3-Nitrocoumarin Amidines: A New Synthetic Strategy for Substituted [1]Benzopyrano[3,4-*d*]imidazol-4(3*H*)-ones

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A new synthesis of substituted [1]benzopyrano[3,4-*d*]imidazol-4(3*H*)-ones, starting from 3-nitrocoumarin *N*-functionalized amidines **3**, has been developed. When the 3-nitro-amidines **3** were treated with $NaBH_4$ in the presence of 10% palladium on charcoal, 2-substituted [1]benzopyrano[3,4-*d*]imidazol-4(3*H*)-ones **4** were produced. Structure elucidation of compounds **4** revealed that they exist as one of the three possible tautomeric structures (i.e., **4dα**). Alkylation of **4d** to give **6**, as well as NOE experiments on **6** and energy calculations allowed the most favoured structure of the **4** derivatives to be identified. Alternatively, the reduction of the 3-nitro-amidines **3** by triethyl phosphite, through a nitrene intermediate, cyclization and a [1.5] sigmatropic shift, yielded 2-morpholino-3-alkyl-[1]benzopyrano[3,4-*d*]imidazol-4(3*H*)-ones **7**.

Introduction

It is well known that coumarin derivatives occur in several natural compounds possessing interesting pharmaceutical and biochemical properties.[1] In the recent years a range of activities have been claimed for some coumarins fused to imidazole rings. The coumarin-imidazole nucleus, for instance, is present in compounds useful as CNS depressants,[2] as growth inhibitors of mammalian cancer[3] and also as phosphodiesterase VII inhibitors for treatment of immunity-associated diseases.[4]

Few synthetic ways to prepare benzopyranoimidazolone derivatives have been reported in the literature. The main synthetic approach involves the condensation of 3,4-diaminocoumarin with formic[2] or acetic acid.[3] Benzopyranoimidazolones can also be obtained from 3,4-diaminocoumarin through fusion or anodic oxidation of the useful amidic[5] or iminic[6] derivatives, respectively. These methods provide coumarin-imidazole derivatives in good yields, but they are restricted to the synthesis of 1- and 2-alkyl(and/or aryl)-substituted compounds.

In recent years we have studied the reactivity of acetamidines[7] bearing a 2*H*-pyran-2-one group at N-1 as key intermediates in the synthesis of functionalized pyridines. In continuation of our study we set out to obtain acetamidines carrying a 3-nitrocoumarin group on N-1 as starting materials from which to synthesize benzopyranoimidazolones.

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It is well known that the C=N groups of amidines undergo nucleophilic reactions with amino groups[8] and that these imino groups also react with nitrenes[9] obtained from the nitro group reduction.

We decided to exploit this behaviour of nitro groups with the purpose of finding a satisfactory route by which to synthesize benzopyranoimidazolones bearing hydrogen or alkyl groups on N-3 and alkyl or amino substituents on C-2.

Results and Discussion

4-Azido-3-nitrocoumarin (**1**) and appropriate enamines **2a**−**e**, previously synthesized, were allowed to react together in dichloromethane solution at −40 °C, these conditions allowing the isolation of the amidines **3a**−**e** in short times and in high yields (67 to 89%) and avoiding the known azide transformation into 4*H*-[1]benzopyrano[3,4-*c*][1,2,5]oxadiazol-4-one 3-oxide.[10] The reaction pathway is depicted in Scheme 1. The 4,5-dihydrotriazole **A** could never be isolated, owing to its thermal instability as a result of the electron-withdrawing effect of the N-1 substituent,[11] which facilitates the cleavage of the N1−N2 bond and promotes amidine rearrangement (Scheme 1).

The proposed structures of the new amidines **3a**−**e** were validated by the spectral data, which were consistent with available literature data for similar substitution patterns in coumarin derivatives[10,12,13a−13c].

Synthesis of 2-Alkyl-benzopyranoimidazolones

The nitrocoumarin amidines **3a**−**e** were then treated, at first, with $NaBH_4$ in the presence of 10% palladium on charcoal. This reagent is known to reduce a wide range of

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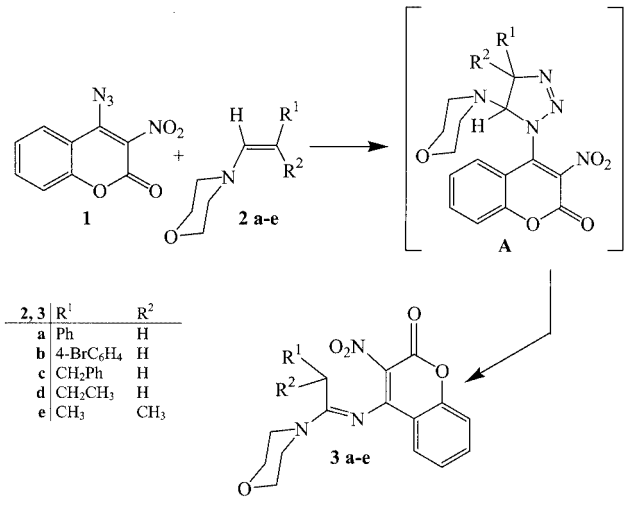
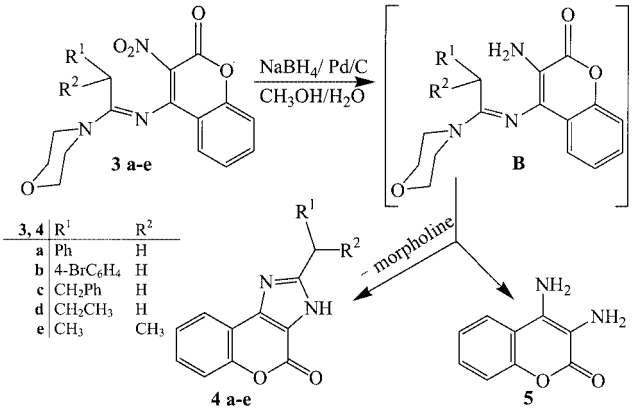


2, 3	R^1	R^2
a	Ph	H
b	4-BrC_6H_4	H
c	CH_2Ph	H
d	CH_2CH_3	H
e	CH_3	CH_3

Scheme 1

substituted nitrobenzenes smoothly to the corresponding amines.[14] When the reactions were carried out in aqueous methanol solution at room temperature, mixtures of two products were obtained. Chromatographic separation of the crude mixtures afforded the coumarin imidazolones **4a**−**e** and the known 3,4-diaminocoumarin (**5**)[3] as a by-product in yields varying from 15 to 20% (Scheme 2).



3, 4	R^1	R^2
a	Ph	H
b	4-BrC_6H_4	H
c	CH_2Ph	H
d	CH_2CH_3	H
e	CH_3	CH_3

Scheme 2

The isolation of 3,4-diaminocoumarin (**5**) is not surprising. In fact, the hydrolytic reactivity of amidines in alkaline solution is influenced by the electron-withdrawing substituent on the nitrogen atom.[15]

It should be quite reasonable to assume (Scheme 2) that the product **4** arose quickly from the nonisolable amine intermediate **B**, subsequent addition of NH_2 group to the amidine and morpholine elimination to give the imidazole ring being favoured by aromatisation.

The ^1H NMR spectra of the compounds **4** showed the expected signals: the substituent on C-2 imidazole,[16] an exchangeable NH proton and the typical doublet for coumarin 9-H in the range $\delta = 7.96-8.20$ ppm, validated by the ^{13}C spectral pattern of the coumarin ring. All coumarin imidazolones **4a**−**e** displayed IR stretching at 1711−1742 cm^{-1} associated with lactone carbonyl groups, also confirmed by the signals appearing between $\delta = 155$ and 162 ppm in the ^{13}C NMR spectra.[12,13] It is known that the derivatives **4** can exist in tautomeric forms **α**, **β** and **γ**, depicted in Figure 1.

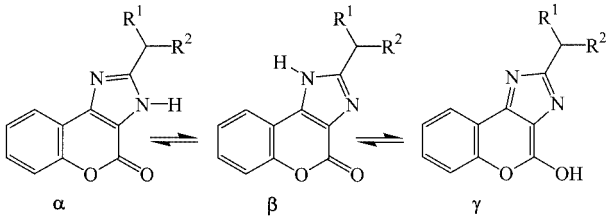


Figure 1. Tautomeric forms of **4** derivatives

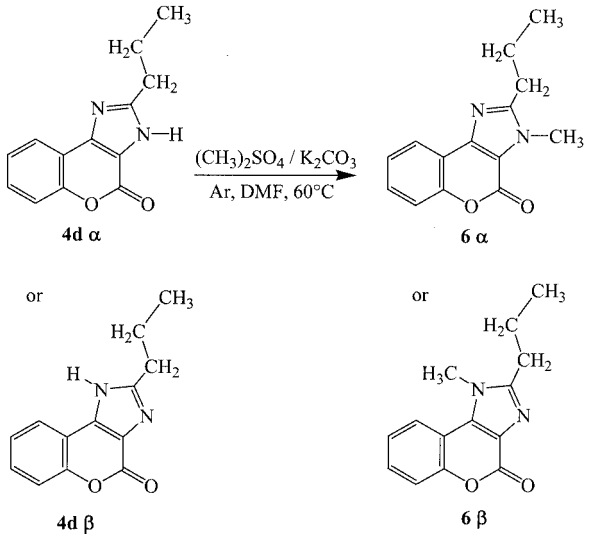
Annular tautomerism is common in heteroaromatic compounds and has been widely studied, but literature relating to the benzopyranoimidazolone nucleus pays poor attention to the tautomerism problem.[3,5] The authors of the cited references[3,5] assign two opposite tautomeric structures to the same compound and the ^1H NMR spectroscopic data for this product are not very detailed.

In our case the **γ** tautomer can be ruled out because all the IR spectra of the coumarin imidazolones **4a**−**e**, recorded in chloroform solution, showed lactone bands[10,12] at 1704−1712 cm^{-1}, confirmed by typical carbonyl patterns in the ^{13}C NMR spectra.[12,13c] ^1H and ^{13}C NMR spectroscopic analyses did not permit distinction to be made between **α** and **β** structures. It is in fact well known that chemical shifts and tautomeric equilibrium are solvent-dependent.[17] Owing to their poor solubility in $CDCl_3$, the ^1H and ^{13}C spectra of the compounds **4** were recorded in DMSO. All ^1H spectra for compounds **4a**−**c** and **4e** recorded in DMSO showed unitary signals at room temperature, but NOESY experiments performed on the compound **4a**, although it indeed appeared to exist in a single form, were unsuccessful in ruling out either the **α** or the **β** isomer.

In contrast, the ^1H NMR spectrum of compound **4d** in DMSO showed split signals for NH and 9-H in the coumarin nucleus. In CD_3OD, the coumarin 9-H appeared split, but NH was exchanged. Performing ^1H NMR spectrum on a diluted solution in [D_6]acetone, we observed excessive line broadening in the NH signals (about 180 Hz). Under these conditions it was not possible to detect any long-range coupling between the NH protons and C-9a. A ROESY experiment, performed on the same acetone solution, in order to observe any through-space interaction between the NH proton and 9-H proton, was unsuccessful. The only ROE observed was between protons 9-H and 8-H. In addition we observed an exchange cross-peak between the 9-H signals associated with the two tautomers, thus proving that the tautomerism is slow on the NMR timescale under these conditions.

For more useful investigative analysis, derivative **4d** was alkylated with dimethyl sulfate in DMF in the presence of

potassium carbonate. After 5 h at 60 °C, the only product obtained was the methyl derivative **6α** or **6β** (Scheme 3).



Scheme 3

The IR spectra of the derivative **6α** or **6β**, both in nujol mull and in chloroform solution, were characterized by carbonyl stretching at 1717 and 1719 cm^{-1}, respectively, also validated by a ^{13}C signal at $\delta = 158$ ppm. The ^1H NMR spectrum showed the expected signals associated with the *n*-propyl group and a singlet at $\delta = 4.05$ ppm associated with methyl on imidazole nitrogen. Structural assignment was achieved by a 2D-NOESY experiment on the compound **6**, which displayed a clear NOE interaction between the CH_2 of the *n*-propyl substituent on C-2 of the imidazole ring and the CH_3 group on N-3. Irradiation of the 9-H proton of the coumarin moiety gave an NOE effect only on adjacent 8-H, suggesting the α isomer structure for compounds **6** and consequently the predominance of the **4dα** form, at least in solution, for **4d** derivative.

In order to verify that the choice of reactions conditions was not affecting the formation of the 3-methyl-benzopyranoimidazolone **6α**, the reaction between **4d** and dimethyl sulfate was also performed at −20 °C. After 72 h complete transformation of **4d** had occurred. The ^1H NMR spectrum of the crude mixture showed the signals only of the **6α** derivative, suggesting the **α** structure for the starting compound **4d** and probably for all the compounds **4**.

Quantum Chemical Calculations

The study and quantitative evaluation of prototropic tautomerism in heterocyclic compounds is of primary interest, influencing both reactivity and biological behaviour, as in, for example, the ability of a drug to bind the active site of a target enzyme.[18] Unfortunately, the literature does not report any reliable structural information on the pyranoimidazolone nucleus and neither experimental nor theoretical data concerning its tautomerism. On the other hand, tautomerism in various substituted imidazoles[19] has been successfully described by ab initio[19a,19b,19d,19e] and DFT calculations both in the gas phase[19b] and in solution by the continuum solvent model[19f] or by the evaluation of explicit solvent interactions.[19a]

With the aim of obtaining more detailed information about the structure of the most favoured tautomers for the compounds reported in this study we thus performed ab initio and DFT calculations. The starting structures of **4aα**, **4aβ**, **4bα**, **4bβ**, **4cα**, **4cβ**, **4dα**, **4dβ**, **4eα**, **4eβ**, **6α** and **6β** were obtained by a conformational search with the Austin Model 1 (AM1)[20] as implemented in Hyperchem 6.3. The most favoured minima were then fully optimized at both RHF and B3LYP[21] levels through the use of the 6−31G**[22] basis set; minima were confirmed by vibrational analysis and no imaginary frequencies were observed. HF calculation were performed with GAMESS,[23] the linear dependence threshold (QMTTOL) was set at 1×10^{-7}, HONDO/ Rys integrals were used for all integrals (INTTYP=

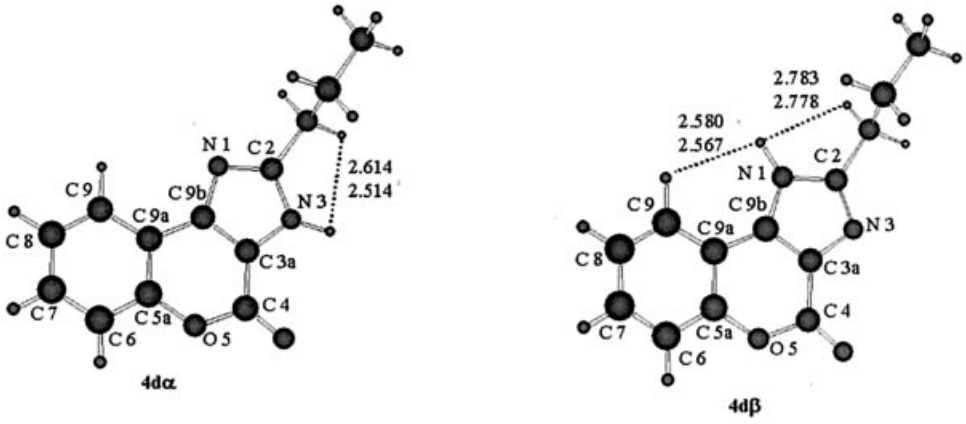


Figure 2. Right: calculated distances between imidazole N1−H and both coumarin 9-H and C-2 linked propyl CH_2 protons in **4dβ**; left: calculated distances between N3−H and propyl CH_2 in **4dα**; units are Å, B3LYP distances are reported below HF distances; selected HF (B3LYP) bond length [Å] for **4dα**: N1−C2 1.306 (1.329), C2−N3 1.346 (1.368), N3-C3a 1.372 (1.377), C3a−C9b 1.354 (1.383), C3a−C4 1.439 (1.435), C4−O5 1.350 (1.391), O5−C5a 1.367 (1.380), C5a−C9a 1.392 (1.411), C9a−C9b 1.392 (1.411), C9b−N1 1.359 (1.370); **4dβ**: N1−C2 1.373 (1.388), C2−N3 1.286 (1.314), N3−C3a 1.371 (1.378), C3a−C9b 1.355 (1.385), C3a−C4 1.455 (1.451), C4−O5 1.367 (1.413), O5−C5a 1.355 (1.367), C5a−C9a 1.392 (1.413), C9a−C9b 1.444 (1.435), C9b−N1 1.360 (1.371).

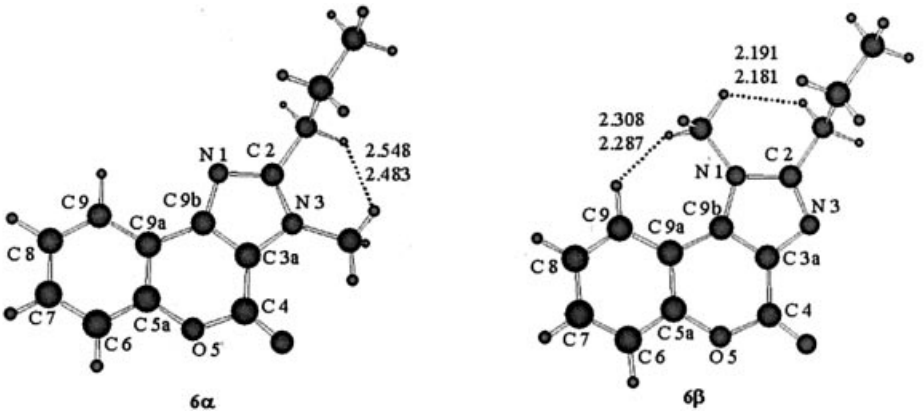


Figure 3. Right: calculated distances between imidazole N−H and both coumarin 9-H and C-2 linked propyl CH_2 protons in **6β**; left: calculated distances between N−H and propyl CH_2 in **6α**; units are Å, B3LYP distances are reported below HF distances; selected HF (B3LYP) bond length for **6α**: N1−C2 1.308 (1.330), C2−N3 1.346 (1.371), N3−C3a 1.380 (1.385), C3a−C9b 1.358 (1.386), C3a−C4 1.443 (1.438), C4−O5 1.350 (1.390), O5−C5a 1.365 (1.379), C5a−C9a 1.389 (1.409), C9a−C9b 1.448 (1.441), C9b−N1 1.352 (1.365); **4dβ**: N1−C2 1.377 (1.393), C2−N3 1.287 (1.314), N3−C3a 1.364 (1.372), C3a−C9b 1.358 (1.388), C3a−C4 1.454 (1.450), C4−O5 1.363 (1.407), O5−C5a 1.354 (1.367), C5a−C9a 1.396 (1.417), C9a−C9b 1.453 (1.442), C9b−N1 1.368 (1.380)

HONDO), and the DIIS converger was used instead of SOSCF. DFT calculation were performed with Gaussian98[24] and tight SCF convergence was requested.

Figure 2 (right) shows calculated distances between imidazole N1−H and both coumarin 9-H and C-2 linked propyl CH_2 protons in **4dβ**.

Figure 3 (right) shows calculated distances between imidazole N−H and both coumarin 9-H and C-2 linked propyl CH_2 protons in **6β**. On the left, calculated distances between N−H and propyl CH_2 in **6α** are shown.

Figure 2 and 3 show predicted structures for compounds **4d α/β** and **6α/β**, respectively. As shown in Figure 3, both HF and B3LYP geometries for compound **6β** give distances of well below 3 Å between hydrogens of the CH_3 group on N-1 and coumarin 9-H, but NOE experiments show the interaction between CH_3 on N-3 and C-2 linked propyl CH_2 as the only one present, allowing us to confirm the presence of **6α** as the only methylation reaction product.

Vacuum energy calculations collected in Table 1 show that tautomer **α** is from 4.56 to 5.28 kcal/mol more stable than tautomer **β** in compounds **4,** both by HF and by B3LYP theories. The results of vacuum calculations confirm the behaviour seen in the methylation reaction conducted on **4d**. They do not, however, explain the split signals typical of mixtures of tautomers, because the energy gap between **4dα** and **4dβ** is too high for such an equilibrium. As reported above, such signals were observed for NH and 9-H of coumarin nucleus in ^1H NMR experiments performed on compound **4d** in DMSO and CD_3OD. For this reason we performed energy calculations with the polarizable continuum model (PCM)[25] in order to consider the effects of both DMSO and CH_3OH on the relative stabilities of compounds **4** in their **α** and **β** tautomeric forms; electrostatic and cavitation contributions were considered, the cavitation component being evaluated by Pierotti−Clavarie's method.[26]

The results reported in Table 1 show that CH_3OH and DMSO notably lower the energy gap between **α** and **β** tautomeric forms for all compounds **4a**−**e**. Tautomer **α** is predicted to be the more favoured in each case except for that of PCM-CH_3OH//B3LYP calculations conducted on **4b**, for which tautomer **β** turns out to be 0.73 kcal/mol more stable than **α**, but such behaviour disagrees with the experimentally observed NMR results; it should be noted that PCM calculations with the B3LYP functional sometimes result in poor agreement with experimentally determined values[27] and such behaviour is also observed in this study. PCM-CH_3OH//HF calculations predict the smallest energy gap to be that between tautomers **4bα** and **4bβ** (0.77 kcal/mol), followed by that between **4dα** and **4dβ** (0.80 kcal/mol), but split signals were observed only in the case of **4d**. PCM-DMSO//HF calculations show the lowest energy gap to be that between tautomers **4dα** and **4dβ** (0.69 kcal/mol), perfectly in agreement with observed NMR results.

Unfortunately, the relative energy differences E_{rel} between compounds **4a**−**e** observed in CH_3OH and DMSO are not sufficiently high for any unambiguous statement to be made, as they all fall within 1 kcal/mol. The reason for the lack of any observed split signal for **4a**−**c** and **4e** could be that the rate of interconversion between the **α** and **β** tautomers for compound **4d** is slower on the NMR timescale for some reason. Another possibility could be that **4dα-4dβ** interconversion is somehow enhanced by minor steric hindrance of the C-2 substituent. On the other hand, the solvent model used in this study might not be sufficiently accurate to predict this tautomeric behaviour correctly; it has indeed been reported by Kleinpeter and Koch[28] that a correct description of tautomerism in 4-substituted 3-methyl-1-phenylpyrazolin-5-ones was possible only through consideration of various dimeric and trimeric complexes of the evaluated compounds or of explicit solvent interactions by a supramolecular approach. Investigation in such depth was

Table 1. Total free energies E_{tot} [a.u.] and relative energies E_{rel} [kcal/mol] at HF/6−31G** and B3LYP/6−31G** for compounds **4a−e** and **6** in their **α** and **β** tautomeric forms; vacuum RHF and B3LYP data include zero point energies; calculations conducted with the PCM solvent model for DMSO and CH_3OH on compounds **4a−e/α-β** include electrostatic and cavitation contributions

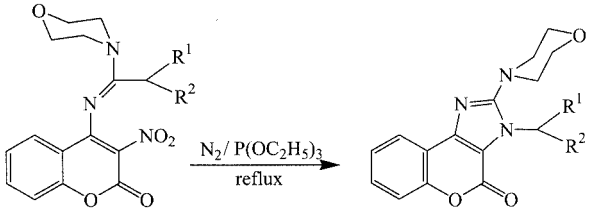
Entry	Method	Tautomer **α**		Tautomer **β**	
		E_{tot}	E_{rel}	E_{tot}	E_{rel}
4a	HF/6−31G**	−909.169383	0.00	−909.161577	4.90
	PCM-CH_3OH// HF/6−31G**	−909.417783	0.00	−909.416330	0.91
	PCM-DMSO// HF/6−31G**	−909.403905	0.00	−909.402508	0.88
	B3LYP/6−31G**	−914.791240	0.00	−914.783361	4.94
	PCM-CH_3OH// B3LYP/6−31G**	−915.028834	0.00	−915.026090	1.72
	PCM-DMSO// B3LYP/6−31G**	−915.004522	0.00	−915.002853	1.05
4b	HF/6−31G**	−3478.524029	0.00	−3478.516575	4.68
	PCM-CH_3OH// HF/6−31G**	−3478.760319	0.00	−3478.759090	0.77
	PCM-DMSO// HF/6−31G**	−3478.745576	0.00	−3478.744400	0.74
	B3LYP/6−31G**	−3485.902382	0.00	−3485.895873	4.08
	PCM-CH_3OH// B3LYP/6−31G**	−3486.127669	0.73	−3486.128827	0.00
	PCM-DMSO// B3LYP/6−31G**	−3486.102670	0.00	−3486.101415	0.79
4c	HF/6−31G**	−948.176781	0.00	−948.169507	4.56
	PCM-CH_3OH// HF/6−31G**	−948.452287	0.00	−948.450587	1.07
	PCM-DMSO// HF/6−31G**	−948.437229	0.00	−948.435502	1.08
	B3LYP/6−31G**	−954.081449	0.00	−954.073179	5.19
	PCM-CH_3OH// B3LYP/6−31G**	−954.340759	0.00	−954.340540	0.14
	PCM-DMSO// B3LYP/6−31G**	−954.318178	0.00	−954.316063	1.33
4d	HF/6−31G**	−757.718356	0.00	−757.709944	5.28
	PCM-CH_3OH// HF/6−31G**	−757.944197	0.00	−757.942921	0.80
	PCM-DMSO// HF/6−31G**	−757.931882	0.00	−757.930786	0.69
	B3LYP/6−31G**	−762.394411	0.00	−762.385214	5.77
	PCM-CH_3OH// B3LYP/6−31G**	−762.605818	0.00	−762.605035	0.49
	PCM-DMSO// B3LYP/6−31G**	−762.586926	0.00	−762.584517	1.51
4e	HF/6−31G**	−757.718176	0.00	−757.709904	5.19
	PCM-CH_3OH// HF/6−31G**	−757.943174	0.00	−757.941872	0.82
	PCM-DMSO// HF/6−31G**	−757.930952	0.00	−757.929749	0.75
	B3LYP/6−31G**	−762.391639	0.00	−762.384242	4.64
	PCM-CH_3OH// B3LYP/6−31G**	−762.605935	0.00	−762.604943	0.62
	PCM-DMSO// B3LYP/6−31G**	−762.586941	0.00	−762.584766	1.36
6	HF/6−31G**	−796.719713	0.00	−796.707214	7.84
	B3LYP/6−31G**	−801.676680	0.00	−801.667435	5.80

not intended in this study, in which we mainly report the synthesis of novel benzopyranoimidazolones, but is the object of future research.

Synthesis of 2-Amino-benzopyranoimidazolones

In order to obtain benzopyranoimidazolone derivatives bearing an amino substituent on C-2, we decided to investigate the transformation of nitrocoumarin amidines **3a−e** into nitrene intermediates.

With this aim, the amidines **3a−e** were heated at reflux in excess triethyl phosphite and slowly transformed (6−14 h) into the expected tricyclic derivatives **7a−e** (Scheme 4), through the reduction of the nitro group, cyclization and rearrangement. Prolonged heating, required to consume the amidines **3,** was detrimental and it lowered the yields of the compounds **7** through formation of unidentified polymeric material. Structural assignments for the 2-amino-benzopyranoimidazolones **7a−e** established by ^1H and ^{13}C NMR relating to the coumarin[13] and imidazole[16] nuclei were in agreement with the literature data.



3, 7	R^1	R^2
a	Ph	H
b	4-BrC_6H_4	H
c	CH_2Ph	H
d	CH_2CH_3	H
e	CH_3	CH_3

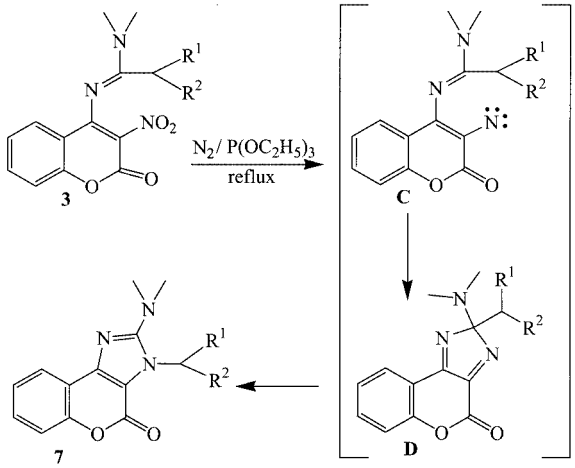
Scheme 4

In each case we observed the expected signals for the 2-morpholino substituent and a typical pattern for the coumarin[12,13] moiety. We noted the downfield shift of the methylene or methyne group for **7a−d** and **7e** derivatives, respectively, relative to the starting amidines **3a−e** as a consequence of the alkyl migration from amidine carbon to imidazole nitrogen and the deshielding effect from the former.

A NOESY experiment performed on derivative **7a** demonstrated interaction between the singlet at δ = 5.55 ppm (CH_2Ph) and the signals of the CH_2 linked to morpholine nitrogen in the δ = 3.25−3.30 ppm range.

Irradiation of the 9-H proton of the coumarin moiety did not give any NOE effect on the (CH_2Ph) group, thus supporting the proposed structure for derivative **7a**. To date, however, no reports about these derivatives are available in the literature.

The production of fused heterocycles **7** can be interpreted as follows (Scheme 5). The reduction of the nitro group by triethyl phosphite is a well established way to generate reactive nitrenes[29] **C**. These intermediates **C** rapidly undergo cyclization through addition to the C=N double bond to form 2,2-disubstituted benzopiranoimidazolones **D**. These intermediates thermally rearrange to the corresponding derivatives **7** through [1.5] sigmatropic shifts of the alkyl group toward nitrogen. This shift is probably also a quick reaction, at least in refluxing triethyl phosphite, since we were not able to identify these intermediates. A few examples of [1.5] shifts in 2,2-imidazoles[30] have been described.



Scheme 5

Conclusion

In conclusion, we have demonstrated a new method by which to synthesize substituted [1]benzopyrano[3,4-*d*]imidazol-4(3*H*)-ones in good yields, starting from easily accessible acetamidines bearing a 3-nitrocoumarin group at N-1.

Furthermore, we have reported the preparation of 2-amino derivatives, which to date seems the only one reported.

The flexibility of this methodology should provide access to many variously 2,3-disubstituted [1]benzopyrano[3,4-*d*]-imidazol-4(3*H*)-ones.

Experimental Section

Melting points were determined with a Büchi 510 (capillary) or an Electrothermal 9100 apparatus and are uncorrected. IR spectra were measured with Perkin−Elmer FT-IR 16 P.C. (nujol), and Perkin−Elmer FT-IR Spectrum One ($CHCl_3$ or KBr) spectrometers. ^{1}H and ^{13}C NMR spectra were recorded with EM Varian Gemini 200, Bruker AC 200 and Bruker Avance 300 spectrometers, with the solvent indicated close to the corresponding compound. Chemical shifts are expressed in ppm from tetramethylsilane as internal standard (δ), coupling constants (*J*) are given in Hz. Column chromatography was performed on Kieselgel 60 (Merck) 0.063−0.200 mm with the eluents and ratios indicated.

Materials: Azide **1**[10] and enamines **2a**−**b**,[31] **2c**,[32] **2d**[33] and **2e**[34] have already been described. 3,4-Diaminocoumarin (**5**) is a known product.[3]

General Procedure for the Synthesis of Amidine Derivatives 3a−e: The appropriate enamine **2a**−**e** (10 mmol) was dissolved in CH_2Cl_2 (20 mL). With careful monitoring of the internal temperature (−40 °C, acetone/CO_2 bath), an equimolar amount of azide **1,** dissolved in CH_2Cl_2 (30 mL), was slowly added dropwise, with stirring. The reaction took place in a few minutes, with slight foaming. The mixture was allowed to come back to room temperature, the solvent was then evaporated, and the crude product was purified by crystallization from *i*Pr_2O to give pure **3a**−**e** as yellow crystals.

4-[(1-Morpholin-4-yl-2-phenylethylidene)amino]-3-nitro-2*H*-[1]-benzopyran-2-one (3a): Yield: 3.2 g (81%). M.p. 175−176 °C. IR (nujol): $\tilde{\nu}_{max}$ = 1716 (C=O) cm^{-1}. ^{1}H NMR ($CDCl_3$): δ = 3.63−3.90 (m, 8 H, morpholine), 3.75 (s, 2 H, CH_2−Ph), 7.08−7.35 (m, 5 H +2 H, arom. and 6-H and 8-H coum.), 7.59 (td, *J* = 8.4, 1.4 Hz, 1 H, 7-H coum.), 7.84 (dd, *J* = 8.0, 1.4 Hz, 1 H, 5-H coum.) ppm. ^{13}C NMR ($CDCl_3$): δ = 38.0 (CH_2), 47.2 (CH_2NCH_2), 66.4 (CH_2OCH_2), 117.0 (CH-8 coum.), 117.9 (C-4a coum.), 120.6 (C−NO_2), 124.4, 126.8, 133.9 (CH coum.), 127.6, 128.3, 129.1, (CH arom.), 133.2 (C arom.), 152.3 (C-4 coum.), 153.2 (C-8a coum.), 155.7 (N−C=N), 161.9 (C=O) ppm. $C_{21}H_{19}N_3O_5$ (393.40): calcd. C 64.12, H 4.87, N 10.68; found C 64.17, H 4.93, N 10.55.

4-{[2-(4-Bromophenyl)-1-morpholinoethylidene]amino}-3-nitro-2*H*-[1]benzopyran-2-one (3b): Yield: 3.9 g (83%). M.p. 158−160 °C (decomp.). IR: (nujol): $\tilde{\nu}_{max}$ = 1714 (C=O) cm^{-1}. ^{1}H NMR ($CDCl_3$): δ = 3.65−3.89 (m, 8 H, morpholine), 3.73 (s, 2 H, CH_2 linked to 4-Br C_6H_5), 6.98 and 7.32 (2 × d, AB system, *J* = 8.4 Hz, 4 H, arom.), 7.25−7.38 (m, 2 H, 6-H and 8-H coum.), 7.62 (t d, *J* = 7.3, 1.8 Hz, 1 H, 7-H coum.), 7.76 (dd, *J* = 7.3, 1.8 Hz, 1 H, 5-H coum.) ppm. ^{13}C NMR ($CDCl_3$): δ = 37.3 (CH_2), 46.9 (CH_2NCH_2), 66.4 (CH_2OCH_2), 117.2 (CH-8 coum.), 117.7 (C-4a coum.), 121.2 (C−NO_2), 121.7 (C-Br), 124.4, 126.6, 134.0 (CH coum.), 130.0, 132.2 (CH arom.), 132.3 (C arom.), 152.4 (C-4 coum.), 153.1 (C-8a coum.), 155.4 (N−C=N), 161.1 (C=O) ppm. $C_{21}H_{18}BrN_3O_5$ (472.30): calcd. C 53.41, H 3.84, N 8.90; found C 53.24, H 3.91, N 8.97.

4-[(1-Morpholin-4-yl-3-phenylpropylidene)amino]-3-nitro-2*H*-[1]-benzopyran-2-one (3c): Yield: 3.4 g (83%). M.p. 73 °C (decomp.). IR (KBr): $\tilde{\nu}_{max}$ = 1724 (C=O), 1479 and 1369 (NO_2) cm^{-1}. ^{1}H NMR ($CDCl_3$): δ = 2.70−2.85 (m, 4 H, CH_2CH_2), 3.57−3.78 (m, 8 H, morpholine), 7.01−7.40 (m, 5 H + 2 H, arom. and 6-H, 7-H, 8-H coum.), 7.58 (d, *J* = 8.0 Hz, 1 H, 5-H coum.) ppm. ^{13}C NMR ($CDCl_3$): δ = 32.8 and 33.0 (CH_2−CH_2), 46.9 (CH_2NCH_2), 66.5 (CH_2OCH_2), 117.1 (CH-8 coum.), 117.8 (C-4a coum.), 120.2 (C−NO_2), 124.5, 126.7, 133.8 (CH coum.), 127.1, 128.2, 128.9 (CH arom.), 138.5 (C arom.), 152.5 (C-4 coum.), 153.0 (C-8a coum.), 155.8 (N−C=N), 163.5 (C=O) ppm. $C_{22}H_{21}N_3O_5$ (407.43): calcd. C 64.86, H 5.20, N 10.31; found 64.71, H 5.24, N 10.43.

4-[(1-Morpholin-4-ylbutylidene)amino]-3-nitro-2*H*-[1]benzopyran-2-one (3d): Yield: 3.0 g (87%). M.p. 148−149 °C (decomp.). IR (KBr): $\tilde{\nu}_{max}$ = 1722 (C=O), 1523 and 1388 (NO_2) cm^{-1}. ^1H NMR ($CDCl_3$): δ = 0.88 (t, *J* = 7.3 Hz, 3 H, CH_3), 1.43−1.61 (m, 2 H, CH_2), 2.38 (t, *J* = 8.4 Hz, 2 H, CH_2C=), 3.60−3.84 (m, 8 H, morpholine), 7.22−7.37 (m, 2 H, 6-H and 8-H coum.), 7.58−7.67 (m, 1 H, 7-H, coum.), 7.78 (dd, *J* = 8.0, 1.8 Hz, 1 H, 5-H coum.) ppm. ^{13}C NMR ($CDCl_3$): δ = 13.9 (CH_3), 20.5 (CH_2), 33.2 (CH_2-C=N), 47.0 (CH_2NCH_2), 66.6 (CH_2OCH_2), 117.1 (CH-8 coum.), 118.0 (C-4a coum.), 120.2 (C−NO_2), 124.5, 126.8, 133.9 (CH coum.), 152.5 (C-4 coum.), 153.1 (C-8a coum.), 155.8 (N−C=N), 164.4 (C=O) ppm. $C_{17}H_{19}N_3O_5$ (345.35): calcd. C 59.12, H 5.55, N 12.17; found C 58.95, H 5.62, N 12.06.

4-[(2-Methyl-1-morpholinopropylidene)amino]-3-nitro-2*H*-[1]-benzopyran-2-one (3e): Yield. 2.3 g (67%). M.p. 108 °C. IR (nujol): $\tilde{\nu}_{max}$ = 1721 (C=O) cm^{-1}. ^1H NMR ($CDCl_3$): δ = 1.10 (d, *J* = 6.9 Hz, 3 H, CH_3), 1.25 (d, *J* = 6.9 Hz, 3 H, CH_3), 3.03 (quint, *J* = 6.9 Hz, 1 H, CH), 3.50−3.70 and 3.75−3.85 (2m, 8 H, morpholine), 7.24−7.34 (m, 2 H, 6-H and 8-H coum.), 7.58−7.63 (m, 1 H, 7-H coum.), 7.74 (d, *J* = 8.0 Hz, 1 H, 5-H coum.) ppm. ^{13}C NMR ($CDCl_3$): δ = 19.3 (CH_3), 21.0 (CH_3), 33.5 (CH), 47.7 (CH_2NCH_2), 66.7 (CH_2OCH_2), 116.0 (C−NO_2), 117.6 (CH-8 coum.), 117.8 (C-4a coum.), 124.6, 127.0, 134.1 (CH coum.), 149.8 (C-4 coum.), 152.8 (C-8a coum.), 156.4 (N−C=N), 168.9 (C=O) ppm. $C_{17}H_{19}N_3O_5$ (345.35): calcd. C 59.12, H 5.55, N 12.17, found C 58.92, H 5.51, N 12.09.

General Procedure for the Preparation of Derivatives 4a−e. Reduction with $NaBH_4$: A solution of $NaBH_4$ (0.61 g, 16 mmol) in water (10 mL) was added to a stirred solution of 10% palladium/carbon (0.16 g) in water, through which a gentle stream of nitrogen was passed. A suspension of the appropriate nitroamidine derivative **3a−e** (4 mmol) in methanol (100 mL) was then slowly added at room temperature. After an additional 15 minutes stirring at room temperature, the catalyst was removed by filtration through Celite. Without heating, the solvents were evaporated under reduced pressure. The remaining aqueous phase was extracted with Et_2O (4 × 30 mL). The combined diethyl ether layers were washed with water and then with organic solution, dried with Na_2SO_4 and evaporated to dryness. The residue was chromatographed on a silica gel column (eluent: cyclohexane/ethyl acetate, 3:7) to afford compounds **4** as the first fraction and 3,4-diaminocoumarin (**5**)[3] as the second fraction. The crude derivatives **4** were crystallized from CH_2Cl_2.

2-Benzyl-[1]benzopyrano[3,4-*d*]imidazol-4(3*H*)-one (4a): Pale yellow crystals (0.72 g, 65%). M.p. 263 °C (decomp.). IR (KBr): $\tilde{\nu}_{max}$ = 3436 (NH), 1742 (C=O) cm^{-1}. IR ($CHCl_3$): $\tilde{\nu}_{max}$ = 3424 and 3205 (NH), 1712 (C=O) cm^{-1}. ^1H NMR ([D_6]DMSO): δ = 4.20 (s, 2 H, CH_2), 7.23−7.54 (m, 5H+3 H, arom. and 6-H, 7-H, 8-H coum.) 7.96 (d, *J* = 7.5 Hz, 1 H, 9-H coum.), 13.84 (br. s, 1 H, N−H) ppm. ^{13}C NMR ([D_6]DMSO): δ = 35.3 (CH_2), 115.8 (C-9a coum.), 121.2 (C-3a coum.), 117.7, 122.8, 125.3 and 130.1 (CH coum.), 127.6, 129.4 and 129.6 (CH arom.), 137.9 (C arom.), 142.8 (N=C−NH), 152.6 (C-9b coum.), 155.5 (C-5a coum.), 155.9 (C=O) ppm. $C_{17}H_{12}N_2O_2$ (276.29): calcd. C 73.90, H 4.38, N 10.14; found C 74.07, H 4.49, N 10.03, and **5**[3] (105 mg) in 15% yield.

2-(4-Bromobenzyl)-[1]benzopyrano[3,4-*d*]imidazol-4(3*H*)-one (4b): White crystals (0.85 g, 60%). M.p. 271 °C (decomp.). IR (KBr): $\tilde{\nu}_{max}$ = 3165 (NH), 1710 (C=O) cm^{-1}. IR ($CHCl_3$): $\tilde{\nu}_{max}$ = 3423 and 3169 (NH), 1711 (C=O) cm^{-1}. ^1H NMR ([D_6]DMSO): δ = 4.20 (s, 2 H, CH_2), 7.31 and 7.54 (2 × d, *J* = 8.3 Hz, AB system, 4 H, *p*Br arom.), 7.34−7.52 (m, 3 H, 6-H, 7-H, 8-H coum.), 7.96 (d, *J* = 7.6 Hz, 1 H, 9-H coum.), 13.80 (br. s, 1 H, N−H) ppm. ^{13}C NMR ([D_6]DMSO): δ = 33.8 (CH_2), 114.9 (C-9a coum.), 119.8 (C-Br), 120.5 (C-3a coum.), 116.8, 122.9, 124.3, 129.1 (CH coum.), 130.9 and 131.3 (CH arom.), 136.4 (C arom.), 141.9 (N=C−NH), 151.6 (C-9b coum.), 154.3 (C-5a coum.), 155.0 (C=O) ppm. $C_{17}H_{11}BrN_2O_2$ (355.19): calcd. C 57.49, H 3.12, N 7.89; found C 57.68, H 3.16, N 7.73, and **5**[3] (120 mg) in 17% yield.

2-(2-Phenylethyl)-[1]benzopyrano[3,4-*d*]imidazol-4(3*H*)-one (4c): Cream crystals (0.64 g, 55%). M.p. 211 °C (decomp.). IR (KBr): $\tilde{\nu}_{max}$ = 3168 (NH), 1705 (C=O) cm^{-1}. IR ($CHCl_3$): $\tilde{\nu}_{max}$ = 3424 and 3198 (NH), 1704 (C=O) cm^{-1}. ^1H NMR ([D_6]DMSO): δ = 3.12 (s, 4 H, CH_2-CH_2), 7.15−7.58 (m, 5H +3 H, arom. and 6-H, 7-H, 8-H coum.), 7.98 (d, *J* = 7.4 Hz, 1 H, 9-H coum.), 13.58 (br. s, 1 H, N−H) ppm. ^{13}C NMR ([D_6]DMSO): δ = 30.8 ($CH_2-C_6H_5$), 37.0 (CH_2C=N), 115.8 (C-9a coum.), 120.5 (C-3a coum.), 117.6, 122.6, 125.2, 129.9 (CH coum.), 126.8, 128.9 and 129.1 (CH arom.), 141.3 (C arom.), 142.7 (N=C−NH), 152.4 (C-9b coum.), 155.6 (C-5a coum.), 156.4 (C=O) ppm. $C_{18}H_{14}N_2O_2$ (290.32): calcd. C 74.47, H 4.86, N 9.65; found C 74.69, H 4.90, N, 9.48, and **5**[3] (140 mg) in 20% yield.

2-Propyl-[1]benzopyrano[3,4-*d*]imidazol-4(3*H*)-one (4d): Pale yellow crystals (0.52 g, 57%). M.p. 202 °C (decomp.). IR (KBr): $\tilde{\nu}_{max}$ = 3391 (NH), 1738 (C=O) cm^{-1}. IR ($CHCl_3$): $\tilde{\nu}_{max}$ = 3431 and 3203 (NH), 1707 (C=O) cm^{-1}. ^1H NMR ([D_6]DMSO): (mixture of two tautomers: the signals of the minor tautomer are given in *italics*) δ = 0.95 (t, *J* = 7.5 Hz, 3 H, CH_3), 1.80 (sext, *J* = 7.5 Hz, 2 H, CH_2), 2.81 (t, *J* = 7.5 Hz, 2 H, CH_2C=N), 7.28−7.58 (m, 3 H, 6-H, 7-H, 8-H. coum.), *7.95* and 8.01 (d, *J* = 7.5 Hz, 1 H, 9-H coum.), *13.42* and 13.60 (br. s, 1 H, N−H) ppm.

^1H NMR (CD_3OD): (mixture of two tautomers: the signals of the minor tautomer are given in *italics*) δ = 1.03 (t, *J* = 7.3 Hz, 3 H, CH_3), 1.88 (sext, *J* = 7.3, 7.7 Hz, 2 H, CH_2), 2.88 (t, *J* = 7.7 Hz, 2 H, CH_2C=N), 7.22−7.58 (m, 3 H, 6-H, 7-H, 8-H. coum.), *7.92* and 7.96 (d, *J* = 7.7 Hz, 1 H, 9-H coum.) ppm, NH signal: not mapped. ^{13}C NMR ([D_6]DMSO): δ = 14.4 (CH_3), 21.8 (CH_2), 31.2 (CH_2 linked to C-2 on imidazole ring), 115.9 (C-9a coum.), 119.8 (C-3a coum.), 117.7, 122.8, 125.3, 130.0 (CH coum.), 149.3 (N=C−NH), 152.8 (C-9b coum.), 155.7 (C-5a coum.), 159.2 (C=O) ppm. $C_{13}H_{12}N_2O_2$ (228.25): calcd. C 68.41, H 5.30, N 12.27; found C 68.47, H 5.27, N 12.33, and **5**[3] (140 mg) in 20% yield.

2-Isopropyl-[1]benzopyrano[3,4-*d*]imidazol-4(3*H*)-one (4e): Cream needles (0.55 g, 60%). m.p. 230 °C (decomp.). IR (KBr): $\tilde{\nu}_{max}$ = 3165 (NH), 1711 (C=O) cm^{-1}. IR ($CHCl_3$): $\tilde{\nu}_{max}$ = 3430 and 3212 (NH), 1709 (C=O) cm^{-1}. ^1H NMR ([D_6]DMSO): δ = 1.36 (d, *J* = 7.0 Hz, 6 H, 2 × CH_3), 3.18 (m, 1 H, CH), 7.32−7.58 (m, 3 H, 6-H, 7-H, 8-H coum.), 8.00 (d, *J* = 7.6 Hz, 1 H, 9-H coum.), 13.4 (br. s, 1 H, N−H) ppm. ^{13}C NMR ([D_6]DMSO): δ = 21.9 (2 × CH_3), 29.1 (CH), 116.4 (C-9a coum.), 120.4 (C-3a coum.), 117.6, 122.7, 125.2, 129.9 (CH coum.), 147.6 (N=C−NH), 152.5 (C-9b coum.), 159.8 (C-5a coum.), 161.9 (C=O) ppm. $C_{13}H_{12}N_2O_2$ (228.25): calcd. C 68.41, H 5.30, N 12.27; found C 68.25, H, 5.21, N 12.42, and **5**[3] (140 mg) in 20% yield.

Synthesis of 3-Methyl-2-propyl-[1]benzopyrano[3,4-*d*]imidazol-4(3*H*)-one (6): Dimethyl sulfate (0.6 mL, 6 mmol) was added dropwise under argon to a mixture of **4d** (0.92 g, 4 mmol), dimethylformamide (15 mL) and anhydrous potassium carbonate (1.18 g). The reaction mixture was stirred at 60 °C for 2 h. The reaction was monitored by TLC (eluent: cyclohexane/ethyl acetate, 6:4), a second portion of dimethyl sulfate (0.6 mL) was added, and heating was continued for further 2 h. The reaction mixture was subsequently poured onto ice and the product was extracted with

chloroform (4 × 20 mL). The combined organic layers were dried with Na_2SO_4 and the solvents were evaporated in vacuo. The crude residue was purified through a short silica gel column (eluent: cyclohexane/ethyl acetate, 6:4) and crystallized from iPr_2O, affording the title compound **6** (0.70 g) in 73% yield as cream crystals. M.p. 113 °C. IR ($CHCl_3$): $\tilde{\nu}_{max}$ = 1719 (C=O). IR (nujol): $\tilde{\nu}_{max}$ = 1717 (C=O) cm^{-1}. ^1H NMR ($CDCl_3$): δ = 1.10 (t, *J* = 7.3 Hz, 3 H, CH_3), 1.90 (sext, *J* = 7.3, 7.7 Hz, 2 H, CH_2), 2.88 (t, *J* = 7.7 Hz, 2 H, CH_2C=N), 4.05 (s, 3 H, CH_3-N), 7.31−7.49 (m, 3 H, 6-H, 7-H and 8-H coum.), 8.14 (d, *J* = 7.7 Hz, 1 H, 9-H coum.) ppm. ^{13}C NMR ($CDCl_3$): δ = 14.0 (CH_3), 21.2 (CH_2), 29.2 (CH_2C=N), 31.95 (CH_3−N), 116.6 (C-9a coum.), 117.2 (C-3a coum.), 117.0, 122.3, 124.5, 129.2 (CH coum.), 146.4 (N=C−NR), 152.3 (C-9b coum.), 155.1 (C-5a coum.), 158.1 (C=O) ppm. $C_{14}H_{14}N_2O_2$ (242.28): calcd. C 69.41, H 5.82, N 11.56; found C 69.51, H 5.95, N 11.37.

General Procedure for the Preparation of 3-Alkyl-2-morpholino Derivatives 7a−e: The appropriate nitroamidine **3a−e** (4 mmol), suspended in triethylphosphite (20 mL), was heated at reflux under nitrogen atmosphere until disappearance (TLC monitoring) of the starting compound. (The reaction times are indicated close to the corresponding derivative **7**.) The excess triethylphosphite was evaporated under reduced pressure, and the crude residue was purified by silica gel column chromatography (eluent: cyclohexane/ethyl acetate, 7:3). The thick oil obtained was crystallized from iPr_2O.

3-Benzyl-2-morpholino-[1]benzopyrano[3,4-*d*]imidazol-4(3*H*)-one (7a): Reaction time 6 h. Cream crystals (0.90 g, 62%). M.p. 122 °C. IR (nujol): $\tilde{\nu}_{max}$ = 1720 (C=O) cm^{-1}. ^1H NMR ($CDCl_3$): δ = 3.25−3.30 (m, 4 H, CH_2NCH_2), 3.77−3.83 (m, 4 H, CH_2OCH_2), 5.55 (s, 2 H, CH−N), 7.21−7.48 (m, 5 H + 3 H, arom. and 6-H, 7-H, 8-H coum.), 8.10 (dd, *J* = 7.7 and *J* = 1.5 Hz, 1 H, 9-H coum.) ppm. ^{13}C NMR ($CDCl_3$): δ = 48.8 (N−CH_2−C_6H_5), 50.8 (CH_2NCH_2), 66.5 (CH_2OCH_2), 115.1 (C-9a coum.), 117.0 (C-3a coum.), 117.1, 122.5, 124.4, 129.3 (CH coum.), 126.8, 128.0, 128.9(CH arom.) 136.5 (C arom.), 146.2 (N=C−NR), 152.6 (C-9b coum.), 154.7 (C-5a coum.), 159.1 (C=O) ppm. $C_{21}H_{19}N_3O_3$ (361.40): calcd. C 69.79, H 5.30, N 11.63; found C 69.98, H 5.34, N 11.50.

3-(4-Bromobenzyl)-2-morpholino-[1]benzopyrano[3,4-*d*]imidazol-4(3*H*)-one (7b): Reaction time: 11 h. Cream crystals (1.05 g, 60%). M.p. 168 °C. IR (nujol): $\tilde{\nu}_{max}$ = 1716.2 (C=O) cm^{-1}. ^1H NMR ($CDCl_3$): δ = 3.23−3.32 (m, 4 H, CH_2NCH_2), 3.81−3.86 (m, 4 H, CH_2OCH_2), 5.48 (s, 2 H, CH_2−N), 7.13 and 7.46 (2 × d, AB system, *J* = 8.4 Hz, 4 H, *p*BrC_6H_4), 7.29−7.48 (m, 3 H, 6-H, 7-H and 8-H coum.), 8.11 (d, *J* = 7.3 Hz, 1 H, 9-H coum.) ppm. ^{13}C NMR ($CDCl_3$): δ = 48.2 (CH_2−N), 50.9 (CH_2NCH_2), 66.5 (CH_2OCH_2), 114.9 (C-9a coum.), 116.9 (C-3a coum.), 122.8 ($C_{arom.}$−Br), 117.4, 122.5, 124.5, 129.5 (CH coum.), 128.6 and 132.1 (CH arom.), 135.5 (C arom.), 146.4 (N=C−NR), 152.6 (C-9b coum.), 154.7 (C-5a coum.), 159.1 (C=O) ppm. $C_{21}H_{18}BrN_3O_3$ (440.30): calcd. C 57.29, H 4.12, N 9.54; found C 57.17, H 4.07, N 9.43.

2-Morpholin-4-yl-3-(2-phenylethyl)-[1]benzopyrano[3,4-*d*]imidazol-4(3*H*)-one (7c): Reaction time 10 h. Cream crystals (0.85 g, 57%). M.p. 92−93 °C. IR (nujol): $\tilde{\nu}_{max}$ = 1716 (C=O) cm^{-1}. ^1H NMR ($CDCl_3$): δ = 3.05−3.11 (m, 4 H, CH_2NCH_2), 3.17 (t, *J* = 6.9 Hz, 2 H, CH_2−C_6H_5), 3.73−3.78 (m, 4 H, CH_2OCH_2), 4.49 (t, *J* = 6.9 Hz, 2 H, CH_2N), 7.05−7.50 (m, 5 H + 3 H, arom. and 6-H, 7-H, 8-H coum.), 8.10 (d, *J* = 6.6 Hz, 1 H, 9-H coum.) ppm. ^{13}C NMR ($CDCl_3$): δ = 36.9 (CH_2−C_6H_5), 47.1 (CH_2−N), 50.9 (CH_2NCH_2), 66.5 (CH_2OCH_2), 114.4 (C-9a coum.), 116.9 (C-3a coum.), 117.1, 122.5, 124.4, 129.3 (CH coum.), 126.9, 128.7 and 129.0 (CH arom.), 137.7 (C arom.), 146.4 (N=C−NR), 152.6 (C-9b coum.), 154.6 (C-5a coum.), 159.3 (C=O) ppm. $C_{22}H_{21}N_3O_3$ (375.43): calcd. C 70.38, H 5.64, N 11.19; found C 70.54, H 5.53, N 11.11.

2-Morpholin-4-yl-3-propyl-[1]benzopyrano[3,4-*d*]imidazol-4(3*H*)-one (7d): Reaction time 13 h. Cream crystals (0.73 g, 58%). M.p. 144−145 °C. IR (nujol): $\tilde{\nu}_{max}$ = 1715 (C=O) cm^{-1}. ^1H NMR ($CDCl_3$): δ = 0.94 (t, *J* = 7.3 Hz, 3 H, CH_3), 1.92 (sext, *J* = 7.3 and *J* = 7.7 Hz, 2 H, CH_2), 3.31−3.39 (m, 4 H, CH_2NCH_2), 3.87−3.95 (m, 4 H, CH_2OCH_2), 4.19−4.27 (t, *J* = 7.7 Hz, 2 H, CH_2N), 7.27−7.52 (m, 3 H, 6-H, 7-H, 8-H coum.), 8.08 (d, *J* = 7.7 Hz, 1 H, 9-H coum.) ppm. ^{13}C NMR ($CDCl_3$): δ = 11.04 (CH_3), 23.7 (CH_2), 47.2 (CH_2NCH_2), 51.0 (CH_2−N), 66.6 (CH_2OCH_2), 114.8 (C-9a coum.), 117.05 (C-3a coum.), 117.03, 122.4, 124.3, 129.1 (CH coum.), 146.2 (N=*C*−NR), 152.6 (C-9b coum.), 154.6 (C-5a coum.), 159.0 (C=O) ppm. $C_{17}H_{19}N_3O_3$ (313.36): calcd. C 65.16, H 6.11, N 13.41; found C 65.28, H 6.29, N 13.36.

3-Isopropyl-2-morpholino-[1]benzopyrano[3,4-*d*]imidazol-4(3*H*)-one (7e): Reaction time 14 h. Cream crystals (0.81 g, 65%). M.p. 161 °C. IR (nujol): $\tilde{\nu}_{max}$ = 1715.0 (C=O) cm^{-1}. ^1H NMR ($CDCl_3$): δ = 1.69 (d, *J* = 6.9 Hz, 6 H, CH_3CCH_3), 3.28−3.35 (m, 4 H, CH_2NCH_2), 3.89−3.97 (m, 4 H, CH_2OCH_2), 4.72 (sept, *J* = 6.9 Hz, 1 H, CH_3CHCH_3), 7.29−7.53 (m, 3 H, 6-H, 7-Hand 8-H coum.), 8.10 (d, *J* = 7.3 Hz, 1 H, 9-H coum.) ppm. ^{13}C NMR ([D_6]DMSO): δ = 21.9 (CH_3CCH_3), 49.9 (CH_3CHCH_3), 51.9 (CH_2NCH_2), 66.4 (CH_2OCH_2), 114.5 (C-9a coum.), 116.9 (C-3a coum.), 117.2, 122.7, 125.1, 130.2 (CH coum.), 147.4 (N=C−NR), 152.7 (C-9b coum.), 153.8 (C-5a coum.), 159.7 (C=O) ppm. $C_{17}H_{19}N_3O_3$ (313.36): calcd. C 65.16, H 6.11, N 13.41; found C 65.34, H 6.27, N 13.49.

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