The Synthesis and Transformation of Ethyl 2-(2-Acetyl-2-benzoyl-1-ethenyl)amino-3-dimethylaminopropenoate. A new Synthesis of 2,3,4-Trisubstituted Pyrroles

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Received June 23, 1997

The synthesis of ethyl 2-(2-acetyl-2-benzoyl-1-ethenyl)amino-3-dimethylaminopropenoate (**4**) from benzoylacetone (**1**) *via* 3-dimethylaminomethylenebenzoylacetone (**2**) and ethyl *N*-(2-acetyl-2-benzoyl-1-ethenyl)glycinate (**3**) and its transformation into 4-benzoyl-2-ethoxycarbonyl-3-methylpyrrole (**9**) is described. Cyclization of **4** into **9** represents a new synthesis of polysubstituted pyrroles.

Substituted alkyl 2-acylamino-3-dimethylamino-propenoates, masked α-formyl-α-amino acid derivatives, are versatile reagents in the synthesis of β-aryl-, β-hetero-aryl-, β-arylamino-α-amino acids and their α,β-dehydro analogs. They are frequently intermediates in the synthesis of many heterocyclic systems, in which an α-amino acid structural element is incorporated or partially incorporated into a heterocyclic system [1].

Recently, alkyl 2-(2,2-disubstituted-ethenylamino)-3-dimethylaminopropenoates, such as ethyl (Z)-2-[2,2-bis-(ethoxycarbonyl)vinyl(amino-3-dimethylamino-propenoate [2,3], alkyl 2-(2-benzoyl-2-ethoxycarbonyl-1-ethenyl)amino-3-dimethylaminopropenoates [4], and methyl 2,2-[bis(acetyl)ethenyl]aminopropenoate [5] have been synthesized and used as reagents for preparation of many heterocyclic systems, among others also for azolo- and azinopyrimidinones with 2,2-disubstituted-1-ethenyl-amino group attached at the 3 position of the newly formed pyrimidinone [2,6] or pyridinone ring [3].

On the other hand, we have observed recently, that 2,2-disubstituted-1-ethenyl, such as 2-benzoyl-2-ethoxycar-bonylethenyl-1 and 2-benzoylamino-2-methoxycar-bonylethenyl-1, groups can be applied as *N*-protecting groups in the synthesis of dehydropeptide derivatives containing *N*-terminal 3-heteroarylamino-2,3-dehydroalanine moiety, since they can be easily removed with hydrazine or hydroxylamine under mild conditions [7].

In continuation of our studies in connection with thia-zolo[3,2-a]pyrimidinones [8,9], we tried to prepare 6-amino-5-oxo-5H-thiazolo[3,2-a]pyrimidine (**7**). On the basis of our previous observations described above, we prepared ethyl 2-(2-acetyl-2-benzoyl-1-ethenyl)amino-3-dimethylaminopropenoate (**4**), as a new reagent in this series in the following manner. Benzoylacetone (**1**) was converted with *N*,*N*-dimethylformamide dimethyl acetal into 3-dimethylaminobenzoylacetone (**2**) followed by treatment with ethyl glycinate hydrochloride to give

ethyl *N*-(2-acetyl-2-benzoyl-1-ethenyl)glycinate (**3**) in 42% yield. This was transformed with *N*,*N*-dimethylfor-mamide dimethyl acetal in dimethylformamide to give **4** in 30% yield. (Scheme 1). When we tried to react com-

Scheme 1
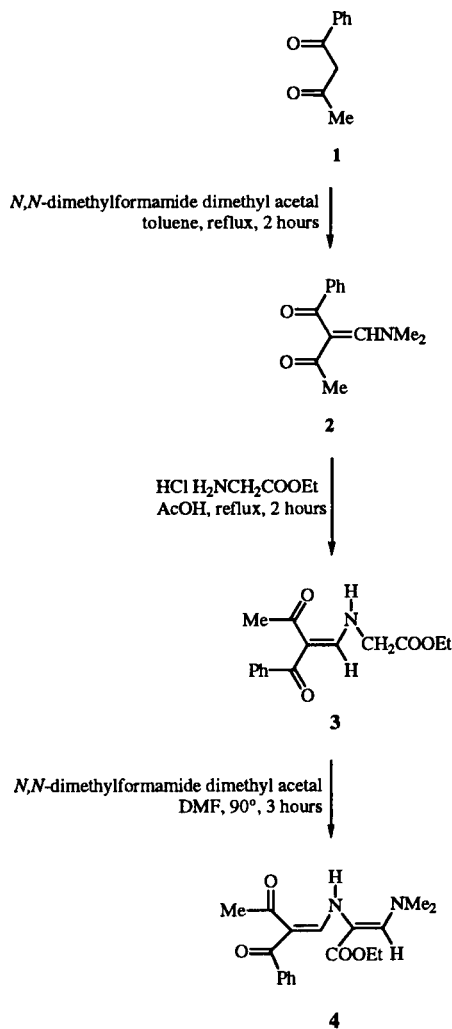
pound **4** with 2-amino-2-thiazoline (**5**) by heating in acetic acid in order to prepare 6-(2-acetyl-2-ben-zoylethenyl-1)amino-5-oxo-5*H*-thiazolo[3,2-*a*]pyrimidine (**6**), no reaction took place. On the other hand, 4-benzoyl-2-ethoxycarbonyl-3-methylpyrrole (**9**) was formed in 10% yield. When compound **4** alone was heated in trifluoroacetic anhydride compound **9** was isolated in 65% yield. (Scheme 2).

Scheme 2
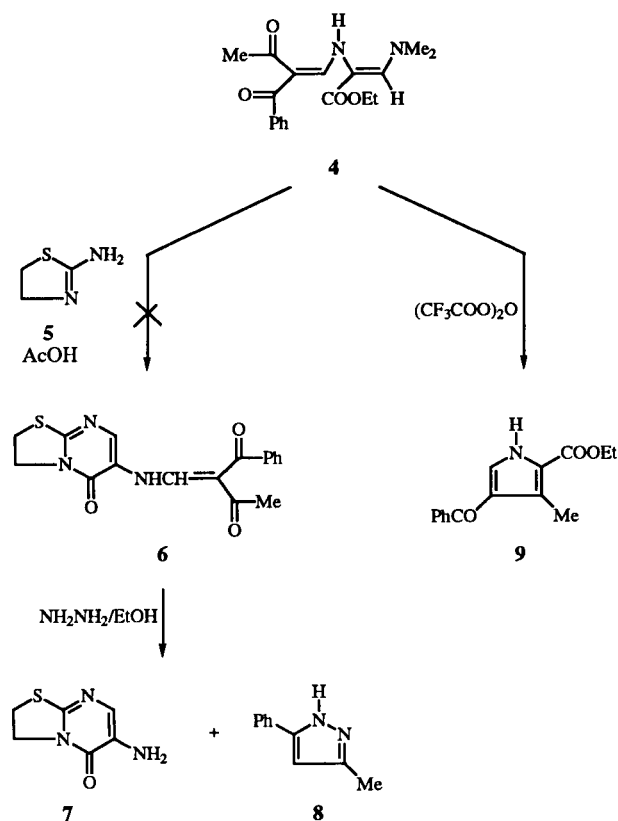
The structures of new compounds **3**, **4** and **9** were determined by elemental analyses for C, H and N, ^{1}H nmr spectra and mass spectra. The X-ray analyses are represented in Figures 1-6 and Tables 1 and 2.
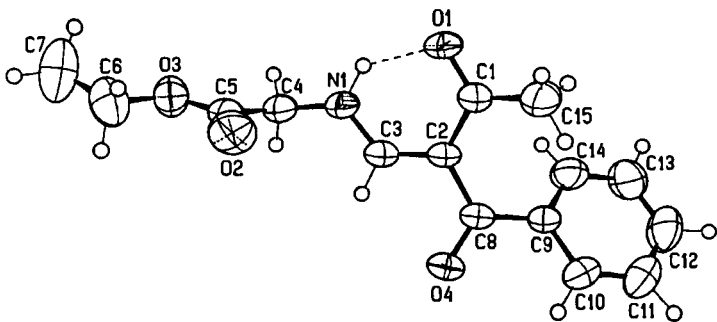
Since this reaction represents a new synthesis of poly-substituted pyrrols [10], further research is in progress.

Figure 2. Ortep view of the molecule of **4** with labeling of nonhydrogen atoms. (Ellipsoids are drawn at 50% probability level.)

Figure 3. Ortep view of two molecules that compose asymmetric unit of **9** with labeling of nonhydrogen atoms. (Ellipsoids are drawn at 40% probability level.)

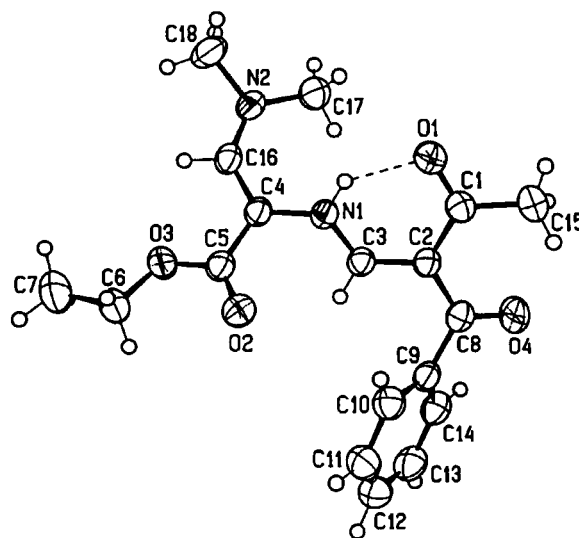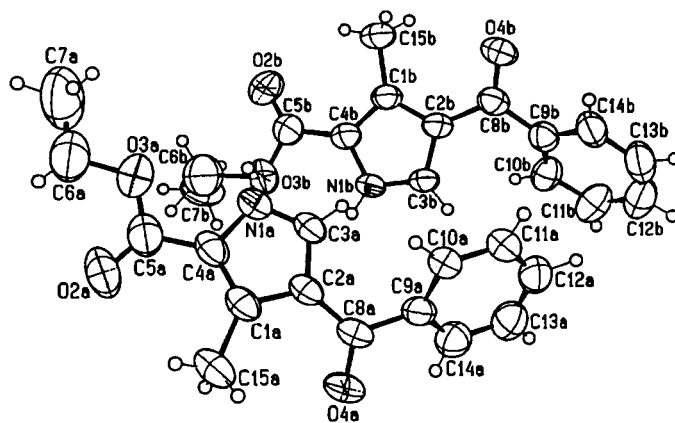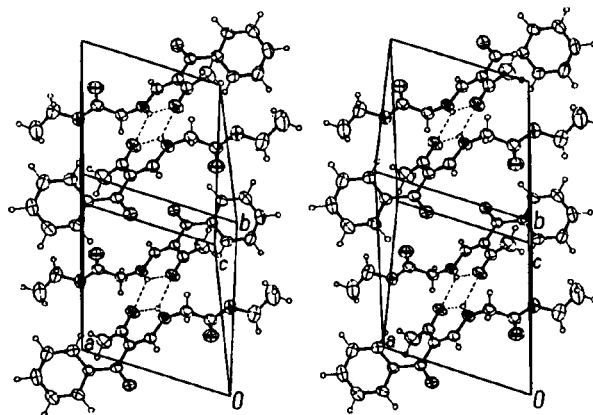Figure 4. Ortep stereoview of the molecular packing in the compound **3**.

Figure 1. Ortep view of the molecule of **3** with labeling of nonhydrogen atoms. (Ellipsoids are drawn at 50% probability level.)

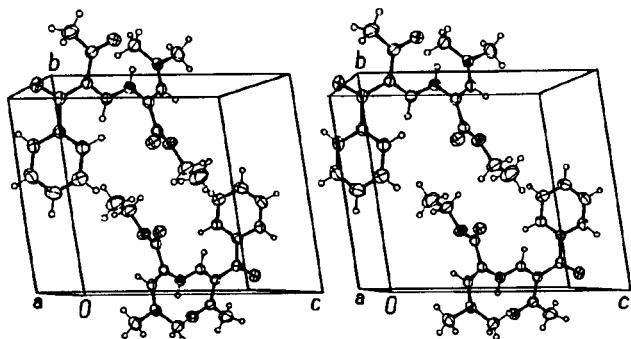Figure 5. Ortep stereoview of the molecular packing in the compound **4**.

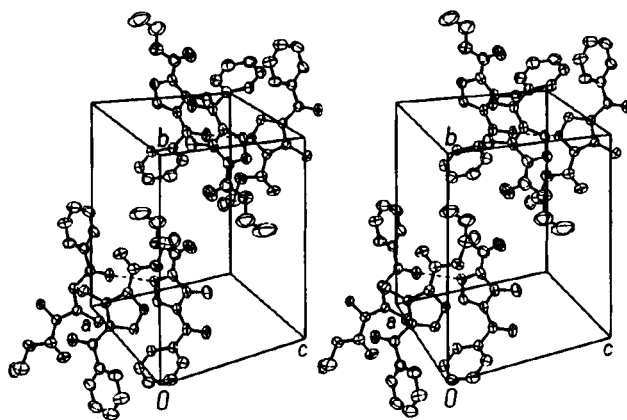Figure 6. Ortep stereoview of the molecular packing in the compound **9**.

Table 1

Fractional Coordinates and Equivalent Temperature Factors (Å^2). U_{eq} is defined as one third of the trace of the orthogonalized U_{ij} tensor

3

	x/a	y/b	z/c	U_{eq}
O(1)	0.6446(4)	0.8790(4)	0.4623(3)	0.068(2)
O(2)	0.0965(5)	1.0042(4)	0.3392(4)	0.086(2)
O(3)	-0.0243(4)	1.2528(4)	0.2955(3)	0.069(2)
O(4)	0.6793(4)	0.8118(4)	0.0615(3)	0.074(2)
N(1)	0.4288(5)	1.0701(4)	0.2872(3)	0.056(2)
C(1)	0.7233(5)	0.8128(5)	0.3828(4)	0.056(2)
C(2)	0.6740(5)	0.8750(5)	0.2472(4)	0.051(2)
C(3)	0.5299(5)	0.9920(5)	0.2129(4)	0.052(2)
C(4)	0.2801(6)	1.1890(6)	0.2448(4)	0.056(2)
C(5)	0.1091(6)	1.1350(6)	0.2998(4)	0.059(2)
C(6)	-0.2002(7)	1.2207(8)	0.3377(7)	0.087(3)
C(7)	-0.3234(11)	1.3587(12)	0.3484(12)	0.127(5)
C(8)	0.7654(5)	0.8130(5)	0.1412(4)	0.052(2)
C(9)	0.9583(5)	0.7617(5)	0.1213(4)	0.049(2)
C(10)	1.0325(6)	0.6509(6)	0.0646(5)	0.064(2)
C(11)	1.2116(7)	0.6061(7)	0.0416(6)	0.078(3)
C(12)	1.3204(7)	0.6709(7)	0.0715(6)	0.084(3)
C(13)	1.2467(7)	0.7828(8)	0.1246(6)	0.084(3)
C(14)	1.0679(6)	0.8277(6)	0.1499(5)	0.067(2)
C(15)	0.8515(9)	0.6691(8)	0.4330(6)	0.078(3)

4

	x/a	y/b	z/c	U_{eq}
O(1)	1.1442(1)	-0.13901(9)	0.75356(9)	0.0568(4)
O(2)	1.0181(1)	0.30854(9)	0.6259(1)	0.0558(4)

Table 1 (continued)

4

	x/a	y/b	z/c	U_{eq}
O(3)	0.7469(1)	0.29266(9)	0.48021(9)	0.0515(3)
O(4)	1.2646(2)	0.0733(1)	1.12552(9)	0.0710(5)
N(1)	0.9667(1)	0.0547(1)	0.67482(9)	0.0404(3)
N(2)	0.6614(1)	-0.0886(1)	0.45568(9)	0.0457(4)
C(1)	1.2007(2)	-0.0778(1)	0.8661(1)	0.0438(4)
C(2)	1.1538(2)	0.0543(1)	0.8955(1)	0.0389(4)
C(3)	1.0370(2)	0.1112(1)	0.7967(1)	0.0383(4)
C(4)	0.8469(2)	0.1089(1)	0.5723(1)	0.0392(4)
C(5)	0.8830(2)	0.2444(1)	0.5645(1)	0.0416(4)
C(6)	0.7837(2)	0.4127(2)	0.4382(2)	0.0632(6)
C(7)	0.6236(3)	0.4448(2)	0.3407(2)	0.0913(9)
C(8)	1.2107(2)	0.1262(1)	1.0281(1)	0.0443(4)
C(9)	1.2051(2)	0.2719(1)	1.0488(1)	0.0415(4)
C(10)	1.2698(2)	0.3503(1)	0.9793(1)	0.0483(4)
C(11)	1.2773(2)	0.4841(1)	1.0102(2)	0.0570(5)
C(12)	1.2171(2)	0.5411(2)	1.1085(2)	0.0610(6)
C(13)	1.1495(2)	0.4643(2)	1.1765(1)	0.0609(6)
C(14)	1.1456(2)	0.3306(1)	1.1486(1)	0.0511(5)
C(15)	1.3203(3)	-0.1462(2)	0.9689(2)	0.0680(7)
C(16)	0.7193(2)	0.0351(1)	0.4724(1)	0.0406(4)
C(17)	0.7054(2)	-0.1727(1)	0.5554(1)	0.0530(5)
C(18)	0.5528(2)	-0.1502(2)	0.3265(1)	0.0611(6)

9

	x/a	y/b	z/c	U_{eq}
O(2a)	0.8452(5)	0.2514(4)	0.6050(3)	0.128(2)
O(3a)	0.9533(6)	0.2648(4)	0.4196(4)	0.130(3)
O(4a)	0.6021(4)	-0.1043(3)	0.6009(2)	0.103(2)
O(2b)	0.7298(5)	0.3308(3)	0.0783(3)	0.117(2)
O(3b)	0.5880(7)	0.2891(3)	0.2485(3)	0.141(3)
O(4b)	0.9526(3)	-0.1176(3)	-0.1372(2)	0.089(1)
N(1a)	0.8734(4)	0.1037(3)	0.3679(3)	0.076(1)
N(1b)	0.6210(4)	0.0828(2)	0.1828(2)	0.070(1)
C(1a)	0.7777(4)	0.0516(3)	0.5476(3)	0.071(1)
C(2a)	0.7666(3)	-0.0185(3)	0.4731(3)	0.066(1)
C(3a)	0.8280(4)	0.0178(3)	0.3630(3)	0.067(1)
C(4a)	0.8444(4)	0.1259(3)	0.4806(3)	0.075(1)
C(5a)	0.8788(5)	0.2187(4)	0.5108(4)	0.095(2)
C(6a)	0.9873(14)	0.3622(8)	0.4386(8)	0.168(7)
C(7a)	1.0761(24)	0.3921(11	0.3513(9)	0.279(16)
C(8a)	0.6894(4)	-0.1012(3)	0.5043(3)	0.071(1)
C(9a)	0.7115(4)	-0.1825(3)	0.4175(3)	0.069(1)
C(10a)	0.8479(5)	-0.2287(3)	0.3297(3)	0.074(2)
C(11a)	0.8582(6)	-0.3015(4)	0.2523(3)	0.088(2)
C(12a)	0.7378(7)	-0.3301(4)	0.2599(4)	0.098(3)
C(13a)	0.6027(6)	-0.2860(4)	0.3460(4)	0.099(2)
C(14a)	0.5902(5)	-0.2137(4)	0.4258(4)	0.087(2)
C(15a)	0.7318(6)	0.0423(5)	0.6752(3)	0.093(2)
C(1b)	0.7837(4)	0.0903(3)	0.0092(3)	0.064(1)
C(2b)	0.7608(4)	-0.0170(3)	0.0239(2)	0.061(1)
C(3b)	0.6593(4)	-0.0163(3)	0.1335(3)	0.064(1)
C(4b)	0.6945(4)	0.1516(3)	0.1093(3)	0.068(1)
C(5b)	0.6758(6)	0.2656(3)	0.1402(3)	0.087(2)
C(6b)	0.5753(16)	0.3964(7)	0.2960(8)	0.198(7)
C(7b)	0.4417(24)	0.4555(21)	0.3054(22)	0.299(10)
C(8b)	0.8380(4)	-0.1140(3)	-0.0558(3)	0.068(1)
C(9b)	0.7809(4)	-0.2117(3)	-0.0361(3)	0.069(1)
C(10b)	0.6278(5)	-0.1959(3)	0.0020(4)	0.082(2)
C(11b)	0.5805(8)	-0.2898(5)	0.0160(5)	0.103(3)
C(12b)	0.6844(9)	-0.3985(5)	-0.0065(5)	0.111(4)
C(13b)	0.8346(9)	-0.4152(4)	-0.0429(4)	0.107(3)
C(14b)	0.8854(6)	-0.3229(3)	-0.0597(3)	0.088(2)
C(15b)	0.8824(6)	0.1331(4)	-0.0948(3)	0.083(2)

Table 2

Bond Distances (Å) and Bond Angles (°) with e.s.d.'s in parentheses

3

O(1)-C(1)	1.246(6)	C(2)-C(8)	1.478(7)
O(2)-C(5)	1.194(7)	C(4)-C(5)	1.505(7)
O(3)-C(5)	1.324(5)	C(6)-C(7)	1.459(12)
O(3)-C(6)	1.455(7)	C(8)-C(9)	1.476(6)
O(4)-C(8)	1.246(7)	C(9)-C(10)	1.391(8)
N(1)-C(3)	1.325(6)	C(9)-C(14)	1.384(9)
N(1)-C(4)	1.421(6)	C(10)-C(11)	1.370(7)
C(1)-C(2)	1.462(6)	C(11)-C(12)	1.378(11)
C(1)-C(15)	1.463(7)	C(12)-C(13)	1.374(11)
C(2)-C(3)	1.373(5)	C(13)-C(14)	1.370(7)
C(5)-O(3)-C(6)	117.3(5)	O(3)-C(6)-C(7)	108.3(7)
C(3)-N(1)-C(4)	124.0(4)	O(4)-C(8)-C(2)	119.5(4)
O(1)-C(1)-C(2)	118.8(4)	O(4)-C(8)-C(9)	118.8(4)
O(1)-C(1)-C(15)	118.3(4)	C(2)-C(8)-C(9)	121.7(5)
C(2)-C(1)-C(15)	122.7(5)	C(8)-C(9)-C(10)	119.2(5)
C(1)-C(2)-C(3)	120.9(4)	C(8)-C(9)-C(14)	121.7(4)
C(1)-C(2)-C(8)	123.7(4)	C(10)-C(9)-C(14)	119.0(4)
C(3)-C(2)-C(8)	115.2(4)	C(9)-C(10)-C(11)	119.7(6)
N(1)-C(3)-C(2)	127.3(4)	C(10)-C(11)-C(12)	121.1(6)
N(1)-C(4)-C(5)	113.2(4)	C(11)-C(12)-C(13)	119.0(5)
O(2)-C(5)-O(3)	125.0(5)	C(12)-C(13)-C(14)	120.7(7)
O(2)-C(5)-C(4)	124.3(4)	C(9)-C(14)-C(13)	120.5(6)
O(3)-C(5)-C(4)	110.6(4)		

4

O(1)-C(1)	1.243(1)	C(2)-C(3)	1.400(2)
O(2)-C(5)	1.214(1)	C(2)-C(8)	1.462(2)
O(3)-C(5)	1.347(1)	C(4)-C(5)	1.457(2)
O(3)-C(6)	1.449(2)	C(4)-C(16)	1.368(1)
O(4)-C(8)	1.228(2)	C(6)-C(7)	1.470(3)
N(1)-C(3)	1.318(1)	C(8)-C(9)	1.505(2)
N(1)-C(4)	1.421(1)	C(9)-C(10)	1.390(2)
N(2)-C(16)	1.332(2)	C(9)-C(14)	1.396(2)
N(2)-C(17)	1.455(2)	C(10)-C(11)	1.383(2)
N(2)-C(18)	1.456(2)	C(11)-C(12)	1.381(3)
C(1)-C(2)	1.452(2)	C(12)-C(13)	1.379(3)
C(1)-C(15)	1.504(2)	C(13)-C(14)	1.381(2)
C(5)-O(3)-C(6)	116.3(1)	O(2)-C(5)-O(3)	122.8(1)
C(3)-N(1)-C(4)	126.4(1)	O(2)-C(5)-C(4)	125.2(1)
C(16)-N(2)-C(17)	125.37(9)	O(3)-C(5)-C(4)	111.93(9)
C(16)-N(2)-C(18)	119.0(1)	O(3)-C(6)-C(7)	108.3(2)
C(17)-N(2)-C(18)	115.5(1)	O(4)-C(8)-C(2)	122.9(1)
O(1)-C(1)-C(2)	121.0(1)	O(4)-C(8)-C(9)	117.4(1)
O(1)-C(1)-C(15)	117.1(1)	C(2)-C(8)-C(9)	119.7(1)
C(2)-C(1)-C(15)	122.0(1)	C(8)-C(9)-C(10)	122.4(1)
C(1)-C(2)-C(3)	119.3(1)	C(8)-C(9)-C(14)	118.6(1)
C(1)-C(2)-C(8)	122.2(1)	C(10)-C(9)-C(14)	118.8(1)
C(3)-C(2)-C(8)	118.2(1)	C(9)-C(10)-C(11)	120.4(1)
N(1)-C(3)-C(2)	124.8(1)	C(10)-C(11)-C(12)	120.2(2)
N(1)-C(4)-C(5)	116.87(9)	C(11)-C(12)-C(13)	119.9(1)
N(1)-C(4)-C(16)	122.7(1)	C(12)-C(13)-C(14)	120.2(2)
C(5)-C(4)-C(16)	119.7(1)	C(9)-C(14)-C(13)	120.4(2)
O(2)-C(5)-O(3)	122.8(1)	N(2)-C(16)-C(4)	131.5(1)

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N(1a)-C(3a)	1.328(6)	N(1b)-C(3b)	1.319(5)
N(1a)-C(4a)	1.391(5)	N(1b)-C(4b)	1.383(5)
O(2a)-C(5a)	1.197(7)	O(2b)-C(5b)	1.193(6)
O(3a)-C(5a)	1.320(7)	O(3b)-C(5b)	1.334(5)

Table 2 (continued)

9

O(3a)-C(6a)	1.447(15)	O(3b)-C(6b)	1.482(13)
O(4a)-C(8a)	1.226(4)	O(4b)-C(8b)	1.231(4)
C(1a)-C(2a)	1.424(6)	C(1b)-C(2b)	1.418(6)
C(1a)-C(4a)	1.368(6)	C(1b)-C(4b)	1.383(4)
C(1a)-C(15a)	1.511(5)	C(1b)-C(15b)	1.506(5)
C(2a)-C(3a)	1.395(4)	C(2b)-C(3b)	1.391(4)
C(2a)-C(8a)	1.448(6)	C(2b)-C(8b)	1.463(5)
C(4a)-C(5a)	1.455(8)	C(4b)-C(5b)	1.450(6)
C(6a)-C(7a)	1.258(18)	C(6b)-C(7b)	1.260(25)
C(8a)-C(9a)	1.492(6)	C(8b)-C(9b)	1.489(6)
C(9a)-C(10a)	1.394(4)	C(9b)-C(10b)	1.396(7)
C(9a)-C(14a)	1.389(7)	C(9b)-C(14b)	1.395(5)
C(10a)-C(11a)	1.371(7)	C(10b)-C(11b)	1.388(9)
C(11a)-C(12a)	1.365(10)	C(11b)-C(12b)	1.370(7)
C(12a)-C(13a)	1.373(7)	C(12b)-C(13b)	1.367(12)
C(13a)-C(14a)	1.382(8)	C(13b)-C(14b)	1.388(9)
C(3a)-N(1a)-C(4a)	109.4(3)	C(3b)-N(1b)-C(4b)	110.1(3)
C(5a)-O(3a)-C(6a)	116.3(6)	C(5b)-O(3b)-C(6b)	116.4(6)
C(2a)-C(1a)-C(4a)	106.5(3)	C(2b)-C(1b)-C(4b)	106.9(3)
C(2a)-C(1a)-C(15a)	126.9(4)	C(2b)-C(1b)-C(15b)	127.7(3)
C(4a)-C(1a)-C(15a)	126.6(5)	C(4b)-C(1b)-C(15b)	125.3(4)
C(1a)-C(2a)-C(3a)	106.9(4)	C(1b)-C(2b)-C(3b)	106.5(3)
C(1a)-C(2a)-C(8a)	127.2(4)	C(1b)-C(2b)-C(8b)	127.2(3)
C(3a)-C(2a)-C(8a)	125.4(4)	C(3b)-C(2b)-C(8b)	126.1(3)
N(1a)-C(3a)-C(2a)	108.8(3)	N(1b)-C(3b)-C(2b)	109.1(3)
N(1a)-C(4a)-C(1a)	108.4(4)	N(1b)-C(4b)-C(1b)	107.3(3)
N(1a)-C(4a)-C(5a)	121.0(4)	N(1b)-C(4b)-C(5b)	122.8(3)
C(1a)-C(4a)-C(5a)	130.5(4)	C(1b)-C(4b)-C(5b)	129.9(3)
O(2a)-C(5a)-O(3a)	122.9(6)	O(2b)-C(5b)-O(3b)	123.8(5)
O(2a)-C(5a)-C(4a)	125.9(5)	O(2b)-C(5b)-C(4b)	125.5(4)
O(3a)-C(5a)-C(4a)	111.2(5)	O(3b)-C(5b)-C(4b)	110.6(4)
O(3a)-C(6a)-C(7a)	113.4(11)	O(3b)-C(6b)-C(7b)	99.5(18)
O(4a)-C(8a)-C(2a)	121.1(4)	O(4b)-C(8b)-C(2b)	120.7(4)
O(4a)-C(8a)-C(9a)	118.6(4)	O(4b)-C(8b)-C(9b)	119.5(3)
C(2a)-C(8a)-C(9a)	120.2(3)	C(2b)-C(8b)-C(9b)	119.8(3)
C(8a)-C(9a)-C(10a)	123.0(4)	C(8b)-C(9b)-C(10b)	122.6(3)
C(8a)-C(9a)-C(14a)	118.0(3)	C(8b)-C(9b)-C(14b)	118.2(4)
C(10a)-C(9a)-C(14a)	118.9(4)	C(10b)-C(9b)-C(14b)	119.2(4)
C(9a)-C(10a)-C(11a)	119.4(5)	C(9b)-C(10b)-C(11b)	120.3(4)
C(10a)-C(11a)-C(12a)	121.3(4)	C(10b)-C(11b)-C(12b)	119.9(7)
C(11a)-C(12a)-C(13a)	120.3(5)	C(11b)-C(12b)-C(13b)	120.4(7)
C(12a)-C(13a)-C(14a)	119.4(6)	C(12b)-C(13b)-C(14b)	121.0(5)
C(9a)-C(14a)-C(13a)	120.6(4)	C(9b)-C(14b)-C(13b)	119.2(5)

EXPERIMENTAL

Melting points were taken on a Leica hot stage microscope. The ^{1}H-nmr spectra were obtained on a Bruker Avance DPX 300 spectrometer with tetramethylsilane as an internal standard. The ir spectra were recorded on a Perkin-Elmer FTIR 1600. Microanalyses for C, H and N were done on a Perkin-Elmer Analyser 2400. Mass spectra (FAB spectra: MH⁺) were recorded on a Varian-MAT 311 A mass spectrometer.

The Synthesis of Ethyl *N*-(2-Acetyl-2-benzoyl-1-ethenyl) glycinate (**3**).

A mixture of benzoylacetone (**1**) (1.62 g, 10 mmoles), toluene (10 ml) and *N,N*-dimethylformamide dimethyl acetal (1.5 ml)

was refluxed for two hours, cooled and volatile components evaporated *in vacuo*. The residue was dissolved in glacial acetic acid (5 ml) and ethyl glycinate hydrochloride (1.4 g, 10 mmoles) was added. The mixture was refluxed for two hours, cooled and volatile components evaporated *in vacuo*. The residue was triturated with a mixture of ethyl acetate and *n*-hexane, the precipitate collected by filtration and recrystallized from a mixture of ethyl acetate and *n*-hexane to give **3** in 42% yield, mp 79-81°; ms: m/z 275 (M+); ^{1}H nmr (deuteriochloroform): δ 1.28 (s, 3H, CH_2CH_3), 2.43 (s, 3H, CH_3CO), 3.98 (d, 2H, $NHCH_2$), 4.22 (q, 2H, CH_2CH_3), 7.36 (td, 1H, CHNH), 7.39-7.95 (m, 5H, PhCO), 10.98-11.01 (m, 1H, CHN*H*), J_{CH2CH3} = 7.16 Hz, J_{CH2NH} = 6.10 Hz, J_{CHNH} = 13.24.

Anal. Calcd. for $C_{15}H_{17}NO_4$: C, 65.44; H, 6.22, N, 5.09. Found: C, 65.25; H, 6.37; N, 5.12.

The Synthesis of Ethyl 2-(2-Acetyl-2-benzoyl-1-ethenyl)amino-3-dimethylaminopropenoate (**4**).

To a solution of *N*-(2-acetyl-2-benzoyl-1-ethenyl)glycine ethyl ester (**3**) (0.55 g, 2 mmoles) in *N,N*-dimethylformamide (4 ml) *N,N*-dimethylformamide dimethyl acetal (0.58 ml, 4 mmoles) was added and the mixture was heated at 90° for 3 hours. After the reaction was completed, the volatile components were evaporated *in vacuo*. The oily residue was dissolved in methylene chloride (60 ml) and the solution was extracted with water (3 x 20 ml). The organic layer was dried over anhydrous sodium sulphate and evaporated *in vacuo*. To the oily residue di(2-propyl) ether was added and, after cooling, the solid product was collected by filtration and recrystallized from di(2-propyl) ether to give **4** in 30% yield, mp 99-101°; ms: m/z 330 (M+); ^{1}H nmr (deuteriochloroform): δ 1.26 (s, 3H, CH_2CH_3), 2.52 (s, 3H, CH_3CO), 3.02 (s, 6H, N(CH_3)$_2$), 4.17 (q, 2H, CH_2CH_3), 7.28 (s, 1H, C*H*N(CH_3)$_2$), 7.42-7.66 (m, 6H, PhCO, CHNH), 11.62 (d, 1H, CHN*H*), J_{CH2CH3} = 7.16 Hz, J_{CHNH} = 12.87 Hz.

Anal. Calcd. for $C_{18}H_{22}N_2O_4$: C, 65.43; H, 6.71, N, 8.48. Found: C, 65.31; H, 6.93; N, 8.39.

Synthesis of 4-Benzoyl-2-ethoxylcarbonyl-3-methylpyrrole (**9**).

Ethyl 2-(2-acetyl-2-benzoyl-1-ethenyl)amino-3-dimethylaminopropenoate (**4**) (80 mg, 0.25 mmole) was dissolved in trifluoroacetic anhydride (2 ml) and stirred at room temperature for 5 minutes. The reaction was followed by tlc (DC-Alufolien Kieselgel 60F$_{254}$, 0.2 mm, E. Merck, and ethyl acetate:methanol, 15:1, as a solvent). After the reaction was completed, the volatile components were evaporated *in vacuo*. To the oily residue the mixture of ethanol and water (1:1) was added. The product, which crystallized from the mixture, was collected by filtration and washed with water to give **9** in 65% yield, mp 127-129°; ms: m/z 257 (M+); ^{1}H nmr (deuteriochloroform): δ 1.42 (s, 3H, CH_2CH_3), 2.66 (s, 3H, CH_3), 4.39 (q, 2H, CH_2CH_3), 7.21 (d, 1H, C*H*NH), 9.32 (bs, 1H, CHN*H*), J_{CH2CH3} = 7.16 Hz, J_{CHNH} = 3.39 Hz.

Anal. Calcd. for $C_{15}H_{15}NO_3$: C, 70.02; H, 5.88, N, 5.44. Found: C, 70.17; H, 6.05; N, 5.04.

X-ray Structure Determination.

A colorless crystal of **3** with dimensions 0.84 x 0.13 x 0.06 mm, an orange crystal of **4** with dimensions 0.56 x 0.52 x 0.36 mm and a colorless crystal of **9** with dimensions 0.57 x 0.41 x 0.14 mm were used for data collection on Enraf Nonius CAD-4 diffractometer with graphite monochromatized MoKα radiation.

Accurate unit-cell parameters were obtained from a least-squares refinement of the angular settings of 25 (**3**), 75 (**4**) and 99 (**9**) reflections in the range 8.0° < θ < 12.8° (**3**), 10.1° < θ < 16.8° (**4**) and 8.0° < θ < 15.6° (**9**). All three compounds crystallize in the triclinic crystal system in the space group P 1̄ (no. 2). Cell dimensions are a = 8.020(2), b = 9.781(3), c = 10.989(2) Å, α = 65.27(2), β = 75.93(4), γ = 73.47(2)° for **3**, a = 8.067(1), b = 10.418(1), c = 10.940(1) Å, α = 98.09(1), β = 108.46(1), γ = 90.82(1)° for **4** and a = 10.185(1), b = 12.476(1), c = 12.682(1) Å, α = 82.68(1), β = 68.34(1), γ = 68.76(1)° for **9**. Other crystal data are: $C_{15}H_{17}NO_4$, M_r = 275.3, V = 742.9(4) Å^3, Z = 2, D_x = 1.231 Mg/m^3, μ = 0.0837 mm^{-1} for **3**, $C_{18}H_{22}N_2O_4$, M_r = 330.4, V = 861.8(1) Å^3, Z = 2, D_x = 1.273 Mg/m^3, μ = 0.0846 mm^{-1} for **4** and $C_{15}H_{15}NO_3$, M_r = 257.3, V = 1395.9(2) Å^3, Z = 4, D_x = 1.224 Mg/m^3, μ = 0.0800 mm^{-1} for **9**. Intensity data for all compounds were collected at room temperature (273(2) K) in the ω/2θ scan mode. Entire sphere to θ$_{max}$ 26.5° for **3**, 28.5° for **4** and 28.0° for **9** of data was measured with an index range -10 ≤ h ≤ 10, -12 ≤ k ≤ 12 and -13 ≤ l ≤ 13 for **3**, -10 ≤ h ≤ 10, -13 ≤ k ≤ 13 and -14 ≤ l ≤ 14 for **4** and -13 ≤ h ≤ 13, -16 ≤ k ≤ 16 and -16 ≤ l ≤ 16 for **9**. Three intensity check reflections were monitored periodically every 20000 seconds of the scanning time in all cases. A change of -0.09% (**3**), 0.70% (**4**) and -12.90% (**9**) of intensities of check reflections was observed and correction applied. Orientation control was every 600 reflections. Due to the low value of the linear absorption coefficient (0.0837 mm^{-1} (**3**), 0.0846 mm^{-1} (**4**), 0.0800 mm^{-1} (**9**)) absorption was ignored. 6184 for **3**, 8794 for **4** and 13500 for **9** reflections were collected, averaging gave 3068 for **3**, 4358 for **4** and 6709 for **9** independent reflections with R_{int} = 0.023 (**3**), 0.007 (**4**) and 0.0161 (**9**). 1341 (**3**), 3343 (**4**) and 2864 (**9**) reflections were observed using I>2.5σ(I) criterion. All three structures were solved by direct methods using SIR92 [11] program. The positions of hydrogen atoms were obtained from intermediate difference Fourier maps. Only the positions of hydrogen atoms being bonded to C(6a), C(7a) and C(7b) in compound **9** were not obtained from difference Fourier map. They were calculated according to geometry. We employed full-matrix least-squares refinement on F magnitudes with anisotropic temperature factors for all non-hydrogen atoms (with the exception of C(7b) in compound **9** which was refined with isotropic temperature factor), using the calculated weighting function: w = 6.0xW_fxW_s where W_f(|F_o|>16.0) = (16.0/|F_o|)$^{1.7}$, W_f(|F_o|≤16.0) = 1.0 and W_s(sinθ<0.293) = (sinθ/0.293)$^{1.5}$, W_s(0.293≤sinθ) = 1 for **3** and W_f(|F_o|>8.79) = (8.79/|F_o|), W_f(|F_o|≤8.79) = 1.0 and W_s(sinθ<0.380) = (sinθ/0.380), W_s(0.380≤sinθ) = 1 for **4**. For **9** we applied Regina weighting scheme [12,14]. In the case of **3** we refined coordinates of hydrogen atoms whereas in **4** and **9** also isotropic temperature factors of hydrogen atoms (with exception of one of the hydrogen atoms being bonded to C(7) in compound **4** and hydrogen atoms being bonded to C(6a), C(6b), C(7a) and C(7b) in compound **9**) were refined. For **4** and **9** Zachariasen extinction correction [13] was also applied with extinction coefficient 0.12(3)·10^4 for **4** and 0.33(7)·10^4 for **9**. In the final least-square cycle for **3** were 2284 contributing reflections and 232 parameters, for **4** 3906 contributing reflections and 302 parameters and for **9** 4929 reflections and 419 parameters. Included were those unobserved reflections for which F_c was greater than F_o. In the case of **9** we applied also 3 restraints of bond lengths (C(6a)-C(7a), C(6b)-C(7b) and O(3b)-C(6b)) since ethyl group is disordered. The final R and R_w values were 0.061

and 0.067 for **3**, 0.037 and 0.044 for **4** and 0.070 and 0.045 for **9**, respectively. Goodness of fit was 0.562 in the first, 0.791 in the second and 1.133 in the third case. Average and maximal shift/error were 0.0005 and 0.0154 for **3**, 0.0001 and 0.0006 for **4** and 0.0226 and 0.0011 for **9**. The maximal residual density in final difference map was 0.325 e/Å^3 for **3**, 0.280 e/Å^3 for **4** and 0.570 e/Å^3 for **9**, and the minimal -0.399 e/Å^3 for **3**, -0.258 e/Å^3 for **4** and -0.584 e/Å^3 for **9**. The Xtal3.4 [14] system of crystallographic programs was used for the correlation and reduction of data, structure refinement and interpretation. ORTEPII [15] was used to produce molecular graphics.

The asymmetric units of **3**, **4** and **9** with atom-numbering scheme are shown in the Figures 1, 2 and 3. The stereoviews of the molecular packing of all three compounds are presented in Figures 4, 5 and 6. Final atomic coordinates and equivalent isotropic thermal parameters with their e.s.d.'s are listed in Table 1. Bond lengths and bond angles are presented in Table 2.

The configuration of substituents at C(2)=C(3) double bond in **3** and **4** is E while at C(4)=C(16) double bond in **4** is Z. Formal double bond C(2)=C(3) in **3** and **4** (1.373(5), 1.400(2) Å) is longer than unpolarised double bond in ethylene (1.314(6) Å) [16]. This is due to the π electron conjugation caused by the electronic influences of bonded substituents (electron withdrawing acetyl and benzoyl group and electron donating substituted amino group). In both compounds this π-conjugated system incorporates intramolecular hydrogen bond N(1)-H..O(1) which in an accordance with resonance assisted hydrogen bonding (RAHB) theory [19] enhances the π electron delocalization. This conjugation (in **3** and **4**) is also reflected in the bond lengths of C(2)-C(1) (1.462(6), 1.452(2) Å), C(2)-C(8) (1.478(7), 1.462(2) Å) and C(3)-N(1) (1.325(6), 1.318(1) Å) which are shorter than corresponding unconjugated single bonds (C(sp^2)-C(sp^2) 1.484(17) Å [17] and C(sp^2)-N(sp^2) 1.470(5) Å [18]). C(1)-C(2) bond is shorter (and thus have more double bond character) than C(2)-C(8) bond, which is also in an agreement with resonance assisted hydrogen bonding theory since acetyl group which takes part in the intramolecular hydrogen bonding participates more in the π electron delocalization than does benzoyl group. Bond lengths in the closeness of C(4)=C(16) double bond in **4** also indicate π electron conjugation of this double bond with the nitrogen atom lone pair electrons of electron donating dimethylamino group and electron withdrawing ethoxycarbonyl substituent: C(4)=C(16) (1.368(1) Å) bond is longer than formal double bond in ethylene whereas C(16)-N(2) (1.332(2) Å) and C(4)-(C5) (1.457(2) Å) bonds are shorter than corresponding unconjugated single bonds. The contact distances O(1)..N(1) and O(1)..H from intramolecular hydrogen bond are 2.639(5) Å and 2.19(5) Å in **3** and 2.580(2) Å and 1.87(2) Å in **4**. The N(1)-H..O(1) angle is 136(4)° in **3** and 138(1)° in **4**. In the structure **3** are N(1) and O(1) atoms also involved in the intermolecular N(1)-H..O(1) hydrogen bond, where the contact distance O(1)..N(1) is 2.892(6) Å, O(1)..H 1.82(4) Å and N(1)-H..O(1) angle is 126(3)°. The asymmetric unit of **3** and **4** consists of one molecule whereas that of **9** contains two independent molecules (**a** and **b**) with the same formula and similar geometry. Ethyl group in ethoxycarbonyl substituent is disordered in **a** and **b** molecules which is reflected in the large temperature factors of atoms C(6a), C(6b), C(7a) and C(7b) and geometrical parameters in the ethyl group: bond lengths C(6a)-C(7a) (1.258(18) Å) and C(6b)-C(7b) (1.260(25) Å) are much shorter than the average C(sp^3)-C(sp^3) single bond distance (1.513(14) Å) [17] and the angle O(3b)-C(6b)-C(7b) (99.5(18)°) should be closer to the tetrahedral angle. The remaining bond

lengths and angles are in a good agreement with the reported average values of corresponding types of bond or angle [17]. Molecules in the structure of **9** are connected by N(1a)-H..O(4b) and N(1b)-H..O(4a) intermolecular hydrogen bonds. The contact distances O(4b)..N(1a), O(4a)..N(1b), O(4b)..H and O(4a)..H are 2.828(4) Å, 2.811(4) Å, 2.10(5) Å and 2.03(4) Å, respectively. The N(1a)-H..O(4b) angle is 146(5)° and N(1b)-H..O(4a) is 155(5)°.

Acknowledgement.

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