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Thermal or acid catalyzed cyclization of several *N*-(*N*-arylbenzimidoyl)-1,4-benzoquinoneimines **2** affords 1-aryl-6-hydroxy-2-phenylbenzimidazoles **3** in fairly good yields. Structural proofs and kinetic support for the reaction mechanism are given.

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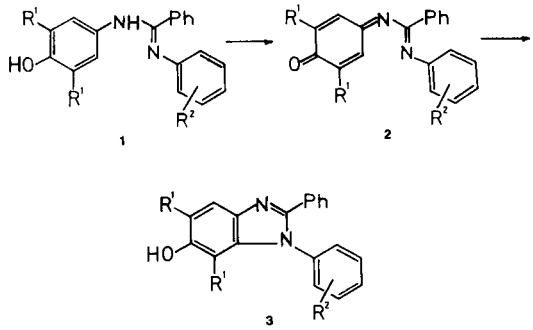
Only two benzimidazole syntheses have been reported in the literature in which the final step is the bond formation between a benzene ring carbon and a nitrogen atom [1,2]. In both cases acceptable yields could be obtained only at the expense of experimental simplicity and feasibility.

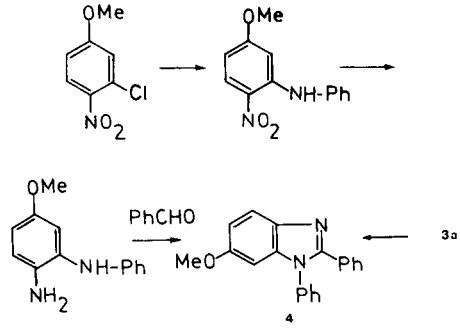
This paper describes an alternative route similar to a known benzoxazole synthesis [3]. The key step in this case is the intramolecular addition of an amidine nitrogen to a quinoneimine system [4].

The general scheme together with the substrates hitherto studied are reported below:



a, $R^1 = R^2 = H$
b, $R^1 = H$, $R^2 = 4\text{-}NO_2$
c, $R^1 = H$, $R^2 = 4\text{-}OMe$
d, $R^1 = H$, $R^2 = 4\text{-}Cl$
e, $R^1 = H$, $R^2 = 4\text{-}Me$
f, $R^1 = H$, $R^2 = 2,6\text{-}diMe$
g, $R^1 = H$, $R^2 = 2,5\text{-}diMe$
h, $R^1 = Cl$, $R^2 = H$
i, $R^1 = Me$, $R^2 = 2,6\text{-}diMe$

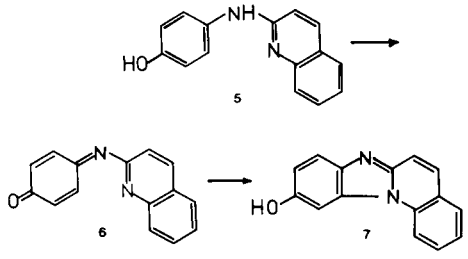
Starting materials **1** were prepared by the reaction of suitable 4-aminophenols with *N*-arylbenzimidoyl chlorides. Their oxidation to quinoneimine derivatives **2** was easily performed with active manganese dioxide in good yields. The final cyclizations could be effected either thermally by brief refluxing **2** in dimethylsulfoxide solution (**2b** and **2d** were unreactive under these conditions even for prolonged reaction times) or by weak acid treatment (acetic acid or silica gel at room temperature). The latter treatment always afforded benzimidazole derivatives **3**, but some by-products were concurrently formed. These however could be easily removed due to the solubility properties of **3** (see Experimental). The yields of **3** ranged from 35 to 65%. The structure of the benzimidazole derivatives **3** was supported by analytical and spectral data, but a chemical proof was also obtained for **3a**. Its methyl ether **4** was independently synthesized following a traditional synthetic scheme [5] starting from the 3-chloro-4-nitroanisole.



As for the cyclization mechanism, it was evident even from preparative experiments that the reaction was slowed down when R^2 was an electron withdrawing substituent and conversely accelerated by electron releasing groups. The kinetics of substrates **2a**, **2b**, **2e** and **2f** were examined in a 10^{-2} *M* 50% dichloromethane-acetic acid solution at 22°. The substrate consumption rates were evaluated by hplc (see Experimental) and found to follow first order kinetics with $k_a = 6.27 \times 10^{-4}$, $k_b = 7.60 \times 10^{-5}$, $k_e = 7.47 \times 10^{-4}$ and $k_f = 7.42$ sec^{-1}. These data demonstrate the intervention of the expected electronic effects in the cyclization process. The substituent effect played by R^1 was checked on the substrate **2i** only. The reaction of **2h** was not clear enough to guarantee a correct interpretation of the kinetic data. The datum recorded for **2i** ($k_i = 1.01 \times 10^{-4}$ sec^{-1}) under the same conditions as described before, accounts for some deactivation of the quinoid system to nucleophilic attack. This was in line with the expected

trend.

An interesting development, worth a more careful investigation, was found in the cyclization of **5**, a system in which the nucleophilic imine nitrogen is incorporated in an aromatic heterocyclic ring.



The formation of the 6-hydroxybenzimidazo[1,2-*a*]quinoline **6** could provide an easily accessible route to many classes of polynuclear heterocycles.

EXPERIMENTAL

Melting points are uncorrected. The ^1H nmr spectra were recorded on a A90 Varian spectrometer using deuteriochloroform as the solvent unless otherwise stated and tetramethylsilane as the internal standard. Chemical shifts are given in δ units and refer to the center of the signal (s, singlet, m, multiplet, d, doublet, dd, double doublet). Kinetic experiments were performed with a model 5000 Varian liquid chromatograph equipped with a 254 nm uv detector; the solvents (acetic acid, methylene chloride, methanol) were Merck LiChrosolv reagents.

N-Arylbenzenecarboximidoyl Chlorides.

All these intermediates were known in the literature with the exception of *N*-(2,5-dimethylphenyl)benzenecarboximidoyl chloride which was prepared according to the procedure described below.

N-(2,5-Dimethylphenyl)benzenecarboximidoyl Chloride.

The *N*-(2,5-dimethylphenyl)benzamide was treated with equimolar amounts of phosphorus pentachloride in refluxing chloroform solution for 60 minutes. After removal of the solvent under reduced pressure, the residue was dissolved in benzene and the resulting solution was warmed to 50° for 1 hour. Removal of the solvent left a yellow oily residue which could be employed in a crude state. A sample was distilled *in vacuo* for analytical purpose and had bp 180° at 2 mm Hg.

Anal. Calcd. for $C_{15}H_{14}ClN$: C, 73.91; H, 5.79; N, 5.74. Found: C, 73.80; H, 5.64; N, 5.65.

General Procedure for the Synthesis of the *N'*-Aryl-*N*-(4-hydroxyphenyl)-benzenecarboximidamides **1**.

The *N'*-phenyl-*N*-(4-hydroxyphenyl)benzenecarboximidamide (**1a**) was known in the literature, and was prepared according to the reported method [6]. The other compounds were synthesized by reacting the 4-aminophenol derivative with equimolar amounts of the suitable *N*-arylbenzimidoyl chloride in acetonitrile solution at room temperature. The hydrochlorides of **1** crystallized from the solution and were recovered by filtration. The free bases could be obtained by treatment of the hydrochlorides with a 10% potassium carbonate solution followed by extraction with chloroform. Removal of the solvent left a residue which was either crystallized from a suitable solvent or chromatographed on a silica gel column (eluant, 50% benzene-ethyl acetate solution) to give **1** in a pure state. Minor variations of this method will be given for each case.

N-(4-Hydroxyphenyl)-*N'*-(4-nitrophenyl)benzenecarboximidamide (**1b**).

In this case the condensation was carried out in the presence of triethylamine at room temperature for 40 hours. Dilution of the solution with water followed by extration with chloroform afforded a solid which was crystallized from 2-propanol to give **1b**, mp 58°, (with one molecule of solvent of crystallization). The yield was 60%; ^1H nmr: 6.4 (2H, broad s exchanging with deuterium oxide, NH and OH), 6.7 (2H, d, aromatic in position *meta* to the NO_2 group), 6.85 (2H, d, aromatic in position *meta* to the OH group), 7.18 (2H, d, aromatic in position *ortho* to the OH group), 7.35 (5H, s, C_6H_5), 8.0 (2H, d, aromatic in position *ortho* to the NO_2 group); additional signals referred to the 2-propanol molecule of crystallization are not reported; ms: 333.

Anal. Calcd. for $C_{19}H_{15}N_3O_3 \cdot C_3H_8O$: C, 67.16; H, 5.98; N, 10.68. Found: C, 67.00; H, 5.59; N, 10.57.

N-(4-Hydroxyphenyl)-*N'*-(4-methoxyphenyl)benzenecarboximidamide (**1c**).

The reaction was completed in 2 hours at 20°. The title product was purified by column chromatography to yield 33% of **1c**, mp 74°; ^1H nmr: 3.80 (3H, s, OCH_3), 5.19 (2H, broad s exchanging with deuterium oxide, NH and OH), 6.55 (2H, d, aromatic in position *meta* to the OH group), 6.75 (5H, m, aromatic in position *ortho* to the OH group and aromatic in position 3, 4 and 5 of the C_6H_5 group), 7.3 (6H, m, aromatic); ms: 318.

Anal. Calcd. for $C_{20}H_{18}N_2O_2$: C, 75.45; H, 5.70; N, 8.80. Found: C, 75.68; H, 5.63; N, 8.58.

N'-(4-Chlorophenyl)-*N*-(4-hydroxyphenyl)benzenecarboximidamide (**1d**).

The reaction was complete after 2 hours at 10°. The title compound was purified by column chromatography to yield 38% of **1d**, with mp 110° dec (cyclohexane); ^1H nmr: 5.5 (2H, broad s exchanging with deuterium oxide, NH and OH), 6.62 (2H, d, aromatic in position *meta* to the Cl group), 6.80 (2H, d, aromatic in position *meta* to the OH group), 7.00 (2H, d, aromatic in position *ortho* to the OH group), 7.10 (2H, d, aromatic in position *ortho* to the Cl group), 7.35 (5H, s, aromatic of the C_6H_5 group); ms: 322.

Anal. Calcd. for $C_{19}H_{15}ClN_2O$: C, 70.69; H, 4.65; N, 8.68. Found: C, 70.49; H, 4.85; N, 8.62.

N-(4-Hydroxyphenyl)-*N'*-(4-methylphenyl)benzenecarboximidamide (**1e**).

The reaction was complete after 2 hours at 10°. The free base was crystallized from 2-propanol to give **1e** in 75% yield, mp 137° dec with one solvent molecule of crystallization; ^1H nmr: 2.32 (3H, s, CH_3), 3.8 (2H, broad s exchanging with deuterium oxide, NH and OH), 6.62 (2H, d, aromatic in position *ortho* to the CH_3 group), 6.95 (6H, m, aromatic in position *meta* to the CH_3 group and aromatic of the hydroxyphenylamino group), 7.35 (5H, m, aromatic of the C_6H_5 group), additional signals referred to the 2-propanol of crystallization are not reported; ms: 302.

Anal. Calcd. for $C_{20}H_{18}N_2O \cdot C_3H_8O$: C, 76.24; H, 7.18; N, 7.73. Found: C, 75.98; H, 6.90; N, 7.89.

N'-(2,6-Dimethylphenyl)-*N*-(4-hydroxyphenyl)benzenecarboximidamide (**1f**).

The 4-aminophenol hydrochloride (15 g) was added portionwise to a solution of triethylamine (20.2 g) and *N*-(2,6-dimethylphenyl)benzimidoyl chloride (24.3 g) in acetonitrile (100 ml). The reaction was exothermic. The solution was refluxed for 20 minutes and then the solvent was removed under reduced pressure. The solid residue was repeatedly extracted with boiling water, and the insoluble product was dissolved in warm chloroform. The hydrochloride of **1f** was precipitated with dry hydrogen chloride. Treatment of the salt with ammonium hydroxide followed by extraction with chloroform gave **1f** as a free base, mp 208° (ethanol); ^1H nmr: 2.25 (6H, s, $2CH_3$), 6.4-7.1 (8H + 2H exchanging with deuterium oxide, aromatic of the C_6H_3 group, aromatic of the 4-hydroxy-phenylamino group, NH and OH), 7.28 (3H, m, aromatic in position 3,4,5 of the C_6H_5 group), 7.41 (2H, m, aromatic in position 2,6 of the C_6H_5 group); ms: 316.

Anal. Calcd. for $C_{21}H_{20}N_2O$: C, 79.71; H, 6.37; N, 8.85. Found: C, 79.48; H, 6.29; N, 8.81.

N'-(2,5-Dimethylphenyl)-*N*-(4-hydroxyphenyl)benzenecarboximidamide (**1g**).

The reaction was complete after 2 hours at 10°. The precipitate was

filtered off and the clear filtrate was evaporated to dryness under reduced pressure to give the hydrochloride of **1g**. A solution of this salt in hot water was filtered to remove impurities and then made alkaline with 26% ammonium hydroxide solution to give **1g** as a solid, mp 197° (2-propanol); ^{1}H nmr (dimethylsulfoxide): 2.14 (6H, s, $2CH_3$), 6.32 (1H, s, aromatic in position *ortho* to the imine nitrogen), 6.90 (1H, d, aromatic in position *meta* to the imine nitrogen), 6.6 (5H, m, aromatic of the 4-hydroxyphenylamino group and aromatic in position *ortho* to the imine nitrogen), 7.32 (5H, m, aromatic of the C_6H_5 group), 7.5 (1H, broad s exchanging with deuterium oxide, NH), 8.85 (1H, broad s exchanging with deuterium oxide, OH); ms: 316.

Anal. Calcd. for $C_{21}H_{20}N_2O$: C, 79.71; H, 6.37; N, 8.86. Found: C, 79.59; H, 6.44; N, 8.67.

N-(3,5-Dichloro-4-hydroxyphenyl)-*N'*-phenylbenzenecarboximidamide (**1h**).

The reaction was complete after 2 hours at 10° . The free base was directly crystallized from diisopropyl ether to give **1h** with mp 180°; ^{1}H nmr: 4.55 (2H, broad s exchanging with deuterium oxide, NH and OH), 6.87 (2H, s, aromatic adjacent to the Cl atoms), 6.9-7.3 (5H, m, aromatic of the phenylimine group), 6.39 (5H, s, aromatic of the C_6H_5 group); ms: 357.

Anal. Calcd. for $C_{19}H_{14}Cl_2N_2O$: C, 63.87; H, 3.96; N, 7.84. Found: 63.56; H, 4.19; N, 7.63.

N'-(3,5-Dimethyl-4-hydroxyphenyl)-*N*-(2,6-dimethylphenyl)benzenecarboximidamide (**1i**).

The reaction was carried out as described for the synthesis of **1f**. A solution of *N*-(2,6-dimethylphenyl)benzimidoylchoride [7] (5.6 g) in acetonitrile (20 ml) was added to a solution of the 4-amino-2,6-dimethylphenol hydrochloride (4 g) and triethylamine (2.3 g) in acetonitrile (50 ml) at 10° with stirring. The reaction was complete after 1 hour at 15°. The hydrochloride of **1f** separated in 86% yield, mp 275°. The free base was triturated with diisopropyl ether, mp 160°; ^{1}H nmr: 2.07 and 2.25 (each 6H, 2s, $4CH_3$), 6.0 (2H, broad s exchanging with deuterium oxide, NH and OH), 6.30 (2H, s, aromatic of the C_6H_2 group), 6.65-7.20 (3H, m, aromatic of the C_6H_3 group), 7.20-7.35 (3H, m, aromatic in position 3,4,5 of the C_6H_5 group), 7.55 (2H, m, aromatic in position 2,6 of the C_6H_5 group); ms: 344.

Anal. Calcd. for $C_{23}H_{24}N_2O$: C, 80.20; H, 7.02; N, 8.13. Found: C, 79.94; H, 6.92; N, 8.14.

N-(4-Hydroxyphenyl)-*N*-(2-quinolinyl)amine (**5**).

A mixture of 4-aminophenol (3.3 g), 2-chloroquinoline (5.0 g) and zinc chloride was heated at 160° on an oil bath for 2 hours. The black solid formed on cooling was exhaustively extracted with a boiling 18% hydrochloric acid solution.The combined acid extracts were filtered on a cell cake to remove the tarry matrials, then made alkaline with a 26% ammonium hydroxide solution. The solid precipitate (3.5 g) was chromatographed on a silica gel column (eluant, 50% benzene-ethyl acetate solution). The title compound was the main product eluted, mp 207° (toluene) (2.0 g); ^{1}H nmr (dimethylsulfoxide): 6.84 (2H, d, aromatic in position *ortho* to the NH group), 7.00 (1H, d, aromatic in position 5 of the quinoline system), 7.96 (1H, d, aromatic in position 4 of the quinoline system), 7.20 (2H, m, aromatic in position 6 and 7 of the quinoline system), 7.60 (2H, m, aromatic in position 5 and 8 of the quinoline system), 7.80 (2H, d, aromatic in position *meta* to the NH group); ms: 236.

Anal. Calcd. for $C_{15}H_{12}N_2O$: C, 76.27; H, 5.09; N, 11.86. Found: C, 76.11; H, 4.99; N, 11.68.

General Procedure for the Synthesis of 4-(*N*-Arylbenzenecarboximidoyl)-imino-2,5-cyclohexadien-1-ones **2**.

These dark red colored compounds were prepared by reacting **1** with two or three fold by weight of active manganese dioxide in methylene chloride solution. The reaction mixtures were stirred at 25-23° until the starting materials disappeared (30 minutes). The slurries were filtered on a cell cake, and the clear filtrates were evaporated to dryness under reduced pressure. The residues in a few cases crystallized from a suitable low boiling solvent even thought they could be successfully employed for the cyclization in the crude state. A rapid chromatographic purification was performed only in a few cases, owing to the reactivity of these materials when adsorbed on silica gel. Even in the solid state these products were rather unstable.

4-(*N*-Phenylbenzenecarboximidoyl)imino-2,5-cyclohexadien-1-one (**2a**).

The title compound was obtained as a solid, mp 88° (2-propanol); ^{1}H nmr: 6.42 (2H, d, hydrogen atoms in position *meta* to the quinone carbonyl group), 6.9 (5H, m, aromatic in position *ortho* and *para* of the C_6H_5N group and residual hydrogen atoms of the quinone system), 7.20 (2H, m, aromatic in position 3,5 of the C_6H_5N group), 7.40 (3H, m, aromatic in position 3,4,5 of the benzimidoyl group), 7.89 (2H, m, aromatic in position 2,6 of the benzimidoyl group); ms: 286.

Anal. Calcd. for $C_{19}H_{14}N_2O$: C, 79.70; H, 4.93; N, 9.78. Found: C, 79.53; H, 4.84; N, 9.67.

4-[*N*-(4-Nitrophenyl)benzenecarboximidoyl]imino-2,5-cyclohexadien-1-one (**2b**).

The title compound was obtained as a solid, mp 124° (cyclohexane); ^{1}H nmr: 6.50 (2H, d, hydrogen atoms in position *meta* to the quinone carbonyl group), 6.92 (4H, 2d, hydrogen atoms in position *ortho* to the quinone carbonyl group and aromatic in position *meta* to the NO_2 group), 7.5 (3H, m, aromatic in position 3,4,5 of the C_6H_5 group), 7.82 (2H, m, aromatic in position 2,6 of the C_6H_5 group), 8.15 (2H, d, aromatic in position *ortho* to the NO_2 group); ms: 331.

Anal. Calcd. for $C_{19}H_{13}N_3O_3$: C, 68.87; H, 3.96; N, 12.68. Found: C, 68.62; H, 3.85; N, 12.48.

4-[*N*-(4-Methoxyphenyl)benzenecarboximidoyl]imino-2,5-cyclohexadien-1-one (**2c**).

The title compound was obtained as a red glassy solid in 30% yield; ^{1}H nmr: 3.72 (3H, s, OCH_3), 6.43 (2H, d, hydrogen atoms in position *meta* to the quinone carbonyl group), 6.88 (6H, m, aromatic of the 4-methoxyphenyl group and hydrogen atoms in position *ortho* to the carbonyl group), 7.43 (3H, m, aromatic in position 3,4,5 of the C_6H_5 group), 7.83 (2H, m, aromatic in position 2,6 of the C_6H_5 group); ms: 316.

4-[*N*-(4-Chlorophenyl)benzenecarboximidoyl]imino-2,5-cyclohexadien-1-one (**2d**).

The title compound was a red oil; ^{1}H nmr: 6.48 (2H, d, hydrogen atoms in position *meta* to the quinone carbonyl group), 6.83 (4H, 2d, aromatic in position *meta* to the Cl group and hydrogen atoms in position *ortho* to the quinone carbonyl group), 7.20 (2H, d, aromatic in position *ortho* to the Cl group), 7.47 (3H, m, aromatic in position 3,4,5 of the C_6H_5 group), 7.8 (2H, m, aromatic in position 2,6 of the C_6H_5 group); ms: 320.

4-[*N*-(4-Methylphenyl)benzenecarboximidoyl]imino-2,5-cyclohexadien-1-one (**2e**).

The title compound was a red solid, mp 86° (*n*-hexane), yield 80%; ^{1}H nmr: 2.3 (3H, s, CH_3), 6.44 (2H, d, hydrogen atoms in position *meta* to the quinone carbonyl group), 6.77 (2H, d, hydrogen atoms in position *ortho* to the CH_3 group), 6.95 (4H, 2d, aromatic in position *meta* to the CH_3 group and hydrogen atoms in position *ortho* to the quinone carbonyl group) 7.45 (3H, m, aromatic in position 3,4,5 of the C_6H_5 group), 7.82 (2H, m, aromatic in position 2,6 of the C_6H_5 group); ms: 300.

Anal. Calcd. for $C_{20}H_{16}N_2O$: C, 79.98; H, 5.37; N, 9.33. Found: C, 79.68; H, 5.26; N, 9.20.

4-[*N*-(2,6-Dimethylphenyl)benzenecarboximidoyl]imino-2,5-cyclohexadien-1-one (**2f**).

The title compound was a red solid with mp 110° (*n*-hexane), yield 60%; ^{1}H nmr: 2.3 (6H, s, $2CH_3$), 6.44 (2H, d, hydrogen atoms in position *meta* to the quinone carbonyl group), 6.9 (5H, m, aromatic of the C_6H_3 group and hydrogen atoms in position *ortho* to the quinone carbonyl group), 7.5 (3H, m, aromatic in position 3,4,5 of the C_5H_5 group), 7.92

(2H, m, aromatic in position 2,6 of the C_6H_5 group); ms: 314.

Anal. Calcd. for $C_{21}H_{18}N_2O$: C, 80.23; H, 5.77; N, 8.91. Found: C, 79.99; H, 5.66; N, 8.82.

4-[*N*-(2,5-Dimethylphenyl)benzenecarboximidoyl]imino-2,5-cyclohexadien-1-one (**2g**).

The title compound was a red solid with mp 109° (*n*-hexane), yield 50%; ^{1}H nmr: 2.26 (6H, s, $2CH_3$), 6.43 (3H, m resulting from the superimposition of 2d, aromatic in position 6 of the C_6H_3 group and hydrogen atoms in position *meta* to the quinone carbonyl group), 6.68 (1H, d, aromatic in position 4 of the C_6H_3 group), 6.92 (3H, 2d, aromatic in position 3 of the C_6H_3 group and hydrogen atoms in position *ortho* to the quinone carbonyl group), 7.48 (3H, m, aromatic in position 3,4,5 of the C_6H_5 group), 7.9 (2H, m, aromatic in position 2,6 of the C_6H_5 group); ms: 314.

Anal. Calcd. for $C_{21}H_{18}N_2O$: C, 80.23; H, 5.77; N, 8.91. Found: C, 79.82; H, 5.69; N, 8.97.

2,6-Dichloro-4-(*N*-phenylbenzenecarboximidoyl)immino-2,5-cyclohexadien-1-one (**2h**).

The title compound, a dark red oil, was subjected to cyclization in a crude state just after the isolation owing to its lability even at room temperature.

2,6-Dimethyl-4-[*N*-(2,6-dimethylphenyl)benzenecarboximidoyl)-imino-2,5-cyclohexadien-1-one (**2i**).

The title compound was a red solid, mp 104° (*n*-hexane), yield 90%; ^{1}H nmr: 1.97 (6H, s, $2CH_3$ in position *ortho* to the quinone carbonyl group), 2.23 (6H, s, $2CH_3$ on the C_6H_3 group), 6.61 (2H, s, hydrogen atoms in position *meta* to the quinone carbonyl group), 6.88 (3H, m, aromatic of the C_6H_3 group), 7.47 (3H, m, aromatic in position 3,4,5 of the C_6H_5 group), 7.90 (2H, m, aromatic in position 2,6 of the C_6H_5 group); ms: 342.

Anal. Calcd. for $C_{23}H_{22}N_2O$: C, 80.67; H, 6.48; N, 8.18. Found: C, 80.70; H, 6.48; N, 8.18.

4-(2-Quinolinyl)imino-2,5-cyclohexadien-1-one (**6**).

The oxidation of **5** was carried out in acetonitrile solution. The title compound was a red solid, mp 122° (diisopropyl ether), yield 85%; ms: 234.

Anal. Calcd. for $C_{15}H_{10}N_2O$: C, 76.92; H, 4.27; N, 11.97. Found: C, 76.83; H, 4.19; N, 11.97.

General Procedure for the Synthesis of 6-Hydroxybenzimidazoles **3** from **2**.

The most general procedure, used for producing **3b, 3c, 3d, 3e, 3f, 3g, 3h** and **6** involved warming quinonimines **2** in glacial acetic acid solution for about 10 minutes at 50°. The solution was then diluted with water and neutralized with 26% ammonium hydroxide solution to precipitate the reaction product. Alternatively, refluxing the quinonimine in dimethylsulfoxide solution for 1-2 minutes gave satisfactory results. This technique was employed for the synthesis of **3a, 3c** and **3i**. It generally gave cleaner results than the acidic treatment, but a few substrates were unreactive under these conditions. The dimethylsulfoxide solutions were diluted with water to precipitate the reaction products. The crude products were purified by the following methods: simple crystallization from a suitable solvent (**3b, 3d, 3f, 3g**); extraction in a hot 10% sodium hydroxide solution followed by acidification with acetic acid (**3e, 3h, 6**); chromatography on a silica gel column (**3c, 3i, 6**); triturating the reaction mixture with chloroform (**3a**), a solvent in which the 6-hydroxybenzimidazoles are generally sparingly soluble. Even silica gel was found to be a good condensing reagent. The conversion of **2f** into **3f** could be easily performed in chloroform solution in the presence of silica gel (20 fold in weight) with stirring at room temperature for 12 hours.

1,2-Diphenyl-6-hydroxybenzimidazole (**3a**).

The title compound was obtained in 46% yield, mp 223°; ^{1}H nmr (dimethylsulfoxide): 6.50 (1H, d, aromatic in position 7), 6.75 (1H, dd, aromatic in position 5), 7.3-7.7 (11H, m, aromatic), 9.36 (1H, s exchanging with deuterium oxide, OH); ms: 286.

Anal. Calcd. for $C_{19}H_{14}N_2O$: C, 79.70; H, 4.93; N, 9.78. Found: C, 79.36; H, 4.63; N, 9.89.

6-Hydroxy-1-(4-nitrophenyl)-2-phenylbenzimidazole (**3b**).

The product separated from the acetic acid solution as a yellow solid in 32% yield, mp 287° (2-propanol); ^{1}H nmr (dimethylsulfoxide): 6.62 (1H, d, aromatic in position 7), 6.78 (1H, dd, aromatic in position 5), 7.4 (5H, s, aromatic of the C_6H_5 group), 7.60 (1H, d, aromatic in position 4), 7.65 (2H, d, aromatic in position *meta* to the NO_2 group), 8.38 (2H, d, aromatic in position *ortho* to the NO_2 group), 9.5 (1H, s exchanging with deuterium oxide, OH); ms: 331.

Anal. Calcd. for $C_{19}H_{13}N_3O_3$: C, 68.87; H, 3.96; N, 12.68. Found: C, 68.84; H, 3.86; N, 12.47.

6-Hydroxy-1-(4-methoxyphenyl)-2-phenylbenzimidazole (**3c**).

The title product was purified by chromatography using first a 4:1 benzene-ethyl acetate solution to elute some impurities. Elution with acetone gave pure **3c** in 36% yield, mp 277° (2-propanol); ^{1}H nmr (dimethylsulfoxide): 3.88 (3H, s, OCH_3), 6.50 (1H, d, aromatic in position 7), 6.80 (1H, dd, aromatic in position 5), 7.1 (2H, d, aromatic in position *ortho* to the OCH_3 group), 7.3 (2H, d, aromatic in position *meta* to the OCH_3 group), 7.4 (5H, m, C_6H_5), 7.6 (1H, d, aromatic in position 4), 9.34 (1H, s exchanging with deuterium oxide, OH); ms: 316.

Anal. Calcd. for $C_{20}H_{16}N_2O_2$: C, 75.93; H, 5.10; N, 8.86. Found: C, 75.74; H, 5.17; N, 8.88.

1-(4-Chlorophenyl)-6-hydroxy-2-phenylbenzimidazole (**3d**).

The title compound was obtained in 57% yield, mp 284° (2-propanol); ^{1}H nmr: 6.52 (1H, d, aromatic in position 7), 6.80 (1H, dd, aromatic in position 5), 7.65 (3H, 2d, 1 aromatic in position 4 and 2 aromatic in position *ortho* to the Cl group), 7.37 (7H, m, aromatic), 9.38 (1H, s exchanging with deuterium oxide, OH); ms: 320.

Anal. Calcd. for $C_{19}H_{13}ClN_2O$: 71.14; H, 4.05; N, 8.74. Found: C, 71.04; H, 3.92; N, 8.59.

1-(4-Methylphenyl)-6-hydroxy-2-phenylbenzimidazole (**3e**).

The title compound was obtained in 62% yield, mp 258° (toluene); ^{1}H nmr (dimethylsulfoxide): 2.50 (3H, s, CH_3), 6.52 (1H, d, aromatic in position 7), 6.80 (1H, dd, aromatic in position 5), 7.4 (9H, m, aromatic of C_6H_5 and C_6H_4 groups), 7.62 (1H, d, aromatic in position 4), 9.34 (1H, s, exchanging with deuterium oxide, OH); ms: 300.

Anal. Calcd. for $C_{20}H_{16}N_2O$: C, 79.98; H, 5.37; N, 9.33. Found: C, 79.68; H, 5.24; N, 9.17.

1-(2,6-Dimethylphenyl)-6-hydroxy-2-phenylbenzimidazole (**3f**).

The title compound was obtained in a 47% yield, mp 264° (toluene). Alternatively to the acetic acid promoted cyclization, the same result could be obtained by stirring a solution of **2f** in chloroform with silca gel (20 fold in weight) for 12 hours; ^{1}H nmr (dimethylsulfoxide): 1.95 (6H, s, $2CH_3$), 6.22 (1H, d, aromatic in position 7), 6.80 (1H, dd, aromatic in position 5), 7.45 (8H, m, aromatic of C_6H_5 and C_6H_3 groups), 7.63 (1H, d, aromatic in position 4), 9.39 (1H, s, exchanging with deuterium oxide, OH); ms: 314.

Anal. Calcd. for $C_{21}H_{18}N_2O$: C, 80.23; H, 5.77; N, 8.91. Found: C, 80.48; H, 5.85; N, 8.70.

1-(2,5-Dimethylphenyl)-6-hydroxy-2-phenylbenzimidazole (**3g**).

The title compound was obtained in 51% yield, mp 262° (2-propanol); ^{1}H nmr (dimethylsulfoxide): 1.83 (3H, s, CH_3 in position 5 of the C_6H_3 group), 2.4 (3H, s, CH_3 in position 2 of the C_6H_3 group), 6.32 (1H, d, aromatic in position 7), 6.80 (1H, dd, aromatic in position 5), 7.20 (1H, s, aromatic in position 6 of the C_6H_3 group), 7.35 (7H, m, aromatic), 7.58 (1H, d, aromatic in position 4); ms: 314.

Anal. Calcd. for $C_{21}H_{18}N_2O$: C, 80.23; H, 5.77; N, 8.91. Found: C, 79.88; H, 5.69; N, 8.97.

5,7-Dichloro-1,2-diphenyl-6-hydroxybenzimidazole (**3h**).

The title compound was obtained in 35% yield, mp 227°; ^{1}H nmr: 7.40 (5H + 1H exchanging with deuterium oxide, C_6H_5 and OH), 7.48 (5H, s, C_6H_5), 7.82 (1H, s, aromatic in position 4); ms: 354.

Anal. Calcd. for $C_{13}H_{21}Cl_2N_2O$: C, 64.24; H, 3.41; N, 7.89. Found: C, 64.01; H, 3.21; N, 7.51.

1-(2,6-Dimethylphenyl)-5,7-dimethyl-6-hydroxy-2-phenylbenzimidazole (**3i**).

The title product was purified by chromatography using a 4:1 benzene-ethyl acetate solution as the eluant. The first fractions eluted were discarded; the following fractions gave **3i** as a colorless solid which was triturate with diisopropyl ether, mp 185°; ^{1}H nmr (dimethylsulfoxide): 1.90 (6H, s, $2CH_3$), 1.70 and 2.38 (each 3H, 2s, CH_3 in position 5 and 7), 7.35 (9H, m, aromatic), 8.05 (1H, s exchanging with deuteruim oxide, OH); ms: 342.

Anal. Calcd. for $C_{23}H_{22}N_2O$: C, 80.67; H, 6.48; N, 8.18. Found: C, 80.38; H, 6.33; N, 8.05.

6-Hydroxybenzimidazo[1,2-*a*]quinoline (**7**).

The cyclization of **6** (0.90 g) was carried out in glacial acetic acid (50 ml) at room temperature for 12 hours; the solution was diluted with water and neutralized with a 26% ammonium hydroxyde solution. The precipitate was filtered and dissolved in boiling methylene chloride. Some impurities were filtered off. The solution was dried over sodium sulphate. The solvent was removed under reduced pressure and the residue (0.22 g) was chromatographed on a silica gel column (eluant: ethyl acetate). The first fractions eluted were combined and rechromatographed (eluant: acetonitrile) to give **7** as a pure brown solid, mp 283°; ^{1}H nmr (dimethylsulfoxide): 7.05 (1H, dd, aromatic in position 5), 8.55 (1H, d, aromatic in position 4), 7.4-8.1 (7H, m, aromatic), 9.65 (1H, s exchanging with deuterium oxide, OH); ms: 234.

Anal. Calcd. for $C_{15}H_{10}N_2O$: C, 76.92; H, 4.27; N, 11.97. Found: C, 76.80; H, 4.12; N, 11.88.

5-Methoxy-2-nitrodiphenylamine.

A solution of 3-chloro-4-nitroanisole [8] (1 g) in aniline (8 ml) was heated at 140° on an oil bath for 24 hours and then treated with a 5% hydrochloric acid solution. The insoluble oil was exhaustively extracted with diethyl ether. The combined organic extracts were dried over sodium sulphate and evaporated to dryness under reduced pressure. The residue was chromatographed on a silica gel column (eluant, chloroform). The first fractions eluted gave the title compound (0.77 g), mp 110° (methanol), yield 60%; ^{1}H nmr: 3.80 (3H, s, OCH_3), 6.27 (1H, dd, aromatic in position 4), 6.54 (1H, d, aromatic in position 6), 7.3 (5H, m, C_6H_5), 8.15 (1H, d, aromatic in position 3), 9.78 (1H, broad s exchanging with deuterium oxide, NH); ms: 244.

Anal. Calcd. for $C_{13}H_{12}N_2O_3$: C, 63.92; H, 4.95; N, 11.47. Found: C, 63.93; H, 4.81; N, 11.62.

2-Amino-5-methoxydiphenylamine.

A 85% solution of hydrazine hydrate (0.28 g) and 5-methoxy-2-nitrodiphenylamine (0.77 g) in ethanol (50 ml) was refluxed with stirring in the presence of a trace of Raney-Nickel for 1 hour. The catalyst was filtered off and the solvent was removed under reduced pressure to give the title compound as a brown solid, mp 71° (*n*-hexane) (0.35 g), yield 53%; ^{1}H nmr: 3.42 (2H, broad s exchanging with deuterium oxide, NH_2), 3.8 (3H, s, OCH_3), 5.31 (1H, broad s exchanging with deuterium oxide, NH), 6.52 (1H, dd, aromatic in position 4), 6.8 and 7.25 (4H, and 3H, 2m, aromatic); ms: 214.

Anal. Calcd. for $C_{13}H_{14}N_2O$: C, 72.87; H, 6.59; N, 13.08. Found: C, 73.01; H, 6.44; N, 13.19.

1,2-Diphenyl-6-methoxybenzimidazole (**4**).

a) From 2-Amino-5-methoxydiphenylamine.

A mixture of 2-amino-5-methoxydiphenylamine (0.20 g), benzaldehyde (0.10 g) and nitrobenzene (3 ml) was refluxed for 30 minutes. The solvent was removed *in vacuo* and the residue crystallized from 2-propanol to give **4** as a white solid, mp 152° (0.084 g); ^{1}H nmr: 3.90 (3H, s, OCH_3), 6.73 (1H, d, aromatic in position 7), 6.93 (1H, dd, aromatic in position 5), 7.2-7.6 (10H, m, $2C_6H_5$), 7.75 (1H, d, aromatic in position 4); ms: 300.

Anal. Calcd. for $C_{20}H_{16}N_2O$: C, 79.98; H, 5.37; N, 9.33. Found: C, 80.05; H, 5.31; N, 9.34.

b) From **3a**.

The benzimidazole derivatives **3a** (0.15 g) was dissolved in a solution of sodium metal (0.013 g) in methanol (0.5 ml). The solvent was removed under reduced pressure and the residue was diluted with dry dimethylformamide (3 ml). Methyl iodide (0.5 ml) was added; the reaction was completed in a few minutes. The reaction mixture was diluted with water and the solid which separated was filtered, washed with water, and crystallized from 2-propanol to give **4** in a pure state, mp 152° (0.060 g); ms: 300.

Anal. Calcd. for $C_{20}H_{16}N_2O$: C, 79.98; H, 5.37; N, 9.33. Found: C, 80.13; H, 5.29; N, 9.42.

Kinetic Experiments.

The rates of disappearance of the substrates **2a,b,c,f,i** were evaluated by hplc analysis using a Merck Lichro Cart Hibar Manufix 250-4 column with methylene chloride-methanol solution as the eluant. The percentage of the latter was gradually increased from zero to 1% during the first three minutes of every injection. Under these conditions only the starting materials were eluted while the reaction products were completely retained on the column. They were eluted at the end of every kinetic run by using a 9:1 methylene chloride-methanol solution as the eluant. At zero time a standardized solution of the substrates (10^{-2} *M*) in methylene chloride was added to an identical amount of standardized acetic acid in a flask thermostated at 22°. An automatic injection device was employed with a 10 μl loop; the injections were effected at 4 minute intervals. The area of the unreacted starting product was evaluated by comparison with the area of the same peak after a 4 minute reaction time as reference. Kinetic data were measured up to 50% conversion. The rate constants, obtained through a linear regression, are the following: 6.27×10^{-4} sec^{-1} for **2a**, 7.6×10^{-5} sec^{-1} for **2b**, 7.47×10^{-4} sec^{-1} for **2c**, 7.42×10^{-4} sec^{-1} for **3f** and 1.01×10^{-4} sec^{-1} for **3i**.

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