Synthesis of Novel 2-Amino-benzo[de]isoquinolin-1,3-dione Derivatives

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From a pioneer bioactive amino-benzoisoquinoline *i.e.* 2-amino-1*H*-benzo[de]isoquinolin-1,3-dione, a new series of Schiff's bases were prepared by the reaction of the active 2-amino group with a variety of aryl(hetero)aldehydes, isothiocyanides and acid anhydrides. The success of all reactions has been followed up by characterization of the synthesized target molecules through IR, Mass spectra and NMR analyses. The structural modifications were designed aiming at synthesis of valuable bioactive agents.

Keywords: 2-Amino-1*H*-benzo[de]isoquinolin-1,3-dione, Aldehydes, Acid anhydrides, NMR.

INTRODUCTION

In organic and medicinal chemistry, studies in the field of synthesis of new effective agents have recently became of especial importance as a result of the increasing spread of various communicable and un-communicable diseases. It was known that many naphthalimide derivatives are famous anti-cancer agents or DNA photocleavers, but there are few hetero-cyclic fused naphthalimides as intercalative photocleavers for DNA[1-3]. The 1H-benzo[de]isoquinolin-1,3-dione-based anti-cancer drugs and potent HDAC inhibitors have been an indispensable part in the development of antitumor agents[4,5]. For example, substituted naphthalimides containing N-(2,2-dimethylaminoethyl) chain best represented by mitonafide (5-nitro group in the aromatic ring), amonafide (5-amino group in the aromatic ring) and the dimer elinafide (Fig. 1) have been shown to possess significant anticancer activities[6-8]. Both Mitonafide and Amonafide have undergone Phase I and II clinical trials with limited success[9]. Furthermore, some derivatives of 1H-benzo[de]isoquinolin-1,3-dione were found to possess antimicrobial activity and other combined very high 5-HT$_{1A}$ receptor affinity to visualize 5-HT$_{1A}$ receptors over expressed in CHO cells by fluorescence microscopy[10,11]. Although promising results have been obtained in this way, most of the compounds were abandoned because of their complicated synthesis[6]. Therefore, this led us to pay a great attention to attempt for synthesis of a new series of 2-mino-benzo[de]isoquinolin-1,3-dione derivatives in order to evaluate their biological activities.
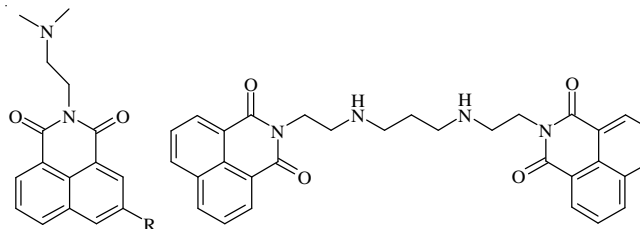

Fig. 1. Structure of Mitonafide (R = NO$_2$), Amonafide (R = NH$_2$) and Elinafide

EXPERIMENTAL

The melting points were determined on a Boetius stage and are not corrected. NMR spectra were measured on a Bruker AMX-500 spectrometer at 500 MHz for (¹H) and 125 MHz for (¹³C) in DMSO-d_6 and the chemical shifts (δ-values) are reported in ppm relative to TMS and coupling constants (*J*-values) in Hz.

2-Amino-benzo[de]isoquinolin-1,3-dione: Off-white amorphous powder, 80 % yield; ¹H NMR (500 MHz, DMSO-d_6): δ 8.54 (br d, *J* = 7 Hz, 2H, H-3/8), 8.49 (br d, *J* = 8 Hz, 2H, H-5/6), 7.90 (t-like, *J* = 8 Hz, 2H, H-4/7), 5.58 (brs, 2H, -NH$_2$); ¹³C NMR (125 MHz, DMSO-d_6): δ 160.3 (C-2/9), 134.5 (C-3/8), 130.8 (C-5/6), 130 (C-2a/8a), 127.3 (C-4/7), 125.9 (C-5a), 122.4 (C-2b); EI-MS, *m/z* (%): 212 [(M⁺, 92)]; corresponding for m.f.: C$_{12}$H$_8$N$_2$O$_2$ and m.w. 212.06.

General procedure for synthesis of compounds 1-15: The starting 2-amino-benzo[de]isoquinolin-1,3-dione (1 mmol) was reacted with appropriate aldehyde (1.1 mmol) in absolute DMF (8 mL) in the presence of few drops of glacial acetic acid for 5.5 h under reflux. Afterwards the reaction mixture

was cooled and poured into ice/water, the precipitate was separated by filtration and washed thoroughly with diethyl ether. Recrystallization from aqueous DMF furnished analytically pure compounds.

2-Ethylideneamino-benzo[de]isoquinolin-1,3-dione (1): Brown amorphous powder, 56 % yield, m.p.: 282-285 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 8.53 (br d, J = 7 Hz, 2H, H-3/8), 8.47 (br d, J = 8 Hz, 2H, H-5/6), 7.91 (m, 1H, H-4/7, =$\underline{CH}$-CH$_3$), 1.90 (br s, 3H, =CH-$\underline{CH}_3$); ^{13}C NMR (125 MHz, DMSO-d_6): δ 160.5 (C-2/9), 148.5 (=$\underline{CH}$-CH$_3$), 134.5 (C-3/8), 131.1 (C-5/6), 130.6 (C-2a/8a), 127.5 (C-4/7), 125.6 (C-5a), 122.2 (C-2b), 14.0 (=CH-$\underline{CH}_3$); EI-MS, m/z (%): 238 [(M$^+$, 75)]; corresponding for m.f.: C$_{14}$H$_{10}$N$_2$O$_2$ and m.w. 238.07.

2-Propylideneamino-benzo[de]isoquinolin-1,3-dione (2): Brown amorphous powder, 48 % yield, m.p.: 298-301 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 8.55 (br d, J = 7 Hz, 2H, H-3/8), 8.50 (br d, J = 8 Hz, 2H, H-5/6), 7.94 (m, H-4/7, 1H, =$\underline{CH}$-CH$_2$-CH$_3$), 2.60 (m, 2H, =CH-$\underline{CH}_2$-CH$_3$), 1.10 (t, J = 7Hz, 3H, =CH-CH$_2$-$\underline{CH}_3$); ^{13}C NMR (125 MHz, DMSO-d_6): δ 161.0 (C-2/9), 143.8 (=$\underline{CH}$-CH$_2$-CH$_3$), 134.7 (C-3/8), 131.0 (C-5/6), 130.5 (C-2a/8a), 127.8 (C-4/7), 125.7 (C-5a), 122.5 (C-2b), 21.4 (=CH-$\underline{CH}_2$-CH$_3$), 11.9 (=CH-CH$_2$-$\underline{CH}_3$); EI-MS, m/z (%): 252 [(M$^+$, 72)]; corresponding for m.f.: C$_{15}$H$_{12}$N$_2$O$_2$ and m.w.: 252.07.

2-Benzylideneamino-benzo[de]isoquinolin-1,3-dione (3): Yellow amorphous powder; 78 % yield, m.p.: 209-212 °C. ^{1}H NMR (500 MHz, DMSO-d_6): δ 8.78 (s, 1H, H-7'), 8.55 (br d, J = 7 Hz, 2H, H-3/8), 8.52 (br d, J = 8 Hz, 2H, H-5/6), 7.97 (br d, J = 7.5 Hz, 2H, H-2'/6'), 7.92 (t-like, J = 8 Hz, 2H, H-4/7), 7.67 (t-like, J = 8 Hz, 1H, H-4'), 7.61 (t-like, J = 7.5 Hz, 2H, H-3'/5'); ^{13}C NMR (125 MHz, DMSO-d_6): δ 172 (C-7'), 160.3 (C-2/9), 134.6 (C-3/8), 132.7 (C-4'), 132.4 (C-1'), 131.4 (C-2a/8a), 131.1 (C-5/6), 129.1 (C-2'/6'), 128.8 (C-3'/5'),127.3 (C-4/7), 126.8 (C-5a), 122.3 (C-2b); EI-MS, m/z (%): 300 [(M$^+$, 77)]; corresponding for m.f.: C$_{19}$H$_{12}$N$_2$O$_2$ and m.w.: 300.09.

2-(2-Methoxy-benzylidene)amino-benzo[de]isoquinolin-1,3-dione (4): Yellow amorphous powder; 72 % yield, m.p.: 200-203 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 8.96 (s, 1H, H-7'), 8.53 (br d, J = 7.5 Hz, 2H, H-3/8), 8.50 (br d, J = 8 Hz, 2H, H-5/6), 8.13 (dd, J = 8, 1.5 Hz, 1H, H-3'), 7.91 (t-like, J = 8 Hz, 2H, H-4/7), 7.65 (td, J = 8.5, 1.5 Hz, 1H, H-4'), 7.24 (br d, J = 8.5 Hz, 1H, H-6'), 7.15 (td, J = 7.5, 1.5 Hz, 1H, H-5'), 3.89 (s, 3H, -OCH$_3$); ^{13}C NMR (125 MHz, DMSO-d_6): δ 167.1 (C-7'), 160.4 (C-2/9), 159.1 (C-2'), 134.5 (C-4' & 3/8), 131.4 (C-2a/8a), 130.9 (C-5/6), 127.3 (C-4/7), 126.9 (C-5a/6'), 122.5 (C-2b), 120.8 (C-5'), 120.3 (C-1'), 112.3 (C-3'), 55.8 (-OCH$_3$); EI-MS, m/z (%): 330 [(M$^+$, 81)]; corresponding for m.f.: C$_{20}$H$_{14}$N$_2$O$_3$ and m.w.: 330.1.

2-(3-Methoxy-benzylidene)amino-benzo[de]isoquinolin-1,3-dione (5): Yellow amorphous powder 74 % yield, m.p.: 171-174 °C. ^{1}H NMR (500 MHz, DMSO-d_6): δ 8.74 (s, 1H, H-7'), 8.54 (br d, J = 7.5 Hz, 2H, H-3/8), 8.51 (br d, J = 8 Hz, 2H, H-5/6), 7.91 (t-like, J = 8 Hz, 2H, H-4/7), 7.53 (m, 3H, H-2', 5', 6'), 7.23 (m, 1H, H-4'), 3.86 (s, 3H, -OCH$_3$); ^{13}C NMR (125 MHz, DMSO-d_6): δ 171.8 (C-7'), 160.3 (C-2/9), 159.6 (C-3'), 134.6 (C-3/8), 133.8 (C-1'), 131.4 (C-2a/8a), 131.1 (C-5/6), 130.3 (C-5'), 127.3 (C-4/7), 126.8 (C-5a), 122.3 (C-2b), 121.7 (C-6'), 120.8 (C-5'), 118.9 (C-4'), 112.5 (C-2'), 55.3

(-OCH$_3$); EI-MS, m/z (%): 330 [(M$^+$, 76)]; corresponding for m.f.: C$_{20}$H$_{14}$N$_2$O$_3$ and m.w.: 330.1.

2-(3-Nitro-benzylidene)amino-benzo[de]isoquinolin-1,3-dione (6): Yellow amorphous powder, 72 % yield, m.p.: 225-228 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 9.02 (s, 1H, H-7'), 8.79 (t-like , J = 1.5 Hz, 1H, H-2'), 8.56 (br d, J = 7.5 Hz, 2H, H-3/8), 8.52 (br d, J = 8 Hz, 2H, H-5/6), 8.49 (m, 2H, H-4'/5'), 8.42 (br d, J = 7.5 Hz, 1H, H-6'), 7.91 (t-like, J = 8 Hz, 2H, H-4/7); ^{13}C NMR (125 MHz, DMSO-d_6): δ 169.7 (C-7'), 160.2 (C-2/9), 148.3 (C-3'), 134.8 (C-3/8), 134.7 (C-1'), 134.4 (C-6'), 133.2 (C-5'), 131.3 (C-2a/8a), 131.2 (C-5/6), 130.9 (C-4'), 127.4 (C-4/7), 126.8 (C-5a), 122.8 (C-2'), 122.5 (C-2b); EI-MS, m/z (%): 345 [(M$^+$, 68)]; corresponding for m.f.: C$_{19}$H$_{11}$N$_3$O$_4$ and m.w.: 345.07.

2-(4-Hydroxy-benzylidene)amino-benzo[de]isoquinolin-1,3-dione (7): Pale green amorphous powder, 80 % yield, m.p.: 149-152 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 10.36 (s, 4'-1H, OH), 8.56 (s, 1H, H-7'), 8.54 (br d, J = 7 Hz, 2H, H-3/8), 8.51 (br d, J = 8 Hz, 2H, H-5/6), 7.92 (t-like, J = 8 Hz, 2H, H-4/7), 7.81 (d, J = 8.5 Hz, 2H, H-2'/6'), 6.95 (d, J = 8.5 Hz, 2H, H-3'/5'); ^{13}C NMR (125 MHz, DMSO-d_6): δ 171.4 (C-7'), 161.6 (C-4'), 160.4 (C-2/9), 134.5 (C-3/8), 131.4 (C-2a/8a), 131.0 (C-5/6), 130.9 (C-2'/6'), 127.3 (C-4/7), 126.8 (C-5a), 123.5 (C-1'), 122.4 (C-2b), 115.9 (C-3'/5'); EI-MS, m/z (%): 316 [(M$^+$, 82)]; corresponding for m.f.: C$_{19}$H$_{12}$N$_2$O$_3$ and m.w.: 316.08.

2-(4-Dimethylamino-benzylidene)amino-benzo[de]isoquinolin-1,3-dione (8): Pale brown amorphous powder, 60 % yield, m.p.: 240-243 °C. ^{1}H NMR (500 MHz, DMSO-d_6): δ 8.53 (br d, J = 7 Hz, 2H, H-3/8), 8.51 (br d, J = 8 Hz, 2H, H-5/6), 8.45 (s, 1H, H-7'), 7.92 (t-like, J = 8 Hz, 2H, H-4/7), 7.75 (d, J = 9 Hz, 2H, H-2'/6'), 6.95 (d, J = 9 Hz, 2H, H-3'/5'), 3.06 (s, 6H, N-(CH$_3$)$_2$); ^{13}C NMR (125 MHz, DMSO-d_6): δ 162.8 (C-7'), 160.6 (C-2/9), 157.7 (C-4'), 134.4 (C-3/8), 131.0 (C-2'/6' & 2a/8a), 130.4 (C-5/6), 127.3 (C-1' & 4/7), 126.8 (C-5a), 123.5 (C-1'), 122.5 (C-2b), 111.4 (C-3'/5'), 40 (N-(CH$_3$)$_2$); EI-MS, m/z (%): 343 [(M$^+$, 69)]; corresponding for m.f.: C$_{21}$H$_{17}$N$_3$O$_2$ and m.w.: 343.07.

2-[(4-Hydroxy-3-methoxy)-benzylidene)amino]benzo[de]isoquinolin-1,3-dione (9): Yellow amorphous powder, 70 % yield, m.p.: 152-155 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 10.01 (s, 1H, 4'-OH), 8.54 (s, 1H, H-7'), 8.52 (br d, J = 7.5 Hz, 2H, H-3/8), 8.48 (br d, J = 8 Hz, 2H, H-5/6), 7.91 (t-like, J = 7.5 Hz, 2H, H-4/7), 7.56 (d, J = 1.5 Hz, 1H, H-2'), 7.33 (dd, J = 8, 1.5 Hz, 1H, H-6'), 6.95 (d, J = 8 Hz, 1H, H-5'), 3.87 (s, 3H, OCH$_3$); ^{13}C NMR (125 MHz, DMSO-d_6): δ 171.5 (C-7'), 160.5 (C-2/9), 151.2 (C-3'), 148.1 (C-4'), 134.5 (C-3/8), 131.0 (C-2a/8a), 130.8 (C-5/6), 127.3 (C-4/7), 126.8 (C-5a), 124.4 (C-6'), 122.4 (C-2b), 115.1 (C-5'), 110.9 (C-2'), 55.6 (-OCH$_3$); EI-MS, m/z (%): 346 [(M$^+$, 92)]; corresponding for m.f.: C$_{20}$H$_{14}$N$_2$O$_4$ and m.w. 346.

2-(2,4-Dimethoxy-benzylidene)amino-benzo[de]isoquinolin-1,3-dione (10): Yellow amorphous powder, 73 % yield, m.p.: 202-205 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 8.61 (s, 1H, H-7'), 8.54 (br d, J = 7 Hz, 2H, H-3/8), 8.51 (br d, J = 8 Hz, 2H, H-5/6), 7.92 (t-like, J = 8 Hz, 2H, H-4/7), 7.59 (d, J = 1.5 Hz, 1H, H-3'), 7.45 (dd, J = 8.5, 2 Hz, 1H, H-5'), 7.16 (d, J = 8.5 Hz, 1H, H-6'), 3.89 and 3.87 (s, 3H each, 2 X-OCH$_3$); ^{13}C NMR (125 MHz, DMSO-δ_6): δ 166 (C-7'), 160.4 (C-2/9), 152.8 (C-4'), 149.1 (C-2'), 134.6 (C-3/8), 131.0 (C-5/

6), 130.9 (C-2a/8a), 127.3 (C-4/7), 126.9 (C-5a), 124.9 (C-1'), 124.6 (C-6'), 122.4 (C-2b), 111.4 (C-5'), 109.1 (C-3'), 55.7 and 55.5 (2 X -OCH$_3$); EI-MS, *m/z* (%): 360 [(M$^+$, 82)]; corresponding for m.f.: C$_{21}$H$_{16}$N$_2$O$_4$ and m.w. 360.11.

2-(2,4-Dichloro-benzylidene)amino-benzo[de]isoqui-nolin-1,3-dione (11): Yellow amorphous powder, 56 % yield, m.p.: 191-194 °C. ^{1}H NMR (500 MHz, DMSO-*d*$_6$): δ 9.12 (s, 1H, H-7'), 8.54 (br d, *J* = 7 Hz, 2H, H-3/8), 8.50 (br d, *J* = 8 Hz, 2H, H-5/6), 8.26 (d, *J* = 8.5 Hz, 1H, H-6'), 7.91 (t-like, *J* = 8 Hz, 2H, H-4/7), 7.89 (d, *J* = 2 Hz, 1H, H-3'), 7.68 (dd, *J* = 8.5, 2 Hz, 1H, H-5'); ^{13}C NMR (125 MHz, DMSO-*d*$_6$): δ 166.9 (C-7'), 160.2 (C-2/9), 138.0 (C-4'), 135.8 (C-2'), 134.6 (C-3/8), 131.3 (C-2a/8a), 131.1 (C-5/6), 129.9 (C-6'), 129.4 (C-3'), 128.8 (C-1'), 128.4 (C-5'), 127.3 (C-4/7), 126.8 (C-5a), 122.3 (C-2b); EI-MS, *m/z* (%): 368 [(M$^+$, 77)]; corresponding for m.f.: C$_{19}$H$_{10}$N$_2$O$_2$Cl$_2$ and m.w. 368.01.

2-[(2-Hydroxy-5-bromo)-benzylidene)amino]benzo-[de]isoquinolin-1,3-dione (12): Yellow amorphous powder, 85 % yield, m.p.: 205-208 °C; ^{1}H NMR (500 MHz, DMSO-*d*$_6$): δ 11.34 (s, 1H, 2'-OH), 8.99 (s, 1H, H-7'), 8.55 (br d, *J* = 7 Hz, 2H, H-3/8), 8.51 (br d, *J* = 8 Hz, 2H, H-5/6), 8.04 (d, *J* = 2.5 Hz, 1H, H-6'), 7.92 (t-like, *J* = 7.5 Hz, 2H, H-4/7), 7.64 (dd, *J* = 9, 2.5 Hz, 1H, H-4'), 7.02 (d, *J* = 9 Hz, 1H, H-3'); ^{13}C NMR (125 MHz, DMSO-*d*$_6$): δ 167.4 (C-7'), 160.4 (C-2/9), 157.8 (C-2'), 136.4 (C-5'), 134.7 (C-3/8), 131.4 (C-2a/8a), 131.1 (C-5/6), 130.7 (C-1'), 127.3 (C-4/7), 126.8 (C-5a), 122.3 (C-2b), 120.1 (C-6'), 119.2 (C-3'), 110.6 (C-4'); EI-MS, *m/z* (%): 394 [(M$^+$, 90)]; corresponding for m.f.: C$_{19}$H$_{11}$N$_2$O$_3$Br and m.w. 394.01.

2-[(Pyridin-3-ylmethylene)-amino]-benzo[de] isoquinolin-1,3-dione (13): Pale green amorphous powder, 76 % yield, m.p.: 198-201 °C. ^{1}H NMR (500 MHz, DMSO-*d*$_6$): δ 7.08 (d, *J* = 1 Hz, 1H, H-2'), 8.91 (s, 1H, H-7'), 8.84 (dd, *J* = 6.5, 1 Hz, 1H, H-4'), 8.55 (br d, *J* = 7.5 Hz, 2H, H-3/8), 8.52 (br d, *J* = 8 Hz, 2H, H-5/6), 8.42 (br d, *J* = 8.5 Hz, 1H, H-6'), 7.93 (t-like, *J* = 7.5 Hz, 2H, H-4/7), 7.02 (dd, *J* = 8.5, 6.5 Hz, 1H, H-5'); ^{13}C NMR (125 MHz, DMSO-*d*$_6$): δ 169.7 (C-7'), 160.2 (C-2/9), 153.2 (C-4'), 150.1 (C-2'), 135.1 (C-6'), 134.7 (C-3/8), 131.4 (C-2a/8a), 131.1 (C-5/6), 128.3 (C-1'), 127.4 (C-4/7), 126.8 (C-5a), 124.3 (C-5'), 122.2 (C-2b); EI-MS, *m/z* (%): 301 [(M$^+$, 87)]; corresponding for m.f.: C$_{18}$H$_{11}$N$_3$O$_2$ and m.w.: 301.06.

2-[(Furan-2-ylmethylene)amino]benzo[de]isoquinolin-1,3-dione (14): Yellow amorphous powder, m.p.: 144-147 °C; ^{1}H NMR (500 MHz, DMSO-*d*$_6$): δ 8.60 (s, 1H, H-6'), 8.53 (2H, br d, *J* = 7.5 Hz, H-3/8), 8.50 (2H, br d, *J* = 8 Hz, H-5/6), 8.12 (1H, br s, H-5'), 7.91 (2H, t-like, *J* = 7.5 Hz, H-4/7), 7.38 (1H, br s, H-3'), 6.85 (1H, br s, H-4'); ^{13}C NMR (125 MHz, DMSO-*d*$_6$): δ 181.2 (C-6'), 160.2 (C-2/9), 159.9 (C-2'), 147.7 (C-5'), 134.6 (C-3/8), 131.4 (C-2a/8a), 131.0 (C-5/6), 127.3 (C-4/7), 126.7 (C-5a), 122.3 (C-2b), 119.8 (C-3'), 112.8 (C-4'); EI-MS, *m/z* (%): 290 [(M$^+$, 60)]; corresponding for m.f.: C$_{17}$H$_{10}$N$_2$O$_3$ and m.w. 290.13.

2-[(Thiophen-3-ylmethylene)amino]benzo[de]-isoquinolin-1,3-dione (15): Yellow amorphous powder, 73 % yield, m.p.: 188-191 °C; ^{1}H NMR (500 MHz, DMSO-*d*$_6$): δ 8.72 (s, 1H, H-6'), 8.53 (br d, *J* = 7.5 Hz, 2H, H-3/8), 8.50 (br d, *J* = 8 Hz, 2H, H-5/6), 8.32 (br d, *J* = 2.5 Hz, 1H, H-5'), 7.91

(t-like, *J* = 7.5 Hz, 2H, H-4/7), 7.79 (dd, *J* = 5, 3 Hz, 1H, H-2'), 7.71 (br d, *J* = 5 Hz, 1H, H-4'); ^{13}C NMR (125 MHz, DMSO-*d*$_6$): δ 166.6 (C-6'), 160.3 (C-2/9), 135.8 (C-3'), 134.5 (C-3/8), 134.0 (C-2'), 131.2 (C-2a/8a), 131.0 (C-5/6), 128.5 (C-5'), 127.3 (C-4/7), 126.8 (C-5a), 124.9 (C-4'), 122.3 (C-2b); EI-MS, *m/z* (%): 306 [(M$^+$, 69)]; corresponding for m.f.: C$_{17}$H$_{10}$N$_2$O$_2$S and m.w.: 306.

General procedure for synthesis of compounds 16-18: A mixture of 2-amino-benzo[de]isoquinolin-1,3-dione (1 mmol) and the corresponding isothiocyanides (1.2 mmol) was heated in DMF (10 mL) for 5 h under reflux. After cooling, the solution was poured in ice water and the solid was collected by filtration. Analytically pure products **16-18** were obtained by recrystallization from aqueous DMF.

1-Allyl-3-(1,3-dioxo-1*H*,3*H*-benzo[de]isoquinolin-2-yl)-thiourea (16): Pale brown amorphous powder, 70 % yield, m.p.: 180-183 °C; ^{1}H NMR (500 MHz, DMSO-*d*$_6$): δ 8.52 (br d, *J* = 8.5 Hz, 2H, H-3/8), 8.48 (br d, *J* = 8.5 Hz, 2H, H-5/6), 7.93 and 7.91 (s, each 1H, 2 × -NH-), 7.90 (t-like, *J* = 8 Hz, 2H, H-4/7), 5.92 (m, 1H, H-2'), 5.22 (dd, *J* = 17.5, 1.5 Hz, 1H, H-3a'), 5.16 (dd, *J* = 10.5, 1.5 Hz, 1H, H-3b'), 4.69 (d, *J* = 5 Hz, 2H, H-1'); ^{13}C NMR (125 MHz, DMSO-*d*$_6$): δ 182.6 (C=S), 160.5 (C-2/9), 134.6 (C-3/8), 131.0 (C-2'), 130.2 (C-2a/8a), 130.8 (C-5/6), 127.3 (C-4/7), 126.0 (C-5a), 121.7 (C-2b), 117.2 (C-3'), 45.0 (C-1'); EI-MS, *m/z* (%): 311 [(M$^+$, 73)]; corresponding for m.f.: C$_{16}$H$_{13}$N$_3$O$_2$S and m.w. 311.06.

1-(1,3-Dioxo-1*H*,3*H*-benzo[de]isoquinolin-2-yl)-3-phenyl-thiourea (17): Yellow amorphous powder, 67 % yield, m.p.: 154-157 °C; ^{1}H NMR (125 MHz, DMSO-*d*$_6$): δ 8.66, 8.58 (br s, each 1H, 2 × -NH-), 8.52 (br d, *J* = 7 Hz, 2H, H-3/8), 8.48 (br d, *J* = 8.5 Hz, 2H, H-5/6), 7.89 (t-like, *J* = 8 Hz, 2H, H-4/7), 7.46 (br d, *J* = 8 Hz, 2H, H-2'/6'), 7.27 (t-like, J = 8 Hz, 2H, H-3'/5'), 6.96 (br t-like, *J* = 7.5 Hz, 1H, H-4'); ^{13}C NMR (500 MHz, DMSO-*d*$_6$): δ 182.5 (C=S), 160.5 (C-2/9), 139.5 (C-1'), 134.5 (C-3/8 & 3'/5'), 131.2 (C-2a/8a), 130.8 (C-5/6), 128.5 (C-2'/6'), 127.3 (C-4/7), 126.7 (C-5a), 122.4 (C-2b), 118.0 (C-4'); EI-MS, *m/z* (%): 347 [(M$^+$, 85)]; corresponding for m.f.: C$_{19}$H$_{13}$N$_3$O$_2$S and m.w.: 347.11.

1-Cyclohexyl-3-(1,3-dioxo-1*H*,3*H*-benzo[de] isoquinolin-2-yl)thiourea (18): Pale green amorphous powder, 79 % yield, m.p.: 227-230 °C; ^{1}H NMR (500 MHz, DMSO-*d*$_6$): δ 9.85, 8.62 (br s, each 1H, 2 × -NH-), 8.54 (br d, *J* = 7 Hz, 2H, H-3/8), 8.51 (br d, *J* = 7 Hz, 2H, H-5/6), 7.91 (t-like, *J* = 8 Hz, 2H, H-4/7), 5.08 (m, 1H, H-1'), 3.35 (br s, 4H, CH$_2$-2'/6'), 2.89 (m, 4H, CH$_2$-3'/5'), 2.73 (br s, 2H, CH$_2$-4'); ^{13}C NMR (125 MHz, DMSO-*d*$_6$): δ 182.4 (C=S), 162.2 (C-2/9), 134.7 (C-3/8), 131.5 (C-2a/8a), 131 (C-5/6), 127.6 (C-5a), 127.3 (C-4/7), 122.8 (C-2b), 46.0 (C-1'), 38.9 (C-2'/6'), 35.7 (3'/5'), 30.7 (C-4'; EI-MS, *m/z* (%): 353 [(M$^+$, 77)]; corresponding for m.f.: C$_{19}$H$_{19}$N$_3$O$_2$S and m.w.: 353.13.

General procedure for synthesis of compounds 19-24: A mixture of 2-amino-benzo[de]isoquinolin-1,3-dione (1 mmol) and the corresponding acid anhydride (1.1 mmol) was heated in glacial acetic acid (15 mL) for 6 h under reflux. After cooling, the solution was poured in ice water and the resulted product was collected by filtration, washing with water, dried. Analytically pure products **19-24** were obtained by recrystallization from aqueous DMF.

2-(2,5-Dioxo-pyrrolidin-1-yl) benzo[de]isoquinolin-1,3-dione (19): Yellow amorphous powder, 80 % yield, m.p.: 260-263 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 8.65 (br d, J = 8 Hz, 2H, H-3/8), 8.63 (br d, J = 7.5 Hz, 2H, H-5/6), 7.99 (t-like, J = 8 Hz, 2H, H-4/7), 3.12 (br s, 4H, 2 × -CH$_2$-3'/4'); ^{13}C NMR (125 MHz, DMSO-d_6): δ 172.8 (C-2'/5'), 159.9 (C-2/9), 136.4 (C-3/8), 133.2 (C-2a/8a), 132.5 (C-5/6), 127.7 (C-4/7), 126.1 (C-5a), 120.3 (C-2b), 26.6 (C-3'/4'); EI-MS, m/z (%): 294 [(M$^+$, 92)]; corresponding for m.f.: C$_{16}$H$_{10}$N$_2$O$_4$ and m.w.: 294.09.

2-(2,5-Dioxo-2,5-dihydro-pyrrol-1-yl)benzo[de]-isoquinolin-1,3-dione (20): Pale green amorphous powder, 76 % yield, m.p.: 284-287 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 8.65 (br d, J = 8 Hz, 2H, H-3/8), 8.63 (br d, J = 7.5 Hz, 2H, H-5/6), 7.94 (t-like, J = 8 Hz, 2H, H-4/7), 6.90 (br s, 2H, 2 × -CH-3'/4'); ^{13}C NMR (125 MHz, DMSO-d_6): δ 171.1 (C-2'/5'), 161.5 (C-2/9), 136.4 (C-3/8), 134.6 (C-3'/4'), 132.9 (C-2a/8a), 132.5 (C-5/6), 127.7 (C-4/7), 126.6 (C-5a), 120.5 (C-2b); EI-MS, m/z (%): 292 [(M$^+$, 72)]; corresponding for m.f.: C$_{16}$H$_8$N$_2$O$_4$ and m.w.: 292.01.

2-(1,3-Dioxo-1,3-dihydro-isoindol-2-yl)benzo[de]-isoquinolin-1,3-dione (21): Pale green amorphous powder, 80 % yield, m.p.: 225-228 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 8.69 (br d, J = 7.5 Hz, 2H, H-3/8), 8.67 (br d, J = 8 Hz, 2H, H-5/6), 8.17 (m, 2H, H-3'/6'), 8.09 (m, 2H, H-4'/5'), 8.01 (t-like, J = 8 Hz, 2H, H-4/7); ^{13}C NMR (125 MHz, DMSO-δ$_6$): δ 166.0 (C-2'/7'), 159.5 (C-2/9), 136.8 (C-4'/5'), 136.2 (C-3/8), 132.7 (C-5/6), 131.6 (C-2a/8a), 128.4 (C-2a/6a), 127.8 (C-4/7), 126.6 (C-5a), 124.6 (C-3'/6'), 122 (C-2b); EI-MS, m/z (%): 342 [(M$^+$, 84)]; corresponding for m.f.: C$_{20}$H$_{10}$N$_2$O$_4$ and m.w. 342.08.

[2,2']Bi[benzo[de]isoquinolinyl]-1,3,1',3'-tetraone (22): obtain as yellow amorphous powder, 87 % yield, m.p.: 205-208 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 8.57 (br d, J = 8.5 Hz, 4H, 2 × H-3/8), 8.54 (br d, J = 7.5 Hz, 4H, 2 × H-5/6), 7.92 (t-like, J = 8 Hz, 4H, 2 × H-4/7); ^{13}C NMR (125 MHz, DMSO-d_6): δ 160.7 (2 × C-2/9), 135.4 (2 × C-3/8), 132.4 (2 × C-5/6), 131.4 (2 × C-2a/8a), 129.7 (2 × C-5a), 127.5 (2 × C-4/7), 119.0 (2 × C-2b); EI-MS, m/z (%): 392 [(M$^+$, 95)]; corresponding for m.f.: C$_{24}$H$_{12}$N$_2$O$_4$ and m.w.: 392.06.
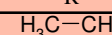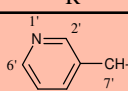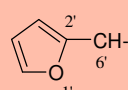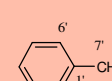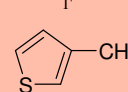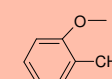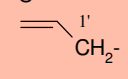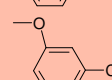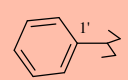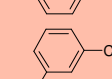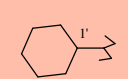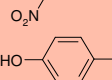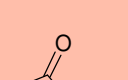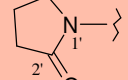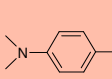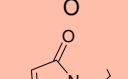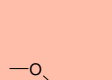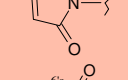
6-(1,3-Dioxo-1H,3H-benzo[de]isoquinolin-2-yl)-2-oxo-6-aza-s-indacene-1,3,5,7-tetraone (23): Green amorphous powder, 50 % yield, m.p.: 257-260 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 8.68 (br d, J = 7.5 Hz, 2H, H-3/8), 8.66 (br d, J = 8 Hz, 2H, H-5/6), 8.43 (s, 2H, H-3'/7'), 8.03 (t-like, J = 8 Hz, 2H, H-4/7); ^{13}C NMR (125 MHz, DMSO-d_6): δ 166.6 (C-4'/6'), 162.5 (C-2'/8'), 160.5 (C-2/9), 136.8 (C-3a'/6a'), 136.6 (C-2a'/7a'), 134.5 (C-3/8), 131.9 (C-2a/8a), 130.4 (C-5/6), 127.7 (C-4/7), 126.4 (C-5a), 122.3 (C-2b), 120.4 (C-3'/7'); EI-MS, m/z (%): 412 [(M$^+$, 61)]; corresponding for m.f.: C$_{22}$H$_8$N$_2$O$_7$ and m.w.: 412.09.

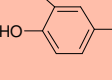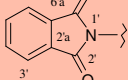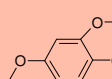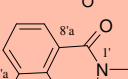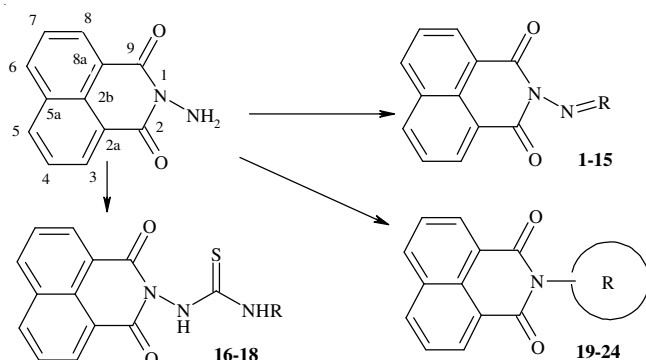**2,6-Bis-(1,3-dioxo-1H,3H-benzo[de]isoquinolin-2-yl)pyrrolo[3,4-f]isoindole-1,3,5,7-tetraone (24):** Yellow amorphous powder, 64 % yield, m.p.: 246-249 °C; H-NMR (500 MHz, DMSO-d_6): δ 8.69 (br d, J = 8 Hz, 4H, H-3/8 & 3"/8"), 8.67 (br d, J = 7.5 Hz, 4H, H-5/6 & 5"/6"), 8.39 (s, 2H, H-3'/7'), 8.02 (t-like, J = 8 Hz, 4H, H-4/7 & 4"/7"); ^{13}C NMR (125 MHz, DMSO-d_6): δ 162.4 (C-2'/8' & 4'/6'), 160.2 (C-2/9 & 2"/9"), 134.0 (C-2a'/7a' & 3a'/6a'), 133.0 (C-3/8 & 3"/8"), 131.8 (C-2a/8a & 2a"/8a"), 129.7 (C-5/6 & 5"/6"), 127.9 (C-4/7 & 4"/7"), 126.5 (C-5a/5a"), 121.3 (C-2b/2b"), 120.3 (C-3'/7'); EI-MS, m/z (%): 606 [(M$^+$, 89)]; corresponding for m.f.: C$_{34}$H$_{14}$N$_4$O$_8$ and m.w.: 606.11.

RESULTS AND DISCUSSION

In present methodology, three main reactions were designed using 2-amino-benzo[de]isoquinolin-1,3-dione as starting compound to afford the target products **1-15**, **16-18** and **19-24** (**Scheme-I** and Table-1). In the first reaction, 2-amino-benzo[de]isoquinolin-1,3-dione was treated with a variety of aryl(hetero)aldehydes in dimethylformamide in the presence of few drops of glacial acetic acid for 5.5 h under reflux condition, affording the desired products **1-15** with satisfactory yields[12-14]. The second group of compounds **16-18** were

		TABLE-1	
		SYNTHESIZED 2-AMINO-BENZO	
		[DE]ISOQUINOLIN-1,3-DIONE DERIVATIVES	
Cpd. Nr	R	Cps.	R
1	H$_3$C—CH-	13	
2		14	
3		15	
4		16	
5		17	
6		18	
7		19	
8		20	
9		21	
10		22	
11		23	
12		24	

Scheme-I: Main routes for synthesis of the target compounds (**1-24**)

synthesized by the reaction of the starting material with appropriate isothiocyanides for 5 h, under reflux, as well. The last set of target compounds **19-24** were obtained by the reaction of 2-amino-benzo[de]isoquinolin-1,3-dione with the convenient acid anhydrides in boiling glacial acetic acid for 6 h. The structures of all products **1-24** were characterized by IR (1776-1700 cm^{-1}) and MS spectra and have been unambiguously proven by ^{1}H- and ^{13}C NMR (see experimental data). An empirical numeration system was chosen for parent compound (**Scheme-I**) and target molecules (Table-1) in order to simplify understanding of the experimental data and discussion of their structures.

^{1}H NMR played an essential role for proving the structures of the target molecules. This is based on the fact of the symmetric structure for 2-amino-1*H*-benzo[de]isoquinolin-1,3-dione as starting compound and parent moiety in all compounds **1-24** due to the presence of 2-fold plane or axis of symmetry. In the ^{1}H NMR spectrum of the parent amine, the symmetric structure was simply detected as three pairs of two equivalent aromatic protons in the form of A2B2M2-spin coupling system at δ_H ppm 8.54 (br d, $J = 7$), 8.49 (br d, $J = 8$) and 7.90 (t-like, $J = 8$), attributable to H-3/8, H-5/6 and H-4/7, respectively. As will as the corresponding ^{13}C-signals were assigned at δ_C ppm 134.5, 130.8 and 127.3, respectively in its ^{13}C NMR spectrum as three key-signals together with the two equivalent imide carbonyl carbon at 160.3 (C-2/9), among a total of seven resonances due to symmetric structure. The most upfield two carbons at 125.9 (C-5a) and 122.4 (C-2b) were another two key signals in all spectra for the junction position. The presence of free amino group was concluded from a broad singlet at 5.58 integrated to two protons. A final proof for the structure of starting compound was acheived from the moleculer ion peak at *m/z* 212 [(M$^{+•}$)] in its EI-MS spectrum. All synthesized compounds showed more or less the same previous key ^{1}H- and ^{13}C-signals of 2-amino-benzo[de]isoquinolin-1,3-dione basic structure as confirmative document of the reaction completion; in addition to the corresponding resonances of new inserted functional group in each case. The condensation product (**1**) that produced with acetaldehyde was confirmed from its intrinsic imine methine proton at 7.91 and methyl at 1.90 (br s) and their own ^{13}C-signals at δ_C ppm 148.5 and 14.0, respectively, alongside the moleculer ion peak at *m/z* 238 [(M$^{+•}$)] with more 26 mu relative to the parent due to extra C$_2$H$_2$ moiety. Similarly, the new imide (**2**) showed the extra ^{1}H-signals of propimide moiety at 7.94 (m) , 2.60 (m) and

1.10 (t, $J = 7$), assignable for methine, methylene and methyl groups, respectively. Their ^{13}C-signals were detected at 143.8, 21.4 and 11.9 which were considered as confirmative document for the condensation product with propanal. EI-MS of imine **2** exhibited a moleculer ion peak at 252 with more 14 mu than that of **1**, corresponding to extra CH$_2$ group. The success of condensation reactions with aromatic aldehydes to form the products **3-12** has been unambiguously proven from the characteristic downfield singlet signal of methine proton in the range of about 9.1-8.6 (H-7') and corresponding ^{13}C-signal in the range of δ_C ppm 172-166, except for **8**, in which H-7' was detected relatively upfield at 8.45 ppm and its own C-signal at 162.8 due to the anisotropic and +R effects of dimethyl-amino group at *p*-position. The intrinsic splitting pattern (multiplicity & J-values) of the aromatic resonances in the ^{1}H NMR spectra represented a finger print in each case of condensation products with aromatic aldehydes (**3-12**). An unsubstituted phenyl group was deduced in compound **3** from its pattern of three signals at 7.97 (br d, $J = 7.5$), 7.67 (t-like, $J = 8$) and 7.61 (t-like, $J = 7.5$), interpretable for H-2'/6', H-4' and H-3'/5' and their ^{13}C-signals at 132.7 (C-4'), 129.1 (C-2'/6') and 128.8 (C- 3'/5'). In case of 2'-methoxyphenyl derivative (**4**), four protons were detected at 8.13 (dd, $J = 8$, 1.5, H-3'), 7.65 (td, $J = 8.5$, 1.5 Hz, H-4'), 7.24 (br d, $J = 8.5$ Hz, H-6'), 7.15 (td, $J = 7.5$, 1.5 Hz, H-5') with intrinsic *J*-values for *meta-* and *ortho*-coupling together with a methoxyl singlet at 3.89. The characteristic four resonances of that ring was assigned according to the effect of methoxylation at C-2', where it caused special downfield shift of the adjacent proton *i.e.* H-3' in ^{1}H NMR, while in ^{13}C NMR C-2' was noticed downfield at 159.1 with about Δ +30 ppm and the adjacent C-3' at 112.3 upfield with Δ -12 ppm according to α-down-/β-upfield substituent additive rules relative to benzene carbons. The 3'-methoxylation in derivative **5** was followed from the downfield shift of the adjacent H-2' at 7.53 in the ^{1}H NMR, whereas C-3' was downfield shifted to 159.6 and C-2' upfield at 112.5. The same splitting pattern was observed in case of 3-nitro derivative (**6**), where the nitro group led to similar effects on ^{1}H and ^{13}C spectra, whereby H-2' was drasticlly downfield shifted at δ_H ppm 8.79 in the form of t-like due to *meta*-coupling of the same *J*-value (1.5) with both H-4' and H-6'. Similarly, in the ^{13}C NMR and according to the substitution additive rules, C-3' was interpreted downfield at δ_C ppm 148.3 and C-2' upfield at 122.8 by the effect of 3'-nitro group. It is of great importance to notice that H-7' has the strongest downfield shift to 9.02 ppm by -I and -R effects of nitro group in the ^{1}H NMR of **6**. The condensation products with *para*-substituted aromatic aldehydes (**7,8**) was clearly explained on the basis of the appearance of their aromatic protons in the form of two A2×2-spin coupling systems as two *ortho*-doublets at δ_H ppm 7.81 and 6.95 ($J = 8.5$) in case of **7** and at 7.75 and 6.95 ($J = 9$) in product **8**, assignable for H-2'/6' and H-3'/5', respectively. In their ^{13}C NMR, the corresponding resonances were detected as two pairs of equivalent C-signals at δ_C ppm 130.9 (C-2'/6') and 115.9 (C-3'/5') and at 131 (C-2'/6') and 111.4 (C-3'/5') in case of **7** and **8**, respectively. As final confirmation for condensation with 4'-OH aldehyde was concluded from the characteristic downfield location of C-4' at 161.6 in **7**, while in **8**, C-4' was detected at 157.7 by the deshielding effect of N-dimethyl

group that was appeared at its intrensic positions of 3.06 and 40 ppm in ^{1}H and ^{13}C NMR spectra. The condensation products with disubstituted aldehydes (**9-12**) were easily interpreted on the basis of their splitting pattern of the three aromatic proton types as *meta* doublet, *ortho-meta* doublet of doublet and *ortho* doublet. The ^{1}H and ^{13}C spectra of **9** were characterized by the downfield shift of H-2' at 7.56 (d, $J = 1$) due to the effect of methoxyl group and coupling with H-6' and characteristic downfield location of C-3' and C-4' at 151.2 and 148.1, respectively, because of their oxygenation (Δ+30). Whereas H-3' was strongly downfield located at 7.59 (d, $J = 1.5$) due to the downfield effect by the two methoxyls attached to the two neighbouring carbons in the ^{1}H NMR of **10**. Taking into account the substitution additive rules, its ^{13}C spectrum was characterized by strong downfield location of C-4' and C-2' at 152.8 and 149.1 due to direct substitution with two OCH$_3$-groups that resulted in sharp dublicated upfield shift of C-3' into 109.1 ppm (Δ-20). Furthermore, ^{13}C NMR of **11** showed intrinsic downfield shift of C-4' and C-2' at 138 and 135.8, respectively due to electron withdrawing effect by chlorine atoms. As well as the brominated C-5' resulted in characteristic downfield shift of both H-6' and H-4' to 8.04 (d, $J = 2.5$) and 7.64 (dd, $J = 9$, 2.5), in the ^{1}H NMR spectrum of condensated product **12** and its ^{13}C NMR showed characteristic downfield location of C-2' at 157.8 and C-5' at 136.4 due to the presence of hydroxyl and bromo groups which were resulted in upfield of both C-3' and C-4' at 119.2 and 110.6, respectively.

The methoxyl groups in compounds **4**, **5**, **9** and **10** were interpreted in the ^{1}H NMR at about 3.9-3.8 and 56-55.5 ppm in the ^{13}C NMR spectra. Further confirmative document for the exchangable OHs-protons in **7**, **9** and **12** was followed from its own highly deshielded singlets at 10.36, 10.01 and 11.34, respectively. The products (**13-15**), which are prepared from the heterocyclic aldehydes gave characteristic ^{1}H- and ^{13}C NMR of the new inserted heteroimine ring together with more or less the same paterrn for the parent structure (2-amino-benzoisoquinoline). The ^{1}H NMR of **13-15** showed an intrinsic singlet of imine CH-proton at δ$_H$ ppm 8.91, 8.60 and 8.72, assignable for H-7' and H-6', respectively, corresponding to characteristic ^{13}C-signals at 169.7 (C-7'), 181.2 and 166.6 (C-6'). The strong downfield shift of H-2' and H-4' to 9.09 (d, $J = 1$) and 8.84 (dd, $J = 6.5$, 1) and their corresponding C-signals at 153.2 (C-4'), 150.1 (C-2'), was confirmative document for the condensated product **13** due to the -I and -R effects of the ring-N atom and conjugation with imine double bond. In addition the characteristic strong downfield shift of ^{1}H-resonances (by the effect of O-ring and imine double bond deshielding) and their splitting pattern was clear indication for the successful preparation of furanimine product (**14**), where all three protons (H-5', H-3' and H-4') appeared at 8.12, 7.38 and 6.85 as broad singlets due to their known very small J-values of furan ring. According to the same deshielding structural parametrs and substituent additive rules C-2' and C-5' were assigned downfield at 159.9 and 147.7, but C-3' and C-4' were upfield located at 119.8 and 112.8 by the effect of β-upfield shift. As an intrinsic structural feature, C-6'-imine was assigned at the largest δ$_C$-value (181.2 ppm) among all imine carbons of the prepared 24 products. Similarly, 3-

thiophenaldehyde product (**15**) showed characteristic splitiing pattern and different small J-values for allyl coupled protons H-2', H-5' and H-4' at 8.32 (br d, $J = 2.5$), 7.79 (dd, $J = 5$, 3) and 7.71 (br d, $J = 5$), respectively; in addition their characteristic ^{13}C-signals at 135.8 (C-3'), 134 (C-2'), 128.5 (C-5') and 124.9 (C-4') by the effect of the ring-S and deshielding by imine double bond. The synthesized coupling products (**16-18**) were established by interpretation of their own intrinsic key-signals of isothiocyanide structural residues as allyl (**16**), phenyl (**17**) and cyclohexyl (**18**) amine in ^{1}H and ^{13}C NMR, especially the most downfield thione-carbonyl carbon at about δ$_C$ ppm 182.5. The allyl residue was revealed by its own splitting pattern for H-1', H-2' and H-3' geminal olifenic protons (see experimental ^{1}H NMR data) and intrinsic ^{13}C signals at 131 (C-2'), 117.2 (C-3') and 45 (C-1'). The N-phenyl derivative was simply confirmed through characteristic three resonances as an A2M2M'-spin coupling system at 7.46 (br d, $J = 8$), 7.27 (t-like, $J = 8$), 6.96 (br t-like, $J = 7.5$) assignable to H-2'/6', H-3'/5' and H-4', respectively, together with phenyl four ^{13}C-resonances at 139.5 (C-1'), 134.5 (C-3'/5'), 128.5 (C-2'/6'), 118 (C-4'). In the aliphatic region of ^{1}H NMR for derivative **18**, characteristic four 1H-signals were clearly detected at 5.08 (m, H-1'), 3.35 (br s, CH$_2$-2'/6'), 2.89 (m, CH$_2$-3'/5') and 2.73 (br s, CH$_2$-4') and their ^{13}C-signals at 46 (C-1'), 38.9 (C-2'/6'), 35.7 (3'/5') and 30.7 (C-4′), respectively. Concerning products **19-24**, their NMR spectra reserved the same pattern of the parent moity along with various aliphatic (**19, 20**) or aromatic (**21-24**) resonances corresponding to the anhydride moiety. Because of the symmetric structure of **19** due to symmetric structures of its components, its ^{1}H NMR displayed an aliphatic singlet for the two equivalent methylene protons together with the same pattern of parent moiety. ^{13}C NMR showed typical seven signals for the parent moiety and two characteristic resonances at 172.8 (C-2'/5'), 26.6 (C-3'/4') for the two equivalent succinimide carbonyls and methylene carbons. Also, based on the structural symmetry in the molecule of **20**, its ^{1}H NMR spectrum revealed a singlet at 6.90 of the two equivalent olifenic methine protons (H-3'/4') that were supported by their own ^{13}C resonance at 134.6 and the carbonyl resonance at 171.1 (C-2'/5'). Moreover, based on the structural symmetry of **21**, the phthalimide residue was simply explained in the ^{1}H NMR data as a pair of *ortho* doublets at 8.17 and 8.09 (d, $J = 8$), attributable to H-3'/6' and H-4'/5' in the form of A2B2-spin coupling system. The ^{13}C NMR showed typical four resonances for phthalimide moiety in particular that of equivalent imide carbonyls at 166 (C-2'/7'). As it was expected, heating a sample of the parent amine in glacial acetic acid resulted in the formation of its symmetric dimer (**22**), which gave the same ^{1}H and ^{13}C NMR spectra of the parent. With respect to **23**, depending on the same structural feature of symmetry, a 2-fold axis or plane of symmetry led to the appearence of the new coplanar part in the form of only strongly deshielded singlet at 8.43 of the two equivalent protons H-3'/7'.

The two carbonyls of the dianhydride moiety were assigned at 166.6 and 162.5 (C-4′/6′ and 2′/8′). In compound **24**, the pyromellitic diimide moiety showed a singlet at 8.39 (H-3′/7′) and ^{13}C-resonances at 162.4, 134.0 and 120.3 to confirm its co-planar symmetric structure.

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