REACTIONS OF 1,2-DIAMINOBENZIMIDAZOLES WITH β-DIELECTROPHILES: SYNTHESIS OF PYRIMIDO[1,2-α]BENZIMIDAZOLE DERIVATIVES.

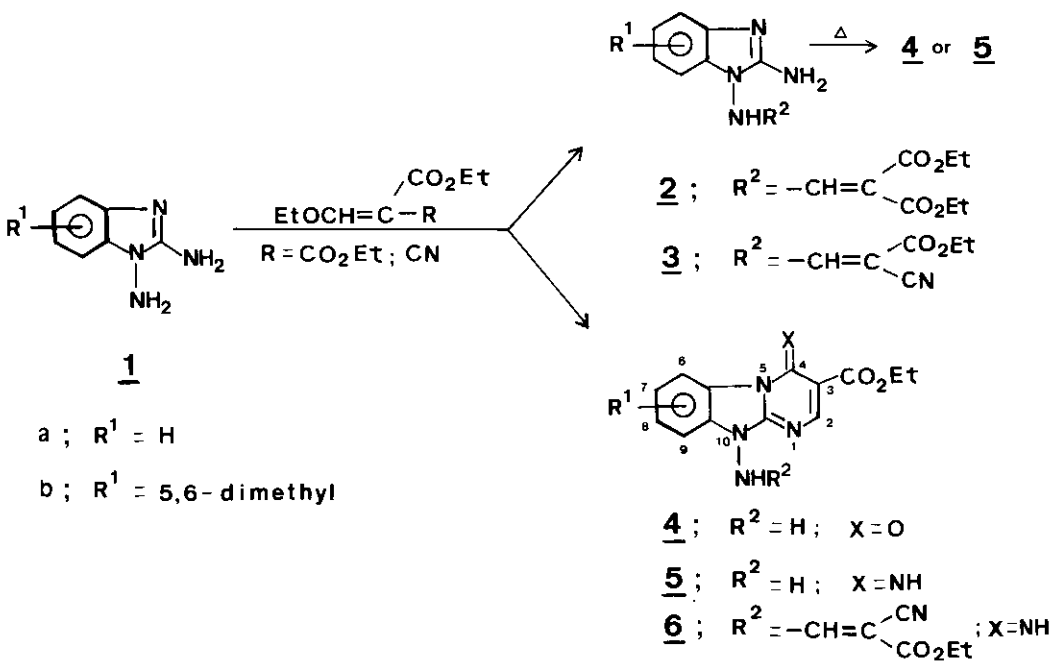
Claudia Romano, Elena de la Cuesta, and Carmen Avendaño*

Depto. de Química Orgánica y Farmacéutica, Facultad de Farmacia, Universidad Complutense, 28040-Madrid, Spain

Abstract- 1,2-Diaminobenzimidazoles react with malonic and β-ethoxymethylenemalonic acid derivatives to give pyrimido[1,2-α]benzimidazole derivatives.

Cyclization reactions of 1,2-diaminobenzimidazoles with β-dielectrophile reagents afforfed seven- or six-membered rings. In a previous work[1] we have shown that condensation with β-diketones and β-keto esters is a good synthetic procedure to obtain 1,2,4-triazepino[2,3-α]benzimidazole derivatives. Here we report the chemical behaviour of 1,2-diaminobenzimidazoles 1 against malonic and β-ethoxymethylenemalonic acid derivatives.

The results obtained in the reaction of 1 with diethyl ethoxymethylenemalonate and ethyl ethoxymethylenecyanoacetate are summarized in Scheme 1.



Scheme 1

Table 1: ^{1}H Nmr data of compounds 1-6 (δ values, TMS as internal reference).

Compound	Solvent	N-NH_2	C-NH_2	Aromatic Protons	Other Significative Protons
2-Amino-benzimidazole[a]	DMSO-d_6	--	6.05	6.65-7.10(H4-H7)	--
2-Amino-5,6-dimethyl-benzimidazole[a]	DMSO-d_6	--	6.01	6.98(s,2H,H4,H7)	2.21(s,6H,Me5,Me6)
1a[a]	DMSO-d_6	5.47	6.11	6.60-7.15(H4-H7)	--
1b[a]	DMSO-d_6	5.49	6.03	6.96(s,2H,H4,H7)	2.25(s,6H,Me5,Me6)
2a[a]	DMSO-d_6	--	6.09	6.95-7.70(m,4H,H4-H7)	8.80(d,J=13Hz,1H, N-CH=C) 11.25(d,J=13Hz,1H,NH)
2b[c]	DMSO-d_6	--	6.05	7.15(s,1H) and 7.35 (s,1H) (H4 and H7)	2.20(s,3H) and 2.31 (s,3H) (Me5 and Me6) 8.73(d,J=13.5Hz,1H, N-CH=C) 11.21(d,J=13.5Hz, 1H,NH)
3a[a]	DMSO-d_6	--	6.13	7.05-7.80(m,4H,H4-H7)	8.65(d,J=13Hz,1H, N-CH=C) 11.35(broad signal,1H,NH)
3b[c]	DMSO-d_6	--	5.81	7.13(s,1H) and 7.21 (s,1H) (H4 and H7)	2.29(s,3H) and 2.31 (s,3H) (Me5 and Me6) 8.81(s,1H,N-CH=C)
4a[c]	DMSO-d_6	6.20	--	7.48(m,1H,H7) 7.63(m,1H,H8) 7.71(m.1H,H9) 8.55(m,1H,H6)	8.75(s,1H,H2)
4b[c]	DMSO-d_6	6.12	--	7.46(s,1H,H9) 8.30(s,1H,H6)	2.38(s,3H) and (2.39) (s,3H) (Me7 and Me8) 8.69(s,1H,H2)
5a[b]	TFA-d	--	--	7.84-8.14(m,3H,H7-H9) 8.51(d,J=8.3Hz,1H,H6)	9.45(s,1H,H2)
5b[c]	DMSO-d_6	6.02	--	7.4(s,1H,H9) 8.38(s,1H,H6)	2.35(s,3H) and 2.39 (s,3H) (Me7 and Me8) 8.98(s,1H,H2)
6a[c]	DMSO-d_6	--	--	7.60-7.78(m,3H,H7-H9) 8.74(d,J=9Hz,1H,H6)	8.60(s,1H,N-CH=C) 9.00(s,1H,H2) 9.66(broad signal,1H,NH)
6b[b]	DMSO-d_6	--	--	7.55(s,1H,H9) 8.67(s,1H,H6)	2.39(s,6H,Me7,Me8) 8.51(s,1H,N-CH=C) 8.96(s,1H,H2)

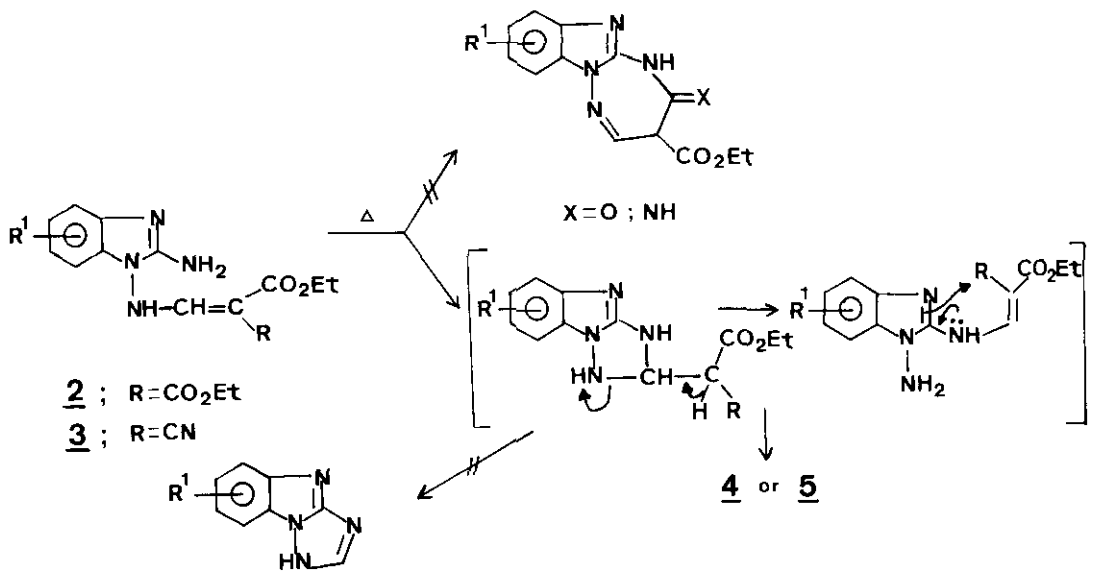
[a] 60 MHz; [b] 200 MH_z; [c] 300 MHz.

Heating at 95°C led to good yields of monocondensation products 2a-b and 3a-b, which were thermally cyclized to the corresponding pyrimido[1,2-a]benzimidazoles 4a-b and 5a-b respectively. When the

condensation reaction was carried out at higher temperatures (160°C), mixtures of the monocondensation products 2 (or 3) and the cyclized derivatives 4 (or 5) were obtained together with small amounts of the double-condensation products 6. It is interesting to remark that, due to the greater reactivity of ethyl ethoxymethylenecyanoacetate, isolation of the intermediates 3a-b required a strict control of the reaction temperature, and that cyclization of 2 and 3 to seven-membered rings was here precluded.

Structural assignment of compounds 2-6 was mainly based on ^{1}H-nmr data. As it is shown in Table 1, the resonances of H6 protons in compounds 4-6 appear at lower field values than those for H7-H9; this can be attributed to the known paramagnetic anisotropic effect of the carbonyl or imino groups at C4.[1-6]

Assignment of compounds 2 and 3 required to determine the position of the free NH_2 groups. The conclusion that the free NH_2 groups are placed on the C2 position of the benzimidazole system rather than on N1 position arrived by using two different criteria. In the first place, previous works on the reactions of 1,2-diaminobenzimidazoles with β-keto esters[1] and aldehydes[7] have proved that the initial nucleophillic attack occurs on the N-NH_2 group leaving a free NH_2 group on C2. This criterion is supported by a comparison of the NH_2 resonance values of compounds 2 and 3 with those of a series of related 2-amino and 1,2-diaminobencimidazole systems (Table 1).

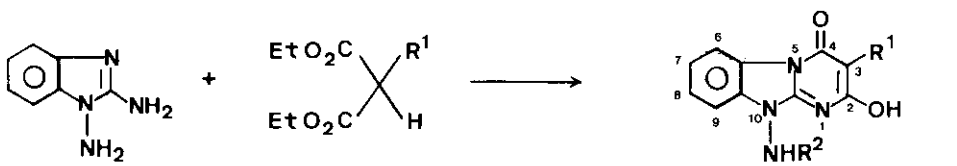


Scheme 2

In accordance with the proposed structures for compounds 2 and 3 and with the fact that, neither in the reactions described in this paper nor in previous condensations of 1,2-diaminobenzimidazoles, direct formation of s-triazolo[2,3-α]benzimidazol derivatives has been observed (Scheme 2), formation of compounds 4 and 5 can be explained by assuming that cyclization is preceded by isomerization of 2 and 3 to the corresponding unisolated isomers bearing the R^2 groups on the C-amino moiety through an intramolecular Michael reaction (R^2=EtO_2CCR=CH-, Scheme 2).

To our knowledge, compounds 5 and 6 are the first known C_4=NH fixed tautomers of 4-aminopyrimido-[1,2-α]benzimidazole systems, because only reactions of 2-aminobenzimidazole and ethyl cyanoacetate have been previously reported. The absence of a substituent on N10 in these compounds explains their existence as C_4-NH_2 tautomers.[3]

Condensation of 1,2-diaminobenzimidazoles 1 with malonic ester derivatives were performed using reaction conditions previously found[8] to yield 3-aryl-1,5-benzodiazepine-2,4-diones starting from o-phenylenediamines. In this case, formation of seven-membered ring compounds was not observed, and compounds 7-9 were obtained instead (Scheme 3). The reactions of 1,2-diaminobenzimidazoles 1 with substituted malonates gave very low yields.



1 R^1 = H, Ph

7 ; R^1 = R^2 = H

8 ; R^1 = Ph, R^2 = H

9 ; R^1 = Ph, R^2 = $-C(=O)-CH(Ph)-CO_2Et$

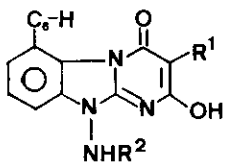
10 ; R^1 = Ph, R^2 = $-C(=O)-H$

Scheme 3

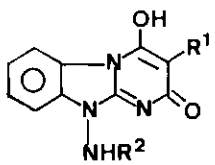
Although in this case the N-acylamino monocondensation intermediates have not been isolated, formation of compounds 7 and 8 can be explained through a mechanism similar to that proposed for the transformation of 2 and 3 into 4 and 5, involving the acylation of the N-amino group, followed by isomerization of the intermediates thus formed to their C-acylamino isomers and cyclization.

The transacylacion reaction involved in the N-amino ⟶ C-amino isomerization is feasible, given the unusually high electrophillic character that can be proposed for the carbonyl group of 1-acyl-amino derivatives of 1 on the basis of the found value for the carbonyl stretching vibration (1730 cm^{-1}) in the ir spectrum of compound 10, prepared by formylation of 8.

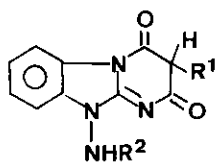
Among the three possible tautomers for compounds 7-10 (A-C), structure A is in accordance with their ^1H nmr, ir and uv spectroscopic data. Structure type C is rejected because of the absence of signals corresponding to the H3 protons in the ^1H nmr spectra of compounds 8-10. The downfield chemical shift values found for the H6 protons confirms the C4 carbonyl tautomer A and excludes B (Table 2).



A



B



C

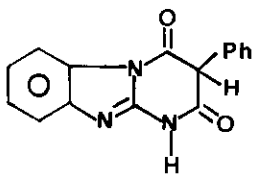
Table 2: ^1H Nmr data of compounds 7-11 in DMSO-d_6 (δ values, TMS as internal reference)

Compound	N-NH_2	Aromatic Protons		Other Significative Protons
7a[a]	5.5-6.5	8.40 (m,1H,H6)	6.80-7.65 (m,3H,H7-H9)	5.20 (s,1H,H3)
8a[b]	5.83	8.41 (m,1H,H6)	7.10-7.65 (m,9H,H7-H9,OH and Ph protons)	--
9a[b]	--	8.39 (m,1H,H6)	6.98-7.86 (m,14H,H7-H9,OH and Ph protons)	4.83 (s,1H,EtO_2C-CHPh)
10a[b]	--	8.48 (m,1H,H6)	7.18-7.55 (m,9H,H7-H9,OH and Ph protons)	11.65 (s,1H,NH) 8.57 (s,1H,NHCHO)
11a[a]	--	8.55 (m,1H,H6)	6.90-8.00 (m,9H,H7-H9,OH and Ph protons)	12.00 (wide signal, 1H,NH)

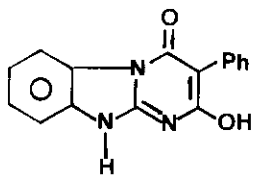
[a] 60 MHz; [b] 200 MHz.

The presence of a substituent in the position N10 of compounds 7-10 precludes the formation of tautomers bearing a 10-10a double bond and therefore allows their use as model compounds in the

study of tautomerism of pyrimido[1,2-*a*]benzimidazol-4-one derivatives. Thus, we reinvestigated the reaction of 2-aminobenzimidazole with diethyl phenylmalonate following the procedure described by Ridi and coworkers[10] in order to establish unambiguously the structures of the 10-unsubstituted analogues of compounds 7-10, for which contradictory assignments have been reported.[9,10] On the basis of the ^{1}H nmr spectrum and uv absorption pattern found for the product thus obtained, which were similar to those of compounds 8, we propose structure 11 instead of the reported D.[10]



D



11

EXPERIMENTAL

Ir spectra were recorded on a Perkin-Elmer 577 spectrophotometer. All compounds were compressed into KBr pellets. ^{1}H Nmr spectra were recorded on a Perkin-Elmer R24-B (60 MHz), a Brucker AC-200P (200 MHz), a Brucker WH 200-SY (200 MHz), and a Varian VXR-300 (300 MHz). Uv spectra were recorded on a Shimadzu UV-visible recording spectrophotometer UV-2100. The solutions were in the range of concentration of 10^{-5} M. Melting points are uncorrected and were measured on a Büchi capillary melting point apparatus. The synthesis of compounds 1a-b is already reported.[11]

General procedure for compounds 2, 3 and 6.

A mixture of 1 mmol of the corresponding 1,2-diaminobenzimidazole 1 and 3 mmoles of diethyl ethoxymethylenemalonate or ethyl ethoxymethylenecyanoacetate was heated at 95 °C with stirring for 1 h. After cooling Et_2O was added and the solid precipitated was collected by filtration and recrystallized. When the same mixture of 1,2-diaminobenzimidazole and ethyl ethoxymethylenecyanoacetate was heated at 160 °C, compounds 6 were obtained in low yields.

2-Amino-1-(2',2'-diethoxycarbonylvynilamino)benzimidazole, 2a.

Crystals from MeOH, 70 % yield, mp 151-153 °C (dec). Ir; 3500-2700 (NH_2, NH); 1685 (CO_2Et); 1620 and 1590 (C=N, C=C) cm^{-1}. Uv λ_{max} MeOH (log ε) 327, 261, 220 nm (4.88, 4.05, 4.59). Anal. Calcd for $C_{15}H_{18}N_4O_4$; C, 56.59; H, 5.69; N, 17.60. Found: C, 56.60; H, 5.73; N, 17.68.

5,6-Dimethyl-2-amino-1-(2',2'-diethoxycarbonylvinylamino)benzimidazole, 2b.

Crystals from EtOH, 73 % yield, mp 178-180 °C (dec). Ir: 3400-2700 (NH_2, NH); 1695 (CO_2Et); 1595 and 1540 (C=N, C=C) cm^{-1}. Uv λ_{max} MeOH (log ε) 335, 268, 218 nm (4.55, 3.98, 4.34). Anal. Calcd for $C_{17}H_{22}N_4O_4$: C, 58.94; H, 6.40; N, 16.17. Found: C, 58.71; H, 6.27; N, 16.45.

2-Amino-1-(2'-cyano-2'-ethoxycarbonylvinylamino)benzimidazole, 3a.

Crystals from EtOH, 84 % yield, mp 178-179 °C (dec). Ir: 3300 and 3185 (NH_2 and NH); 2200 (CN); 1685 (CO_2Et); 1630 and 1590 (C=N and C=C) cm^{-1}. Uv λ_{max} MeOH (log ε) 337, 219 nm (4.46, 4.21). Anal. Calcd for $C_{13}H_{13}N_5O_2$: C, 57.55; H, 4.83; N, 25.81. Found: C, 57.34; H, 4.58; N, 26.15.

5,6-Dimethyl-2-amino-1-(2'-cyano-2'-ethoxycarbonylvinylamino)benzimidazole, 3b.

Crystals from EtOH, 77 % yield, mp 191-192 °C (dec). Ir: 3600-2700 (very complex broad absorption including NH_2 and NH stretching vibrations); 2200 (CN); 1685 (CO_2Et); 1610 and 1550 (C=N and C=C) cm^{-1}. Uv λ_{max} MeOH (log ε) 353, 268, 216 nm (4.64, 4.06, 4.80). Anal. Calcd for $C_{15}H_{17}N_5O_2$: C, 60.18; H, 5.72; N, 23.39. Found: C, 60.35; H, 5,57; N, 23.28.

Ethyl 4-imino-10-(2'-cyano-2'-ethoxycarbonylvinylamino)pyrimido[1,2-α]benzimidazole-3-carboxylate, 6a.

Crystals from MeOH, 13% yield,mp 201-202 °C (dec). Ir: 3340 and 3160 (wide absorption band =NH, NH); 2180 (CN); 1690 (CO_2Et); 1660, 1650 and 1620 (C=N, C=C) cm^{-1}. Uv λ_{max} MeOH (log ε) 355, 281, 258, 228 nm (4.21, 4.46, 4.48, 4.59). Anal. Calcd for $C_{19}H_{18}N_6O_4$: C, 57.71; H, 4.84; N, 21.20. Found: C, 57.86; H, 4.60; N, 21.31.

Ethyl 7,8-dimethyl-4-imino-10-(2'-cyano-2'-ethoxycarbonylvinylamino)pyrimido[1,2-α]benzimidazole-3-carboxylate, 6b.

Crystals from EtOH, 7 % yield, mp 204-206 °C (dec). Ir: 3400-3100 (wide absorption band, =NH, NH); 2180 (CN); 1690 (CO_2Et); 1615 and 1580 (C=N, C=C) cm^{-1}. Uv λ_{max} MeOH (log ε) 349, 268, 261, 216 nm (3.70, 4.09, 4.13, 4.70). Anal. Calcd for $C_{21}H_{22}N_6O_4$: C, 59.70; H, 5.24; N, 19.89. Found: C, 59.50; H, 5.20; N, 20.10.

General procedures to compounds 4 and 5.

A).- Compounds 2 or 3 (1.5 mmol) were refluxed in 1,2,4-trichlorobenzene (10 ml) for 2 h. The solution was cooled and the solid precipitated was collected by filtration and recrystallized.

Ethyl 4-oxo-10-aminopyrimido[1,2-α]benzimidazole-3-carboxylate, 4a.

Crystals from EtOH, 61 % yield, mp 266-268 °C (dec). Ir: 3300 (N-NH_2); 1700 (CO_2Et); 1690 (CO); 1625 and 1585 (C=C, C=N) cm^{-1}. Uv λ_{max} MeOH (log ε) 336, 269, 241, 220 nm (4.22, 3.67, 4.14, 4.41). Anal. Calcd for $C_{13}H_{12}N_4O_3$: C, 57.34; H, 4.44; N, 20.58. Found: C, 57.70; H, 4.76; N, 20.95.

Ethyl 7,8-dimethyl-4-oxo-10-aminopyrimido[1,2-α]benzimidazole-3-carboxylate, 4b.

Crystals from EtOH-H_2O, 63 % yield, mp 238-240 °C (dec). Ir: 3300 (N-NH_2); 1720 (CO_2Et); 1700 (CO); 1650 and 1620 (C=C, C=N) cm^{-1}. Uv λ_{max} MeOH (log ε) 341, 246 223 nm (4.01, 3.97, 4.23). Anal. Calcd for $C_{15}H_{16}N_4O_3.H_2O$: C, 56.59; H, 5.69; N, 17.60. Found: C, 56.90; H, 5.31; N, 17.49.

Ethyl 4-imino-10-aminopyrimido[1,2-α]benzimidazole-3-carboxylate, 5a.

Crystals from EtOH, 70 % yield, mp 214-216 °C (dec). Ir: 3300 (N-NH_2); 1690 (CO_2Et); 1635 and 1615 (C=C, C=N) cm^{-1}. Uv λ_{max} MeOH (log ε) 355, 254, 220 nm (4.34, 4.28, 4.57). Anal. Calcd for $C_{13}H_{13}N_5O_2$: C, 57.55; H, 4.83; N, 25.81. Found: C, 57.55; H, 4.73; N, 26.20.

Ethyl 7,8-dimethyl-4-imino-10-aminopyrimido[1,2-α]benzimidazole-3-carboxylate, 5b.

Crystals from ethyl acetate, 68 % yield, mp 281-283 °C (dec). Ir: 3300 (N-NH_2); 1660 (CO_2Et); 1625 and 1570 (C=C, C=N) cm^{-1}. Uv λ_{max} MeOH (log ε) 344, 269, 247, 223 nm (4.45, 3.99, 4.49, 4.71). Anal. Calcd for $C_{15}H_{17}N_5O_2$; C, 60.18; H, 5.72; N, 23.39. Found: C, 60.24; H, 5.63; N, 23.18.

B).- A solution of 5.2 mmol (0.7 g) of 1a and 5.2 mmol (1.13 g) of ethyl ethoxymethylenemalonate in EtOH (20 ml) was refluxed for 5 h. After cooling the precipitated solid was filtered and after purification by column chromatography over kieselgel using ethyl acetate as eluent, compounds 2a (11 % yield) and 4a (10 % yield) were obtained.

C).- A mixture of 6.7 mmol (1 g) of 1a and 6.7 mmol (1.14 g) of ethyl ethoxymethylenecyanoacetate was heated neat in an oil bath at 120 °C for 1.5 h. After cooling the resulting yellow solid was filtered to yield 1.73 g of a crude product whose nmr and ir spectra indicated the presence of compounds 5a and 3a. The crude was recrystallized in EtOH and compound 5a was obtained in 21 % yield. From the mother liquors the secondary product 3a was isolated and recrystallized in EtOH (14 % yield).

General procedures to 7 and 8.

A).- To a solution of 1 mmol of 1 in 1,2,4-trichlorobenzene (10 ml), 1 mmol of the corresponding diethyl malonate was added dropwise. The solution was warmed under reflux for 2 h. After cooling, the crude products were precipitated, filtered and purified.

2-Hydroxy-10-aminopyrimido[1,2-α]benzimidazol-4-one, 7.

Crystals from MeOH, 60 % yield, mp 257-259 °C. Ir: 3700-2300 (NH_2, OH); 1680 (CO); 1610-1555 (C=C, C=N) cm^{-1}. Uv λ_{max} MeOH (log ε) 309, 281, 221 nm (4.03, 4.02, 4.58). Anal. Calcd for $C_{10}H_8N_4O_2$: C, 55.55; H, 3.72; N, 25.91. Found: C, 55.24; H, 3.94; N, 25.56.

2-Hydroxy-3-phenyl-10-aminopyrimido[1,2-α]benzimidazol-4-one, 8.

Crystals from MeOH, 5 % yield, mp 276-278 °C (dec). Ir: 3700-2600 (NH_2); 1660 (CO); 1610 and 1600 (C=C, C=N) cm^{-1}. Uv λ_{max} MeOH (log ε) 319, 258, 225 nm (4.43, 4.54, 4.80). Anal. Calcd for

$C_{16}H_{12}N_4O_2.4.5\ H_2O$: C, 51.47; H, 5.66; N, 15.00. Found: C, 51.86; H, 5.36; N, 15.38.

B).- A mixture of 1 mmol (0.15 g) of 1 and 5 mmol (1.2 g) of diethyl phenylmalonate was refluxed with stirring for 1 h. After cooling the solid precipitated was filtered and purified by column chromatography over kieselgel using ethyl acetate:methanol (8:2) as eluent. Compounds 8 and 9 were obtained in 5 % and 2 % yield respectively.

2-Hydroxy-3-phenyl-10-(2'-phenyl-2'-ethoxycarbonylacetamido)pyrimido[1,2-α]benzimidazol-4-one, 9. Crystals from MeOH/Et_2O, mp 191-192 °C (dec). Ir: 3700-2400 (NH); 1725 (CO_2Et); 1660 (CO); 1615 and 1600 (C=C, C=N) cm^{-1}. Uv λ_{max} MeOH (log ε) 307, 220 nm (4.25, 4.67). Anal. Calcd for $C_{27}H_{22}N_4O_5.4H_2O$: C, 58.47; H, 5.45; N, 10.10. Found: C, 58.20; H, 5.43; N, 10.38.

2-Hydroxy-3-phenyl-10-formamidopyrimido[1,2-α]benzimidazol-4-one, 10.

Tre crude 8, was heated in an excess of formic acid and, after cooling, the precipitated solid was crystallized. Crystals from DMF/H_2O, mp 296-297 °C (dec), 15 % yield. Ir: 3600-2200 (NH); 1730 (-NHCHO); 1650 (CO); 1600 (C=C, C=N) cm^{-1}. Uv λ_{max} MeOH (log ε) 312, 258, 223 nm (4.26, 4.36, 4.66). Anal. Calcd for $C_{17}H_{12}N_4O_3$: C, 63.74; H, 3.77; N, 17.49. Found: C, 63.72; H, 3.90; N, 17.47.

2-Hydroxy-3-phenylpyrimido[1,2-α]benzimidazol-4-one, 11.

Crystals from formic acid, mp 300 °C (described 285 °C)[10]. Ir: 3600-2000 (very complexed broad absorption including OH and NH stretching vibrations); 1650 (CO); 1600 and 1530 (C=C, C=N) cm^{-1}. Uv λ_{max} MeOH (log ε) 310, 259, 224 nm (4.33, 4.56, 4.80). Anal. Calcd for $C_{16}H_{11}N_3O_2$: C, 69.30; H, 3.99; N, 15.15. Found: C, 69.50; H, 4.12; N, 15.36.

ACKNOWLEDGEMENTS

This work was supported by the spanish CICYT (PA86-0317). One of us (C, Romano) also is indebted to CONACYT (México) for a grant.

REFERENCES

1. C. Romano, E. de la Cuesta, C. Avendaño, F. Florencio, and J. Sainz-Aparicio, Tetrahedron, 1988, 44, 7185.
2. J. J. Wade, C. B. Toso, Ch. J. Matson, and V. L. Stelzer, J. Med. Chem., 1983, 26, 608.
3. A. W. Chow, D. R. Jakas, B. P. Trotter, N. M. Hall, and J. R. E. Hoover, J. Heterocycl. Chem., 1973, 10, 71.
4. E. C. Taylor and A. Mckillop, J. Am. Chem. Soc., 1965, 87, 1986.
5. K. Nagarajan, M. D. Nair, and P. M. Pillai, Tetrahedron, 1967, 23, 1683.
6. H. Ogura, M. Kawano, and T. Itoh, Chem. Pharm. Bull., 1973, 21, 2019.
7. A. V. Zeiger and M. M. Joullié, J. Org. Chem., 1977, 42, 542.
8. T. Ramos, C. Avendaño, and J. Elguero, J. Heterocycl. Chem., 1987, 24, 247.

9. A. Kreutzberger and M. Leger, Arch. Pharm., 1983, 316, 582.

10. M. Ridi, S. Checchi, and P. Papini, Ann. Chim., 1954, 44, 769.

11. V. Zeiger and M. M. Joullié, Synth, Comm., 1976, 6, 457.

Received, 18th September, 1989