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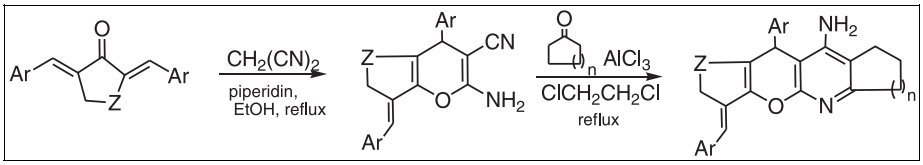

In this paper, we describe a two-step synthesis of a series of tacrine analogues. In the first step, α,α'-bis(substituted-benzylidene)cycloalkanones are reacted with malononitrile to afford 2-amino-3-cyano-4*H*-pyrans. The second step involves the conversion of pyrans to pyrano [2,3-*b*]pyridines with the use of $AlCl_3$ as catalyst.

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Pyranopyridines are important motifs that find wide applications in drugs and pharmaceuticals [1]. They are present in the framework of numerous biologically active alkaloids such as ribalinine, geibalasine, and flindersine [2]. Pyranopyridines exhibit a wide range of drug activities such as anti-allergic, psychotropic, anti-inflammatory, and estrogenic properties [3]. On the other hand, benzopyrano pyridines possess antiproliferative [4], cancer chemopreventive [5], anti-bacterial (including anti-tubercular) [6], anti-myopic [7], anti-histamic [8], hypotensive [9], anti-rheumatic [10], and anti-asthmatic activities [11]. In recent years, much attention has been devoted to the synthesis of tacrine (9-amino-1,2,3,4-tetrahydroacridine) commercially knows as THA. Tacrine is an approved drug for the treatment of Alzheimer disease [12].

Various methods have been reported for the synthesis of this drug [13], but the Friedländer [14] reaction is the most popular and convenient approach to the synthesis of polysubstituted pyridines involving the annulation of *o*-aminoaryl ketones with carbonyl compounds having a reactive α-methylene group [15]. Lewis acids have been reported to catalyze this reaction [16].

As a part of our ongoing research on heterocyclic compounds of biological significance [17], we have carried out a two-step reaction setup for the synthesis of some novel tacrine analogues (Scheme 1).

RESULTS AND DISCUSSION

α,α′-Bis(substituted-benzylidene)cycloalkanones (**1**) were prepared and employed as starting materials with the use of a previously described method [18]. On the basis of previous reports [19] on systems similar to ours (**2a–2h**), a possible mechanism for the (**2**) to (**3**) transformation is shown in (Scheme 2). It is clear that $AlCl_3$ plays an important acid catalysis function in these reactions [20]. A series of heterocycles (**2a–2h**) were prepared and converted to the corresponding novel pyrano[2,3-*b*]pyridines (**3a–3j**). Reaction times in our work are shorter than previously reported [21], and work-up procedures do not require column chromatography. The reactions seem to show similar results (65–80%) irrespective of the ring size of the cycloalkanones under investigation. Use of different aryl groups does not affect the yields. The yields for naphthyl derivatives are, however, lower relative to the phenyl analogues.

CONCLUSIONS

In conclusion, we have applied the Michael addition–cyclization reaction to a new type of α,β-unsaturated starting materials and have found that these compounds react favorably to give the corresponding 2-amino-3-cyano-4*H* pyrans. Finally, we have used $AlCl_3$ to transform these 4*H*-pyrans to novel pyrano[2,3-*b*]pyridines (tacrine analogues) via the Friedländer reaction with promising drug potentials. In both steps of the synthesis, the reaction conditions are mild and yields are high.

EXPERIMENTAL

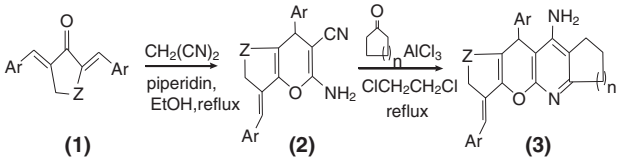
General procedure for the synthesis of 2-amino-3-cyano-4*H*-pyrans (2a–2h). α,α′-Bis(substituted-benzylidene)cycloalkanones (1.0 eq.), malononitrile (1.2 eq.), and catalytic amount of piperidine were refluxed in ethanol for 2–5 h. After cooling, the solvent was distilled and the residue was recrystallized from ethanol. The results are tabulated in Table 1.

***(7E)*-2-Amino-7-benzylidene-4,5,6,7-tetrahydro-4-phenylcyclopenta[*b*]pyran-3-carbonitrile (2a).** mp 228 °C; Ref. mp 228–230 °C; IR (KBr): 3447, 3328, 3246, 3202, 2914, 2842, 2196, 1683, 1638, 1587, 1490, 1451, 1408, 1382, 1106,

700 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): $\delta = 2.18$ (1H, m, CH); 2.33 (1H, m, CH); 2.39 (2H, m, CH_2); 4.24 (1H, s, CH); 4.63 (2H, s, NH_2); 6.44 (1H, s, CH); 7.18–7.39 (10H, Ar); ^{13}C NMR (75 MHz, $CDCl_3$): $\delta = 26.9$, 28.0, 41.0, 60.8, 117.2, 119.9, 121.7, 126.5, 127.4, 127.8, 128.1, 128.5, 128.8, 136.7, 137.2, 141.5, 146.3, 159.9 ppm. *Anal*. Calcd for $C_{22}H_{18}N_2O$: C, 80.96; H, 5.56; N, 8.58%. Found: C, 80.89; H, 5.49; N, 8.50%.

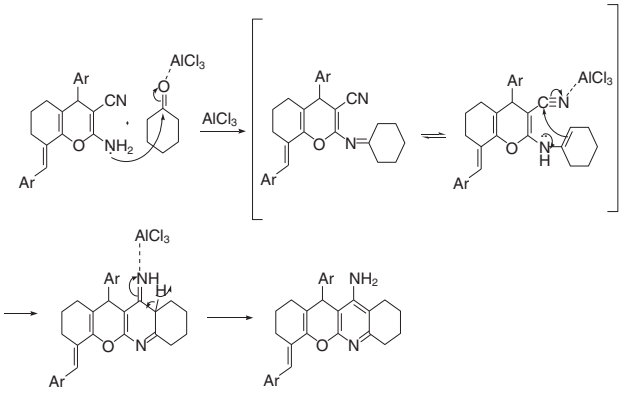
***(8E)*-2-Amino-8-benzylidene-5,6,7,8-tetrahydro-4-phenyl-4*H*-chromene-3-carbonitrile (2b)**. mp 230 °C; Ref. mp 230–231 °C; IR (KBr): 3431, 3337, 3047, 3023, 2945, 2921, 2844, 2830, 2188, 1669, 1636, 1619, 1412, 1131, 700 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): $\delta = 1.55$ (2H, m, CH_2); 1.99 (2H, m, CH_2); 2.52 (1H, m, CH_2); 2.67 (1H, m, CH_2); 3.96 (1H, s, CH); 4.50 (2H, s, NH_2); 6.87 (1H, s, CH); 7.21–7.38 (10H, Ar); ^{13}C NMR (75 MHz, $CDCl_3$): $\delta = 22.2$, 27.0, 27.4, 43.5, 60.4, 115.2, 119.8, 122.6, 126.81, 127.3, 127.9, 128.1, 128.7, 129.2, 129.4, 137.0, 159.0 ppm.

Scheme 1. Synthesis of tacrine analogues from α,α'-bis(substituted-benzylidene)cycloalkanones.



2a-2h(Table 1) 3a-3j(Table2)

Scheme 2. Proposed mechanism.



***(8E)*-2-Amino-5,6,7,8-tetrahydro-4-(naphthalen-2-yl)-8-((naphthalen-6-yl)methylene)-4*H*-chromene-3-carbonitrile (2c)**. mp 244–245 °C; IR (KBr): 3457, 3326, 3256, 3211, 3184, 3051, 2918, 2905, 2851, 2195, 1674, 1643, 1596, 1410, 1130, 879, 759 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): $\delta = 1.60$ (2H, m, CH_2); 1.91 (2H, m, CH_2); 2.64 (1H, m, CH); 2.79 (1H, m, CH); 4.1 (1H, s, CH); 4.55 (2H, s, NH_2); 7.06 (1H, s, CH); 7.38–7.86 (14H, Ar); ^{13}C NMR (75 MHz, $CDCl_3$): $\delta = 23.0$, 24.6, 31.6, 42.8, 58.0, 110.8, 117.6, 122.6, 123.4, 123.7, 124.0, 124.5, 124.8, 126.3, 126.5, 126.8, 127.3, 128.0, 130.4, 130.5, 130.6, 130.8, 132.6, 140.3, 140.5, 140.8, 160.0. *Anal*. Calcd for $C_{31}H_{24}N_2O$: C, 84.52; H, 5.49; N, 6.36%. Found: C, 84.46; H, 5.50; N, 6.40%.

***(8E)*-2-Amino-5,6,7,8-tetrahydro-6-methyl-4-(naphthalen-2-yl)-8-((naphthalen-6-yl)methylene)-4*H*-chromene-3-carbonitrile (2d)**. mp 194–196 °C; IR (KBr): 3457, 3327, 3210, 3184, 3049, 3017, 2951, 2901, 2868, 2828, 2191, 1671, 1640, 1595, 1410, 1129, 758 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): $\delta = 0.84$ (3H, m, CH_3); 1.61 (1H, m, CH); 1.86 (1H, m, CH); 1.94 (1H, dd, $J = 2.1$, 12 Hz, CH); 2.15 (1H, dd, $J = 1.5$, 11.4 Hz, CH); 2.91 (1H, d, $J = 15$ Hz, CH); 4.14 (1H, s, CH); 4.57 (2H, s, NH_2); 7.07 (1H, s, CH); 7.37–7.87 (14H, Ar); ^{13}C NMR (75 MHz, $CDCl_3$): $\delta = 20.9$, 28.9, 34.8, 35.2, 36.1, 43.4, 60.4, 114.5, 119.8, 122.9, 125.6, 125.8, 126.0, 126.2, 126.7, 126.8, 127.6, 127.9, 128.0, 128.1, 128.8, 129.8, 132.2, 133.2, 134.5, 139.8, 158.9, 159.0 ppm. *Anal*. Calcd for $C_{32}H_{26}N_2O$: C, 84.55; H, 5.77; N, 6.16%. Found: C, 84.50; H, 5.76; N, 6.15%.

***(8E)*-2-Amino-6-ethyl-5,6,7,8-tetrahydro-4-(naphthalen-2-yl)-8-((naphthalen-6-yl)methylene)-4*H*-chromene-3-carbonitrile (2e)**. mp 205–207 °C; IR (KBr): 3457, 3329, 3254, 3212, 3048, 2955, 2900, 2872, 2864, 2822, 2195, 1673, 1642, 1595, 1409, 1136, 747 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): $\delta = 0.68$ (3H, m, CH_3); 1.12 (2H, m, CH_2); 1.27 (2H, m, CH_2); 1.98 (1H, m, CH); 1.99 (2H, m, CH_2); 4.14 (1H, d, $J = 3.9$ Hz, CH); 4.56 (2H, d, $J = 7.5$ Hz, NH_2); 7.07 (1H, s, CH); 7.25–7.87 (14H, Ar); ^{13}C NMR (75 MHz, $CDCl_3$): $\delta = 11.3$, 28.2, 32.7, 33.2, 33.8, 35.0, 35.5, 43.4, 60.6, 114.4, 114.5, 122.9, 123.1, 126.0, 126.2, 126.7, 127.4, 127.6, 127.6, 127.9, 128.1, 128.9, 129.6, 129.8, 132.2, 132.9, 133.2, 133.4, 139.9, 158.8 ppm. *Anal*. Calcd for $C_{33}H_{28}N_2O$: C, 84.58; H, 6.02; N, 5.98%. Found: C, 84.48; H, 6.08; N, 5.90%.

***(8E)*-2-Amino-8-benzylidene-5,6,7,8-tetrahydro-6-methyl-4-phenyl-4*H*-chromene-3-carbonitrile (2f)**. mp 201–203 °C; IR (KBr): 3431, 3338, 3026, 2947, 2850, 2826, 2189, 1672, 1638, 1619, 1593, 1414, 1150, 699 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): $\delta = 0.86$ (3H, t, $J = 6.59$ Hz, CH_3); 1.63 (3H, m, CH_2); 2.17 (1H, m, CH_2); 2.80 (1H, m, CH_2); 3.93 (1H, s, CH); 4.49 (2H, s, NH_2);

Table 1

Preparation of 2-amino-3-cyano-4*H*-pyrans from α,α′-bis(substituted-benzylidene)cycloalkanones.

Product	Ar	Z	Time (h)	Yield (%)	mp (°C)
2a	C_6H_5	CH_2	1	75	228
2b	C_6H_5	CH_2CH_2	1	80	(228–230)[a]
2c	$C_{10}H_7$	CH_2CH_2	3	80	230
2d	$C_{10}H_7$	CH(Me)–CH_2	4	61	(230–231) [a]
2e	$C_{10}H_7$	CH(Et)–CH_2	5	60	244–245
2f	C_6H_5	CH(Me)–CH_2	3	70	194–196
2g	*o*-BrC_6H_4	CH_2CH_2	4	87	205–207
2h	*p*-$CF_3C_6H_4$	CH_2CH_2	3	80	

[a]mp References [22,23].

6.87 (1H, s, CH); 7.21–7.39 (10H, Ar); ^{13}C NMR (75 MHz, $CDCl_3$): δ = 20.2, 32.4, 32.7, 36.8, 45.7, 54.7, 110.4, 123.3, 123.5, 124.4, 124.6, 126.7, 126.9, 128.4, 128.8, 130.6, 130.7, 142.5, 145.7, 158.8. *Anal*. Calcd for $C_{24}H_{22}N_2O$: C, 81.33; H, 6.26; N, 7.90%. Found: C, 81.28; H, 6.24; N, 7.87%.

***(8E)*-8-(2-Bromobenzylidene)-2-amino-4-(2-bromophenyl)-5,6,7,8-tetrahydro-4*H*-chromene-3-carbonitrile (2g)**. mp 219–221 °C; IR (KBr): 3448, 3331, 2197, 1667, 1637, 1599, 1486, 1419, cm^{-1}; ^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.60–2.70 (6H, m, aliph.); 3.94 (1H, s); 4.56 (2H, s, NH_2); 6.79 (1H, s, CH); 7.11–7.48 (8H, Ar); ^{13}C NMR (75 MHz, $CDCl_3$): δ = 22.1, 27.0, 27.3, 43.1, 59.9, 115.1, 119.7, 120.8, 121.3, 121.7, 129.6, 129.8, 130.8, 131.3, 131.9, 135.7, 141.4, 141.8, 158.8 ppm. *Anal*. Calcd for $C_{23}H_{18}Br_2N_2O$: C, 55.42; H, 3.61; N, 5.62%. Found: C, 55.17; H, 3.31; N, 5.62%.

***(8E)*-8-(4-(trifluoromethyl)benzylidene)-2-amino-4-(4-(trifluoromethyl)phenyl)-5,6,7,8-tetrahydro-4*H*-chromene-3-carbonitrile (2h)**. mp 263–265 °C; IR (KBr): 3450, 3333, 2190, 1668, 1640, 1598, 1480, 1418, cm^{-1}; ^{1}H NMR (300 MHz, MeOH-d_6): δ = 1.58–1.71 (4H, m, CH_2); 1.82–1.90 (1H, m, CH); 2.06–2.15 (1H, m, CH); 2.95 (2H, s, NH_2); 4.10 (1H, s, CH); 7.06 (1H, s, CH); 7.42–7.66 (8H, Ar); ^{13}C NMR (75 MHz, MeOH-d_6): δ = 23.3, 24.1, 25.2, 45.0, 57.0, 117.0, 121.5, 122.7, 126.0, 126.1, 126.6, 127.5, 129.6, 130.2, 130.6, 132.8, 142.5, 142.7, 149.6, 162.0 ppm. *Anal*. Calcd for $C_{25}H_{18}F_6N_2O$: C, 63.03; H, 3.81; F, 23.93; N, 5.88; O, 3.36%. Found: C, 63.00; H, 3.78; F, 23.89; N, 5.81; O, 3.31%.

General procedure for the synthesis of pyrano[2,3-*b*]pyridines (3a–3j). 2-Amino-3-cyano-4*H*-pyrans (1.0 eq.), cycloalkanone (1.2 eq.), and $AlCl_3$ (1.2 eq.) were suspended in 1,2-dichloroethane (10 Ml). The mixture was then refluxed for 3–5 h under nitrogen. After cooling, the solvent was removed, the residue was washed with petroleum ether, and the precipitate was recrystallized from methanol. The results are tabulated in Table 2.

***(7E)*-7-Benzylidene-4-phenyl-5,6-dihydrocyclopenta[*e*]-4*H*-pyrano-[2,3-*b*]-(5,6,7,8-tetrahydro-4-aminoquinoline) (3a)**. mp 144–146 °C; IR (KBr): 3658, 3484, 3453, 3099, 2937, 2921, 2878, 2851, 2406, 1642, 1593, 1573, 1445, 1382, 695 cm^{-1}; ^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.83 (4H, m, CH_2), 2.27 (4H, m, CH_2), 2.83 (4H, m, CH_2), 3.95 (2H, s, NH_2), 4.56 (1H, s, CH), 6.81 (1H, s, CH), 7.13–7.40 (10H, Ar); ^{13}C NMR (75 MHz, $CDCl_3$): δ = 22.5, 22.8, 26.9, 28.0, 32.3, 41.6, 97.9, 112.9, 117.6, 119.7, 125.9, 127.4, 127.8, 128.2, 128.3, 129.1, 137.8, 138.0, 142.2, 147.3, 151.6, 153.9, 156.0, 160.5 ppm. *Anal*. Calcd for $C_{28}H_{26}N_2O$: C, 82.73; H, 6.45; N, 6.89%. Found: C, 82.68; H, 6.40; N, 6.83%.

***(4E)*-4-Benzylidene-2,3,4,7,8,9,10,12-octahydro-12-phenyl-1*H*-chromeno[2,3-*b*]quinolin-11-amine (3b)**. mp 213–215 °C; IR (KBr): 3478, 3384, 3205, 3058, 3022, 2928, 2858, 2834, 1624, 1598, 1575, 1451, 1421, 1384, 1253, 1200, 697 cm^{-1}; ^{1}H NMR (300 MHz, acetone-d_6): δ = 0.85 (2H, m, CH_2), 1.59 (4H, m, CH_2), 1.74 (4H, m, CH_2), 2.63 (2H, m, CH_2), 2.69 (2H, m, CH_2), 4.45 (2H, s, NH_2), 4.89 (1H, s, CH), 7.18 (1H, s, CH), 7.20–7.43 (10 H, Ar); ^{13}C NMR (75 MHz, acetone-d_6): δ = 23.6, 27.7, 28.1, 30.3, 30.5, 33.0, 43.9, 99.4, 112.9, 115.8, 123.0, 127.2, 127.3, 127.7, 128.9, 129.4, 130.0, 131.6, 138.4, 142.9, 144.7, 151.8, 156.2, 160.46 ppm. *Anal*. Calcd for $C_{29}H_{30}N_2O$: C, 82.43; H, 7.16; N, 6.63%. Found: C, 82.39; H, 7.12; N, 6.59%.

***(4E)*-2,3,4,7,8,9,10,12-Octahydro-12-(naphthalen-2-yl)-4-((naphthalen-2-yl)methylene)-1*H*-chromeno[2,3-*b*]quinolin-11-amine (3c)**. mp 143–145 °C; IR (KBr): 3457, 3327, 2951, 2828, 1671, 1640, 1595, 1410, 1129, 758 cm^{-1}; ^{1}H NMR (300 MHz, MeOH-d_6): δ = 1.50 (2H, m, CH_2); 1.83 (4H, m, CH_2); 2.16 (4H, m, CH_2); 2.54 (2H, m, CH_2); 2.78 (2H, m, CH_2); 3.67 (2H, s, NH_2); 4.60 (1H, s, CH); 7.29–7.85 (14H, Ar); 7.93 (1H, s, CH); ^{13}C NMR (75 MHz, MeOH-d_6): δ = 21.9, 22.3, 23.0, 23.3, 26.4, 27.8, 28.1, 28.1, 42.2, 45.1, 98.9, 114.4, 117.8, 124.8, 126.4, 127.1, 127.3, 127.6, 128.3, 128.5, 128.5, 128.6, 128.7, 128.8, 128.9, 129.2, 130.2, 130.4, 135.7, 139.1, 146.2, 152.0, 158.5 ppm. *Anal*. Calcd for $C_{37}H_{32}N_2O$: C, 85.35; H, 6.19; N, 5.38%. Found: C, 85.30; H, 6.12; N, 5.31%.

***(4E)*-2,3,4,7,8,9,10,12-Octahydro-2-methyl-12-(naphthalen-2-yl)-4-((naphthalen-2-yl)methylene)-1*H*-chromeno[2,3-*b*] quinolin-11-amine (3d)**. mp 249–251 °C; IR (KBr): 3330, 3205, 3050, 2925, 2857, 1640, 1607, 1462, 1325, 1124, 751 cm^{-1}; ^{1}H NMR (300 MHz, MeOH-d_6): δ = 0.85 (3H, dd, J = 6.6, 18 Hz, CH_3), 1.28 (4H, m, CH_2), 1.84 (4H, m, CH_2), 2.15 (2H, d, J = 3.3 Hz, CH_2), 2.18 (2H, m, CH_2), 3.35 (2H, s, NH_2), 4.69 (1H, s, CH), 7.32 (1H, s, CH), 7.32–7.94 (14H, Ar), 7.93 (1H, s, CH); ^{13}C NMR (75 MHz, MeOH-d_6): δ = 22.3, 24.1, 30.1, 30.6, 35.4, 36.1, 38.8, 42.5, 110.9, 114.4, 117.1, 126.5, 127.1, 127.3, 127.7, 128.1, 128.4, 128.6, 128.7, 128.8, 128.9, 129.2, 130.2, 130.4, 134.3, 134.6, 135.6, 142.2, 146.4, 156.8, 158.6, 164.8 ppm. *Anal*. Calcd for $C_{38}H_{34}N_2O$: C, 85.36; H, 6.41; N, 5.24%. Found: C, 85.30; H, 6.36; N, 5.19%.

Table 2

Preparation of pyrano[2,3-*b*]pyridine catalyzed by $AlCl_3$ at 83 °C under reflux.

Product	Ar	Z	Time (h)	Yield (%)	mp (°C)
3a[a]	C_6H_5	CH_2	3	80	144–146
3b[a]	C_6H_5	CH_2CH_2	5	70	213–215
3c[a]	$C_{10}H_7$	CH_2CH_2	5	77	143–145
3d[a]	$C_{10}H_7$	CH(Me)–CH_2	4	65	249–251
3e[a]	$C_{10}H_7$	CH(Et)–CH_2	5	70	162–164
3f[a]	C_6H_5	CH(Me)–CH_2	5	65	234–235
3g[a]	*o*-BrC_6H_4	CH_2CH_2	4	79	198–200
3h[b]	C_6H_5	CH_2CH_2	5	67	253–255
3i[b]	C_6H_5	CH_2	5	65	173–174
3j[a]	*p*-$CF_3C_6H_4$	CH_2CH_2	3	66	153–154

[a](n = 2).
[b](n = 1).

***(4E)*-2-Ethyl-2,3,4,7,8,9,10,12-octahydro-12-(naphthalen-2-yl)-4-((naphthalen-2-yl)methylene)-1*H*-chromeno[2,3-*b*]quinolin-11-amine (3e)**. mp 162–164 °C; IR (KBr): 3332, 3205, 3053, 2924, 2855, 1641, 1608, 1467, 1364, 752, 476 cm^{-1}; ^1H NMR (300 MHz, MeOH-d_6): $\delta = 0.66$ (3H, m, CH_3); 0.74 (1H, m, CH); 1.19 (2H, m, CH_2); 1.77 (4H, m, CH_2); 2.21 (4H, m, CH_2); 2.80 (2H, s, NH_2); 2.98 (4H, m, CH_2); 4.69 (1H, d, $J = 5.4$ Hz, CH); 7.30 (1H, s, CH); 7.35–7.96 (14H, Ar). ^{13}C NMR (75 MHz, MeOH-d_6) $\delta = 11.6$, 21.9, 22.3, 23.1, 45.5, 114.5, 126.4, 127.2, 127.4, 127.7, 128.2, 128.3, 128.6, 128.7, 128.8, 128.9, 129.2, 130.2, 133.8, 134.7, 135.6, 142.2, 145.8, 158.7 ppm. *Anal.* Calcd for $C_{39}H_{36}N_2O$: C, 85.37; H, 6.61; N, 5.11%. Found: C, 85.34; H, 6.57; N, 5.10%.

***(4E)*-4-Benzylidene-2,3,4,7,8,9,10,12-octahydro-2-methyl-12-phenyl-1*H*-chromeno[2,3-*b*]quinolin-11-amine (3f)**. mp 234–235 °C; IR (KBr): 3478, 3391, 3200, 2925, 2868, 2829, 1623, 1597, 1575, 1446, 1421, 1381, 1246, 699 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$): $\delta = 0.87$ (3H, d, J = 6.6 Hz, CH_3), 1.61 (1H, m, CH), 1.79 (4H, m, CH_2), 1.98 (2H, m, CH_2), 2.17 (4H, m, CH_2), 2.76 (2H, m, CH_2), 4.03 (2H, s, NH_2), 4.19 (1H, s, CH), 7.25 (1H, s, CH), 7.30 (10H, Ar); ^{13}C NMR (75 MHz, $CDCl_3$): $\delta = 22.3$, 22.5, 22.7, 28.5, 32.0, 34.5, 34.9, 43.5, 113.9, 117.3, 119.4, 123.8, 126.3, 127.4, 127.9, 128.0, 128.4, 129.0, 129.4, 137.7, 142.9, 146.8, 154.9, 156.8, 160.8 ppm. *Anal.* Calcd for $C_{30}H_{32}N_2O$: C, 82.53; H, 7.39; N, 6.42%. Found: C, 82.47; H, 7.35; N, 6.39%.

***(4E)*-4-(2-Bromobenzylidene)-12-(2-bromophenyl)-2,3,4,7,-8,9,10,12-octahydro-1*H*-chromeno[2,3-*b*]quinolin-11-amine (3g)**. mp 198–200 °C; IR (KBr): 3454, 3389, 3297, 3148, 2928, 2861, 2832, 2558, 1669, 1644, 1609, 1464, 1431, 1327, 1023, 740 cm^{-1}; ^1H NMR (300 MHz, MeOH-d_6): $\delta = 1.55$ (2H, m, CH_2); 1.82 (4H, m, CH_2); 2.27 (4H, m, CH_2); 2.77 (2H, s, NH_2); 3.20 (4H, m, CH_2); 5.01 (1H, s, CH); 7.06 (1H, s, CH); 7.12–7.62 (8H, Ar). ^{13}C NMR (75 MHz, MeOH-d_6): $\delta = 22.3$, 23.1, 24.3, 27.5, 27.8, 27.9, 28.0, 29.5, 30.7, 41.7, 98.9, 114.6, 124.6, 125.2, 128.2, 130.0, 130.3, 131.1, 131.4, 132.0, 132.3, 133.8, 134.3, 138.1, 141.0, 142.5, 147.4, 152.5, 158,1 ppm. *Anal*. Calcd for $C_{29}H_{26}Br_2N_2O$: C, 60.23; H, 4.53; N, 4.84%. Found: C, 60.17; H, 4.49; N, 4.79%.

***(8E)*-8-Benzylidene-5,6,7,8-tetrahydro-4-phenyl-4*H*-chromeno-[2,3-*b*]-(5,6-dihydrocyclopenta[*b*]pyridine-4-amine) (3h)**. mp 253–255 °C; IR (KBr): 3464, 3345, 3350, 3208, 2920, 2862, 2833, 1671, 1636, 1594, 1413, 1130, 1034, 748 cm^{-1}; ^1H NMR (300 MHz, MeOH-d_6): $\delta = 1.62$ (4H, m, CH_2); 2.23 (4H, m, CH_2); 2.68 (4H, m, CH_2); 3.03 (2H, m, NH_2); 4.51 (1H, s, CH); 7.09–7.38 (11H, Ar). ^{13}C NMR (75 MHz, MeOH-d_6): $\delta = 23.1$, 23.3, 27.9, 28.3, 28.5, 32.0, 42.3, 110, 9, 114.4, 118.0, 124.5, 128.1, 128.9, 129.1, 129.3, 130.0, 130.3, 142.3, 147.4, 152.5, 157.1 ppm. *Anal*. Calcd for $C_{28}H_{26}N_2O$: C, 82.73; H, 6.45; N, 6.89%. Found: C, 82.68; H, 6.42; N, 6.85%.

***(7E)*-7-Benzylidene-4-phenyl-5,6-dihydrocyclopenta[*e*]-4*H*-pyrano-[2,3-*b*]-(5,6-dihydrocyclopenta[*b*]pyridine-4-amine) (3i)**. mp 173–174 °C; IR (KBr): 3470, 3350, 3205, 3020, 3022, 2924, 2856, 2830, 1619, 1596, 1570, 1446, 1421, 1380, 1248, 1200, 687 cm^{-1}; ^1H NMR (300 MHz, acetone-d_6): $\delta = 1.60$ (2H, m, CH_2); 2.08 (2H, m, NH_2); 2.76 (8H, m, CH_2); 3.55 (1H, s, CH); 7.12–7.56 (11H, Ar). ^{13}C NMR (75 MHz, acetone-d_6): $\delta = 21.3$, 24.6, 25.6, 26.9, 27.9, 28.4, 127.1, 128.7, 129.0, 129.1, 129.4, 129.6, 130.0, 130.5, 131.7. *Anal*. Calcd for $C_{27}H_{24}N_2O$: C, 82.62; H, 6.16; N, 7.14%. Found: C, 82.60; H, 6.13; N, 7.11%.

***(4E)*-4-(4-(Trifluoromethyl)benzylidene)-12-(4-(trifluoromethyl)phenyl)-2,3,4,7,8,9,10,12-octahydro-1*H*-chromeno-[2,3-*b*]quinolin-11-amine (3j)**. mp 153–154 °C; IR (KBr): 3467, 3393, 3295, 3156, 2943, 2860, 2841, 2563, 1667, 1641, 1611, 1470, 1435, 1332, 1029, 780 $cm^{-1;}$ ^1H NMR (300 MHz, MeOH-d_6): $\delta = 0.91$ (2H, m, CH_2); 1.21 (4H, m, CH_2); 1.72 (4H, m, CH_2); 2.21 (4H, m, CH_2); 2.69 (2H, m, NH_2); 4.54 (1H, s, CH); 7.30 (1H, s, CH); 7.43–7.72 (8H, Ar). ^{13}C NMR (75 MHz, MeOH-d_6): $\delta = 23.6$, 23.9, 28.0, 28.5, 32.7, 43.7, 106.7, 119.8, 122.7, 123.6, 124.5, 124.7, 124.9, 126.0, 126.5, 128.9, 129.8, 130.8, 133.7, 135.7, 153.8, 155.6, 164.8 ppm. *Anal*. Calcd for $C_{31}H_{26}F_6N_2O$: C, 66.90; H, 4.71; N, 5.03%. Found: C, 66.86; H, 4.69; N, 4.98%.

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