9(11*H*)-trione derivatives.



obtained as yellow powder. ^{1}H NMR (500 MHz, DMSO-d_6): δ=1.08 (s, 3H, CH_3), 1.10 (s, 3H, CH_3), 2.23 (s, 2H, CH_2), 3.07 (dd, J_1 = 2.5 Hz, J_2 = 16.5 Hz, 1H, CH_2), 3.21 (dd, J_1 = 1.5 Hz, J_2 = 17.5 Hz, 1H, CH_2), 3.72 (s, 3H, OCH_3), 6.10 (s, 1H, CH), 6.84 (m, 2H, Ar-H), 6.96 (d, J = 10.5 Hz, 1H, CHCO), 7.03 (d, J = 10.5 Hz, 1H, CHCO), 7.26 (m, 2H, Ar-H); IR (KBr): 2959, 1663, 1586, 1512, 1442, 1391, 1363, 1248 cm^{-1}; MS (EI, 70 eV) *m/z* (%): 352 (M^+, 59.5), 308 (49.5), 270 (100), 245 (81.3), 217 (38.2). *Anal*. Calcd for $C_{20}H_{20}N_2O_4$: C, 68.17; H, 5.72; N, 7.95. Found: C, 68.10; H, 5.68; N, 7.99.

11-(4-fluorophenyl)-3,4-dihydro-3,3-dimethyl-2H-pyridazino [1,2-a]indazole-1,6,9(11H)-trione (4d). This compound was obtained as yellow powder. ^{1}H NMR (500 MHz, DMSO-d_6): δ=1.07 (s, 3H, CH_3), 1.10 (s, 3H, CH_3), 2.23 (s, 2H, CH_2), 3.04 (dd, J_1 = 2.0 Hz, J_2 = 16.5 Hz, 1H, CH_2), 3.17 (dd, J_1 = 1.0 Hz, J_2 = 17.5 Hz, 1H, CH_2), 6.17 (s, 1H, CH), 6.97 (d, J = 10.0 Hz, 1H, CHCO), 7.05 (d, J = 10.0 Hz, 1H, CHCO), 7.11−7.44 (m, 4H, Ar-H); IR (KBr): 3053, 2963, 1659, 1625, 1589, 1507, 1439, 1365, 1313, 1271 cm^{-1}; MS (EI, 70 eV) *m/z* (%): 340 (M^+, 34.7), 259 (36.5), 245 (100), 217 (37.3). *Anal*. Calcd for $C_{19}H_{17}FN_2O_3$: C, 67.05; H, 5.03; N, 8.23. Found: C, 66.93; H, 5.01; N, 8.28.

3,4-dihydro-3,3-dimethyl-11-p-tolyl-2H-pyridazino[1,2-a]indazole-1,6,9(11H)-trione(4e). This compound was obtained as yellow powder. ^{1}H NMR (500 MHz, DMSO-d_6): δ=1.06 (s, 3H, CH_3), 1.09 (s, 3H, CH_3), 2.22 (s, 2H, CH_2), 2.25 (s, 3H, CH_3), 3.03 (dd, J_1 = 2.5 Hz, J_2 = 16.5 Hz, 1H, CH_2), 3.17 (dd, J_1 = 1.5 Hz, J_2 = 17.5 Hz, 1H, CH_2), 6.10 (s, 1H, CH), 6.96 (d, J = 10.5 Hz, 1H, CHCO), 7.04 (d, J = 10.5 Hz, 1H, CHCO), 7.09−7.24 (m, 4H, Ar-H); IR (KBr): 3017, 2960, 2873, 1666, 1652, 1587, 1512, 1442, 1392, 1315, 1272 cm^{-1}; *Anal.* Calcd for $C_{20}H_{20}N_2O_3$: C, 71.41; H, 5.99; N, 8.33. Found: C, 71.33; H, 5.91; N, 8.38.

3,4-dihydro-3,3-dimethyl-11-(4-nitrophenyl)-2H-pyridazino [1,2-a]indazole-1,6,9(11H)-trione (4f). This compound was obtained as yellow powder. ^{1}H NMR (500 MHz, DMSO-d_6): δ=1.06 (s, 3H, CH_3), 1.11 (s, 3H, CH_3), 2.23 (s, 2H, CH_2), 3.07 (dd, J_1 = 2.0 Hz, J_2 = 16.5 Hz, 1H, CH_2), 3.17 (dd, J_1 = 1.0 Hz, J_2 = 17.5 Hz, 1H, CH_2), 6.32 (s, 1H, CH), 7.02 (d, J = 10.0 Hz, 1H, CHCO), 7.11 (d, J = 10.0 Hz, 1H, CHCO), 7.72−8.18 (m, 4H, Ar-H); IR (KBr): 3061, 2968, 1661, 1624, 1589, 1522, 1435, 1347, 1311, 1269 cm^{-1}; *Anal*. Calcd for $C_{19}H_{17}N_3O_5$: C, 62.12; H, 4.66; N, 11.44. Found: C, 62.17; H, 4.70; N, 11.38.

11-(3-bromophenyl)-3,4-dihydro-3,3-dimethyl-2H-pyridazino [1,2-a]indazole-1,6,9(11H)-trione (4g). This compound was obtained as yellow powder. ^{1}H NMR (500 MHz, DMSO-d_6): δ=1.07 (s, 3H, CH_3), 1.10 (s, 3H, CH_3), 2.22 (s, 2H, CH_2), 3.05 (dd, J_1 = 2.0 Hz, J_2 = 16.5 Hz, 1H, CH_2), 3.16 (dd, J_1 = 1.0 Hz, J_2 = 17.5 Hz, 1H, CH_2), 6.18 (s, 1H, CH), 6.97 (d, J = 10.0 Hz, 1H, CHCO), 7.05 (d, J = 10.0 Hz, 1H, CHCO), 7.15−7.44 (m, 4H, Ar-H); IR (KBr): 3063, 2958, 1663, 1614, 1588, 1521, 1445, 1346, 1313, 1269 cm^{-1}; *Anal*. Calcd for $C_{19}H_{17}BrN_2O_3$: C, 56.87; H, 4.27; N, 6.98. Found: C, 56.77; H, 4.23; N, 7.02.

3,4-dihydro-3,3-dimethyl-11-(2-nitrophenyl)-2H-pyridazino [1,2-a]indazole-1,6,9(11H)-trione (4h). This compound was obtained as yellow powder. ^{1}H NMR (500 MHz, DMSO-d_6): δ=1.05 (s, 3H, CH_3), 1.10 (s, 3H, CH_3), 2.22 (s, 2H, CH_2), 3.05 (dd, J_1 = 2.5 Hz, J_2 = 16.5 Hz, 1H, CH_2), 3.14 (dd, J_1 = 1.0 Hz, J_2 = 17.5 Hz, 1H, CH_2), 7.00 (s, 1H, CH), 6.98 (d, J = 10.0 Hz, 1H, CHCO), 7.08 (d, J = 10.0 Hz, 1H, CHCO), 7.52−7.97 (m, 4H, Ar-H); IR (KBr): 2961, 2933, 1659, 1627, 1590, 1531, 1440, 1391, 1360, 1312, 1271 cm^{-1}; MS (EI, 70 eV) *m/z* (%): 367 (M^+, 31.7), 350 (100), 264 (30.3), 233 (29.0). *Anal.* Calcd for $C_{19}H_{17}N_3O_5$: C, 62.12; H, 4.66; N, 11.44. Found: C, 62.18; H, 4.71; N, 11.36.

11-(2-chlorophenyl)-3,4-dihydro-3,3-dimethyl-2H-pyridazino [1,2-a]indazole-1,6,9(11H)-trione (4i). This compound was obtained as yellow powder. ^{1}H NMR (500 MHz, DMSO-d_6): δ=1.07 (s, 3H, CH_3), 1.11 (s, 3H, CH_3), 2.19 (s, 2H, CH_2), 3.06 (dd, J_1 = 2.5 Hz, J_2 = 16.5 Hz, 1H, CH_2), 3.17 (dd, J_1 = 1.5 Hz, J_2 = 17.5 Hz, 1H, CH_2), 6.49 (s, 1H, CH), 6.99 (d, J = 10.0 Hz, 1H, CHCO), 7.09 (d, J = 10.0 Hz, 1H, CHCO), 7.28−7.46 (m, 4H, Ar-H); IR (KBr): 3051, 2963, 1658, 1628, 1589, 1440, 1364, 1314, 1270 cm^{-1}; *Anal*. Calcd for $C_{19}H_{17}ClN_2O_3$: C, 63.96; H, 4.80; N, 7.85. Found: C, 63.82; H, 4.74; N, 7.86.

3,4-dihydro-3,3-dimethyl-11-(naphthalen-3-yl)-2H-pyridazino [1,2-a]indazole-1,6,9(11H)-trione (4j). This compound was obtained as yellow powder. ^{1}H NMR (500 MHz, DMSO-d_6): δ=1.05 (s, 3H, CH_3), 1.12 (s, 3H, CH_3), 2.16 (s, 2H, CH_2), 3.11 (dd, J_1 = 2.5 Hz, J_2 = 16.5 Hz, 1H, CH_2), 3.24 (dd, J_1 = 1.5 Hz, J_2 = 17.5 Hz, 1H, CH_2), 6.97 (s, 1H, CH), 6.99 (d, J = 10.0 Hz, 1H, CHCO), 7.09 (d, J = 10.0 Hz, 1H, CHCO), 7.41−7.94 (m, 7H, Ar-H); IR (KBr): 3051, 2960, 1655, 1627, 1589, 1437, 1362, 1314, 1269 cm^{-1}; MS (EI, 70 eV) *m/z* (%): 372 (M^+, 38.7), 291 (20.7), 245 (100), 217 (27.4). *Anal*. Calcd for $C_{23}H_{20}N_2O_3$: C, 74.18; H, 5.41; N, 7.52. Found: C, 74.25; H, 5.44; N, 7.48.

11-Ethyl-3,3-dimethyl-2,3,4,11-tetrahydro-pyridazino[1,2-a] indazole-1,6,9-trione (4k). This compound was obtained as yellow powder. ^{1}H NMR (500 MHz, DMSO-d_6): δ=0.63 (t, J = 7.5 Hz, 3H, CH_3), 1.10 (d, J = 4.9 Hz, 6H, $(CH_3)_2$), 1.90 (dqd, J = 14.9, 7.5, 2.8 Hz, 1H), 2.37–2.27 (m, 3H), 2.99 (dd, J = 18.9, 2.5 Hz, 1H), 3.12 (d, J = 19.1 Hz, 1H,), 5.44–5.32 (m, 1H, CH),7.08–7.03 (m, 2H, CHCO) ppm; ^{13}C NMR (500 MHz, DMSO-d_6): 192.7, 154.8, 153.7, 151.6, 135.2, 134.9, 115.6, 63.0, 50.3, 36.8, 34.1, 28.1, 27.7, 20.8, 6.9 ppm. IR (KBr): 1700, 1662, 1658, 1589 cm^{-1}; MS (EI, 70 eV) *m/z* (%): 274 (M^+, 2.2), 246 (15.7), 245 (100), 217 (18.1). *Anal*. Calcd for $C_{14}H_{16}N_2O_3$: C, 65.68; H, 6.61; N, 10.21. Found: C, 65.54; H, 6.52;N, 9.90.

3,3-Dimethyl-11-propyl-2,3,4,11-tetrahydro-1H-pyridazino [1,2-a]-indazole-1,6,9-trione (4l). This compound was obtained as yellow powder. 1H NMR (500 MHz, DMSO-d_6) δ = 0.79 (t, J = 7.3 Hz, 3H,CH_3), 1.05 (dd, J = 15.0, 7.0 Hz, 2H,CH_2), 1.09 (s, 6H, $(CH_3)_2$), 1.88 (ddd, J = 11.6, 5.7, 2.9 Hz, 1H), 2.22 (dd, J = 11.9, 3.6 Hz, 1H), 2.31 (q, J = 16.0 Hz, 2H), 2.54–2.48 (m, 1H), 2.98 (dd, J = 18.9, 2.4 Hz, 1H, CH_2), 3.11 (d, J = 18.9 Hz, 1H, CH_2), 5.35 (t, J = 8.1 Hz, 1H, CH), 7.02–7.07 (m, 2H, CHCO); ^{13}C NMR (500 MHz, DMSO-d_6): 192.7, 154.9, 153.7, 151.3, 135.6, 134.9, 116.2, 62.3, 50.3, 36.8, 34.1, 30.2, 28.1, 27.8, 16.0, 13.7 ppm. IR (KBr): n = 1685, 1654, 1650, 1582 cm^{-1}; *Anal.* Calcd for $C_{16}H_{20}N_2O_3$: C, 66.65; H, 6.99; N, 9.72. Found: C, 64.73; H, 6.62; N, 9.50.

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