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Formation and Reduction Reactions of 3-Indol-3-yl-isoxazolidines

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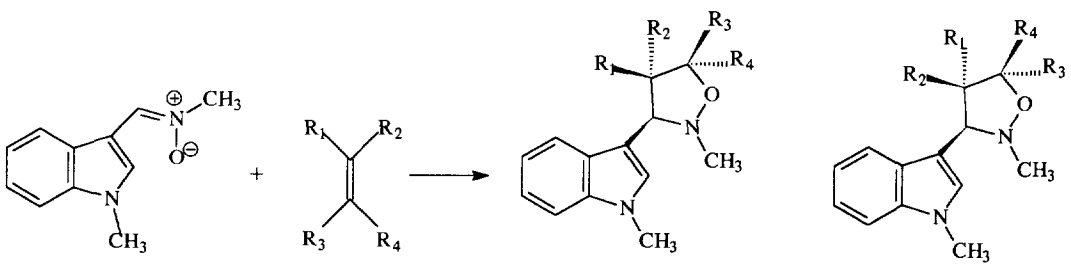
Abstract: 1,3-Dipolar cycloaddition reactions of C-(1-methylindol-3-yl)-N-methylnitrone (**1**) with carbonyl substituted dipolarophiles lead to the formation of indolyl-isoxazolidines **3-6**. Further reduction of the cycloadducts bearing a 5-methoxycarbonyl substituent give the pyrrolidinones **8, 10**. The stereoselectivity of the reactions and the structure elucidation of the products are discussed. Copyright © 1996 Elsevier Science Ltd

Among the plethora of indole alkaloids 3-heterosubstituted indoles have recently attracted a considerable interest because of their many biological applications.[1] In connection with our earlier studies[2] on the synthesis of indole derivatives we envisaged reactions of indolyl 1,3-dipoles as convenient routes for the synthesis of heterosubstituted indoles. Reactions of indol-2-yl nitrile oxides and indol-2-yl nitrones with alkenes have already been studied by us and were found to readily give indol-2-yl isoxazolines and isoxazolidines[3]. The latter, in some cases are further transformed to interesting fused indoles. In this paper we examine the 1,3-dipolar cycloaddition reaction of indol-3-yl nitrile oxides and nitrones as well as possible transformations of the initial cycloadducts with the aim to synthesize several 3-heterosubstituted indoles.

The reactions of indol-3-yl nitrile oxide and 1-methylindol-3-yl nitrile oxide were attempted by the *in situ* formation of the dipole from the corresponding aldoximes in the presence of alkenes. Unlike the reactions of the 2-isomers they were unsuccessful and under several conditions tested it was not possible to isolate cycloadducts in any appreciable amount. On the contrary, reactions of C-(1-methylindol-3-yl)-N-methyl nitrone (**1**) were more effective. Thus **1** reacted readily with the carbonyl dipolarophiles **2a-d** to give cycloadducts **3-6** in good to high total yields (55-93%). The reactions were carried out using nitrone : alkene in 1 : 2 molar ratio in refluxing benzene for 5-10 h. In the case of the reaction with methyl acrylate (**2c**), the alkene was used in excess as solvent.

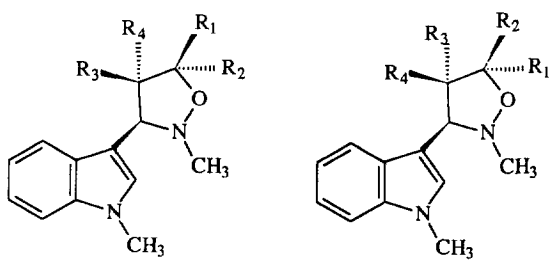
The reaction of nitrone **1** with dimethyl fumarate (**2a**) was highly diastereoselective and gave the two diastereoisomers **4a** and **3a** in a relative ratio 10 : 1. The minor isomer **3a** was not separated but it was characterized and used for further transformations from its mixture with **4a**. The reaction of **1** with dimethyl maleate was less diastereoselective and the diastereoisomers **3b** and **4b** were obtained in a relative ratio 1.6 : 1. The observed diastereoselectivity is analogous to that of the reactions of the 2-isomers[3b] and is in accordance with that usually observed in the reactions of nitrones with fumarates and maleates.[4,5] It

is worth mentioning here that in the reaction mixture of **1** with dimethyl maleate traces of cycloadduct **4a** and dimethyl fumarate were detected in agreement with the previously reported results[5] and the conclusion that some conversion of dimethyl maleate to dimethyl fumarate occurs and cycloaddition to the latter gives the *trans* cycloadducts. The distinction between diastereoisomers **3a** and **4a** as well as **3b** and **4b** was based mainly on the chemical shift of 4-$COOCH_3$ protons, which are shielded when they are *cis* to the indolyl ring. Thus the chemical shifts of 4-$COOCH_3$ of **3a** and **4b** appear at δ 3.12 and 3.20 respectively whereas the corresponding peaks of their isomers **4a** and **3b** appear at δ 3.68 and 3.62. Also the $J_{4,5}$ for the **3a** and **4a** are 6.7 and 3.9 Hz respectively consistent with a quasi-equatorial position of 4-H and 5-H in **4a** and a quasi-axial position in **3a**[5]. For the **3b, 4b** isomers the value of $J_{4,5}$ is almost equal, 9.2 and 8.7 Hz respectively, since in both isomers the 4-H, 5-H are quasi-axial quasi-equatorial. The $J_{3,4}$ could not be measured since the 3-H and 4-H appear as broad signals. The line broadening of some of ^1H NMR and ^{13}C NMR signals reveals a dynamic process of the molecules due to the nitrogen inversion occuring in analogous isoxazolidine rings.[5,6] With increasing temperature the broadening is reduced but still all the splittings are not obvious. The proposed structures were further supported by NOE experiments performed on their reduction products **8, 10**.



1 **2 (a-d)** **3 (a-d)** **4 (a-d)**

a: $R_2 = R_3 = H$, $R_1 = R_4 = COOCH_3$
b: $R_1 = R_3 = H$, $R_2 = R_4 = COOCH_3$
c: $R_1 = R_2 = R_3 = H$, $R_4 = COOCH_3$
d: $R_1 = R_2 = R_3 = H$, $R_4 = COCH_3$



5c **6 (c,d)**

Scheme 1

The reaction of methyl acrylate (**1c**) with the nitrone **1** afforded four adducts, two diastereoisomeric 5-methoxycarbonyl-isoxazolidines **3c** and **4c** and two diastereoisomeric 4-methoxycarbonyl-isoxazolidines **5c** and **6c** in relative ratio 2.9 : 1.3 : 1.5 : 1 (ratio of 5 to 4 isomers 4.2 : 2.5). The isomers **3c, 5c, 6c** could be

separated whereas the isomer **4c** was characterized and used for further transformations as a mixture . From the reaction of **1** with methyl vinylketone three cycloadducts were isolated, one pair of 5-carbonyl substituted diastereoisomers **3d** and **4d** and one 4-carbonyl substituted isomer **6d** in relative ratio 2.1 : 1.5 : 1 (ratio of 5 to 4 isomers 3.6 : 1). The regiochemistry of the obtained cycloadducts is readily assigned on the basis of their ^{1}H NMR and ^{13}C NMR spectra. The 5-substituted isoxazolidines **3c, 4c, 3d, 4d** exhibit a signal for the 5-H at δ 4.39-4.77, whilst the 4-H protons occur at δ 2.55-3.02. The 4-substituted regioisomers **5c, 6c, 6d** exhibit signals for the 5-H at δ 4.26-4.46 and for the 4-H at δ 3.67-4.00. In the ^{13}C NMR spectra the difference in the chemical shifts of C-4 and C-5 is significantly greater in the 5-substituted isomers than in the 4-isomers. The C-4 and C-5 of the 5-isomers resonate at δ 40-41 and 74-81 respectively, whereas the C-4 and C-5 of the 4-isomers resonate at δ 53-63 and 68-69 respectively. These values are similar to those given in the literature for analogous systems.[7] The regioselectivity of the reactions is also in accordance with that usually observed in the reactions of nitrones with acrylates and vinylketones.[8] The formation of 5-substituted isoxazolidines, which is favored by a LUMO-dipole interaction predominates. 4-Substituted isoxazolidines, which are favored by a HOMO-dipole interaction are usually the minor products.

The stereochemical assignment of 4-substituted isomers **5c** and **6c** was rather safely made on the basis of the chemical shift of the ester methyl group, which is shielded when it is *cis* to the indolyl ring similar to that of **3a** and **4b**. Thus the *cis*- isomer **6c** exhibits the signal for its $COOCH_3$ at δ 3.08 , whilst the *trans*-isomer **5c** at δ 3.69. For the isolated 4-isomer from the reaction with **2d** the rather high field signal of ketone methyl group at δ 2.06 compared with that of 5-isomers at δ 2.43 and 2.28 is indicative of a *cis* arrangement to the indole ring (structure **6d**), although the lack of the other stereoisomer does not permit direct comparisons. The difference in the chemical shifts of the ketone methyl group between the two 5-substituted cycloadducts with **2d** can also be taken as an indication for their stereochemistry. The high field methyl must be attributed to the cis isomer **4d**. A significant difference is also observed in the chemical shifts of 5-H which is shielded in the *trans* isomer (δ 4.39 versus 4.64).

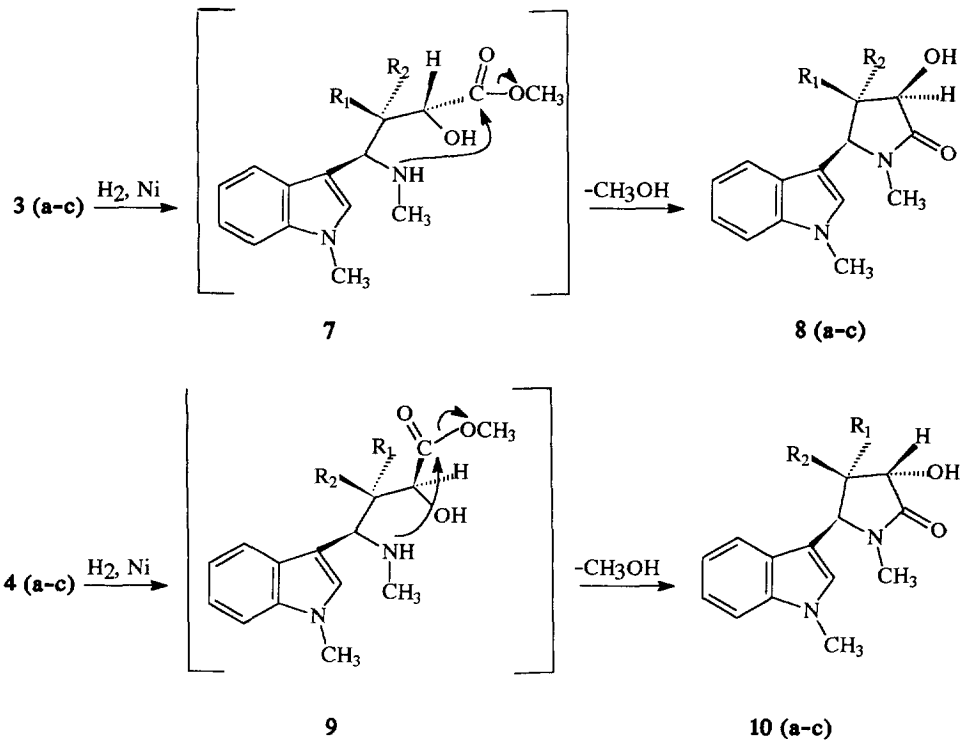
The 5-substituted isomers **3c, 4c** cannot be easily differentiated on the basis of their ^{1}H NMR spectra. They do not exhibit significant differences in the chemical shifts of methoxycarbonyl protons and 5-H protons. Thus in the major isomer the methoxycarbonyl occurs at δ 3.81 and the 5-H at δ 4.77. In the minor isomer the corresponding signals appear at δ 3.83 and 4.69. The literature references about the stereochemical course of analogous reactions are rather controversial. In an attempt to establish the structure of hydroxycotinine, a metabolite of nicotine, the major cycloadducts of C-phenyl-N-methylnitrone and C-pyrid-2-yl-N-methylnitrone to methyl acrylate ha e been assigned as *trans*-5-methoxycarbonyl-isoxazolidines *via* a series of chemical transformations.[9] Padwa accepts the *cis* 5-isomer as the major product (77%) of the reaction of C-phenyl-N-methyl nitrone with methyl acrylate and the *trans*-5-isomer as the major product (91%) of the reaction with C-phenyl-N-*tert*-butylnitrone.[8d] According to Hamelin the reaction of C-phenyl-N-phenylnitrone with methyl acrylate gives the two *cis*-, *trans* -5-isomers in ratio 28 : 38 and the reaction of C-phenyl-N-methylnitrone gives also two 5-isomers in ratio 70 : 30 but the structure of each isomer was not assigned.[8a] Also nitrones formed *via* Michael addition of oximes to electron deficient alkenes are reported to give the four possible cycloadducts in several ratios with a small preference for the *cis*-isomers.[8c] From the reaction with methyl acrylate the *cis*-, *trans*-5-isomers were obtained in a ratio 4 :

3. For the differentiation of the *cis-, trans* 5-isomers two features of their ^{1}H NMR spectra were used : (i) The difference in chemical shifts of 4-methylene protons in the *cis*-isomer is greater than in the trans isomer. (ii) The difference in the chemical shifts of 3-H and 5-H protons is greater in the *cis*-isomer than in the *trans*-isomer. In our case the major isomer exhibits the greater difference in $\Delta\delta$ (3-H / 5-H) and the smaller in $\Delta\delta$ (4-H). Thus for the major isomer the $\Delta\delta$ (3-H / 5-H) = 0.70 and the two overlapping 4-H give a multiplet at δ 2.75-2.90. For the minor isomer the $\Delta\delta$ (3-H / 5-H) = 0.60 and the multiplet of 4-H occurs at δ 2.77-3.02. There is a close similarity of the ^{1}H NMR data of the obtained cycloadducts to that of the corresponding indol-2-yl derivatives.[3b] We have accepted the *cis* arrangement for the major cycloadduct with methyl acrylate on the basis of its susceptibility to acid induced intramolecular acylation reaction, although both stereoisomers can lead to the same acylation product if a ring opening of the isoxazolidine ring takes place prior to the acylation. Unfortunately because of the overlapping of the 4-H protons and the line broadening induced by dynamic effects, the ^{1}H nmr spectra of isoxazolidines **3c**, **4c** are not suitable for helpful NOE experiments. However NOE experiments performed on their reduction products, as described below, support strongly the *trans* arrangement, structure **3c**, for the major 5-isomer with methyl acrylate.

As it has been mentioned, indol-2-yl isoxazolidines afford fused[b]indoles *via* acid induced intramolecular cyclizations.[3b] However, attempts to induce analogous cyclizations to the cycloadducts **3 - 6** were unsuccessful. Under several conditions tested (hydrochloric acid, boron trifluoride etherate, polyphosphoric acid) only 1-methyindole-3-carbaldehyde and other undentified decomposition products were obtained. 1-Methylindole-3-carbaldehyde was also isolated from the attempted alkaline hydrolysis of the esters **3a,b**, **4a,b**. It seems that the connection of the isoxazolidine ring with the electron rich 3-indole position makes it more sensitive to both acid and bases. Due probably to the same reason attempted cycloadditions by *in situ* formation of indol-3-yl nitrile oxides failed.

Reduction reactions of the obtained isoxazolidines were more fruitful. Thus isoxazolidines **3a**, **3b**, **3c**, **4a**, **4b**, **4c** bearing a 5-methoxycarbonyl were transformed almost quantitatively (90-98%) to pyrrolidinones **8** or **10** upon reduction with hydrogen over Raney Nickel (Scheme 2). The formation of pyrrolidinones **8** and **10** takes place through recyclization of the open intermediates **7** or **9** respectively and is a reaction path known to proceed in this type of compounds.[9,10] Reduction reactions of 4-methoxycarbonyl-isoxazolidines **5c**, **6c** and acetyl-isoxazolidines **3d**, **4d**, **6d** gave complicated mixtures of no characterized products probably *via* unstable intermediates analogous to **7** or **9**.

The structure of the obtained pyrrolidinones was assigned on the basis of their spectroscopic data. Thus in the mass spectra they give peaks for the molecular ion whilst in the IR spectra the characteristic absorbances at ν 3220-3280 cm^{-1} for the hydroxyl and at ν 1655-1665 cm^{-1} for the lactamic carbonyl. The latter is also obvious in the ^{13}C NMR spectra where peaks appear at δ 170-175. The stereochemical assignment of compounds **8**, **10** was based on their ^{1}H NMR, which give nicely separated signals without the troublesome dynamic effects observed in the ^{1}H NMR of the corresponding isoxazolidines. The discrimination between the chemical shifts of 3-H and 5-H and the assignment of the more downfield shift



Scheme 2

to 5-H was possible by the appearance of a coupling between 3-H and hydroxyl hydrogen in the spectrum of analytically pure samples. Thus the 5-H of compounds **8a**, **8b**, **10a** gives a doublet at δ 4.97-5.30 with J = 6.2-8.6 Hz, whereas the 3-H gives a doublet of doublets at δ 4.60-5.02 with one large J = 7.1-8.6 Hz for the coupling with 4-H and a smaller one J = 3.3-4.4 Hz for the coupling with the hydroxyl hydrogen. The smaller J is removed with D_2O. The 4-H is more shielded and appears as doublet of doublets or triplet at δ 3.50-3.67 (Table 1). The connection in space of these three hydrogens is confirmed by NOE experiments and is in accordance with that anticipated from Scheme 2. The reductive cleavage of isoxazolidines is a stereospecific reaction since the amino bearing stereocenter is determined in the cycloaddition step.[11] Thus reduction of **3** or **4** must lead stereospecifically to the diastereomeric intermediates **7** or **9** respectively. Subsequent ring closure brings the initial 5-H to the opposite site of the new ring, as is apparent from molecular models. From the NOE enhancements given in Table 2, the *cis* arrangement is obvious for the 4-H and 5-H of **8a** and **10b** and the *trans* for that of **8b** and **10a**, the same with that in the corresponding initial isoxazolidines. The relative arrangement of 3-H and 4-H is reversed compared with that of the initial cycloadducts. Thus it is *cis* in **8a** and **10a**, the transformation products of the cycloadducts with dimethyl fumarate and *trans* in **8b** and **10b** , the transformation products of the cycloadducts with dimethyl maleate.

Table 1. Chracteristic ^{1}H NMR Chemical Shifts and Coupling Constants of Stereoisomeric Isoxazolidines **8a, 8b, 10a, 10b**

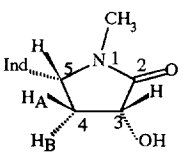
	3-H(δ)	$J_{3,4}$ (Hz)	$J_{3,OH}$ (Hz)	4-H (δ)	5-H (δ)	$J_{4,5}$ (Hz)
8a	4.60	7.1	4.4	3.67	5.19	7.1
8b	4.75	8.5	3.3	3.50	4.97	8.5
10a	4.76	7.6	4.2	3.55	5.30	6.2
10b	5.02	8.6	-	3.57	5.23	8.6

Table 2. ^{1}H NOE (%)[a] Data for Isoxazolidines **8a, 8b, 10a, 10b**

Proton Irradiated	Proton Observed											
	8a			**8b**			**10a**			**10b**		
	3-H	4-H	5-H	3-H	4-H	5-H	3-H	4-H	5-H	3-H	4-H	5-H
3-H	-	17	‹1	-	7	4	-	20	‹1	-	‹1	‹1
4-H	18	-	20	8	-	7	19	-	6	3	-	20
5-H	‹1	13	-	4	7	-	‹1	4	-	‹1	23	-

[a] Derived from the ratio between peak areas in the difference and reference spectra

Table 3. ^{1}H NOE (%)[a] Data for Compound **8c**



Proton Irradiated	Chemical Shift (δ)	Proton Observed			
		3-H	4_A-H	4_B-H	5-H
3-H	4.51	-	8	‹1	4
4_A-H	2.83	7	-	11	13
4_B-H	2.31	2	17	-	2
5-H	4.72	3	10	‹1	-

[a] Derived from the ratio between peak areas in the difference and reference spectra

For the stereochemical assignment of **8c** and **10c** there are no helpful indications from the stereochemistry of their mother isoxazolidines **3c** and **4c.** The most characteristic difference in their ^{1}H NMR is that the signals of the methylene 4-H occur as separate dt and ddd at δ 2.31 and 2.83 for the transformation product of the major isomer instead of a multiplet centered at δ 2.49 for the other isomer. A comparison of the chemical shifts of 4-H in diastereoisomers **8a, 8b, 10a, 10b** reveals that both the indolyl and the hydroxyl groups cause a shielding effect on their adjacent *cis* hydrogen. Thus the signals of 4-H at δ 3.50 and 3.55 of the isomers **8b** and **10a** with 4-H *cis* to indole are upfield shielded compared with that at δ 3.57 and 3.67 of isomers **10b** and **8a** with 4-H *trans* to indole (Δδ 0.07 and 0.12 respectively).

Also the 4-H in **8b** and **10b** where it is *cis* to hydroxyl is upfield shielded by $\Delta\delta$ 0.05 and 0.1 in respect with that of **10a** and **8a** where it is *trans* to hydroxyl (Table 1). Although in the saturated rings the shielding effects of the several groups depend on the conformation and are not so informative as in the fixed unsaturated systems, these observations are indicative that the isomer with the separated 4-H chemical shifts corresponds to the structure **8c**, in which the indolyl and the hydroxyl groups are *cis* and both protect the same 4-H hydrogen. Consequently, the structure of the isoxazolidine , which gives pyrrolidinone **8c** must be **3c** with the indolyl and methoxycarbonyl substituents in *trans* position. These indications were further supported by NOE experiments (Table 3). Saturation of 4_A-H causes significant enhancements (7% and 13%) to both 3-H and 5-H, whilst saturation of 4_B-H causes smaller enhancements (2%). Mutual saturation of 3-H and 5-H causes enhancements, 8 and 10% respectively, only to 4_A-H. These results are consistent with a *cis* arrangement of the three hydrogens 3-H, 4_A-H and 5-H.

In conclusion 1,3-dipolar cycloaddition reactions of indol-3-yl nitrones can serve as a route for the synthesis of 3-heterosubstituted indoles. Although the scope of the reactions is more limited than that of indol-2-yl dipoles due to the greater susceptibility of indol-3-yl derivatives, reduction reaction of the cycloadducts can lead to products with determined stereochemistry.

EXPERIMENTAL

Melting points were determined with a Kofler hot-stage apparatus and are uncorrected. The IR spectra were obtained with a Perkin-Elmer Model 297 spectrometer. ^{1}H NMR spectra were recorded at 300 MHz on a Bruker 300 AM spectrometer and ^{13}C NMR at 75.5 MHz on the same spectrometer and are quoted relative to tetramethylsilane as internal reference, in deuteriochloroform solutions. Mass spectra were determined on a VG-250 spectrometer with ionization energy maintained at 70eV. Microanalyses were performed on a Perkin-Elmer 240B elemental analyser. Column chromatography was carried out on Merck Kieselgel (particle size 0.063-0.200).

Preparation of starting materials. 1-Methylindole-3-carbaldehyde was prepared by methylation of indole-3-carbaldehyde according to known procedure.[12] C-(1-Methylindol-3-yl)-N-methyl-nitrone (**1**) was prepared from 1-methylindole-3-carbaldehyde, N-methyl-hydroxylamine hydrochloride and sodium carbonate in ethanol according to the procedure previouly described[3b] for the 2-isomer; m.p. 148-150°C (from hexane / methylene chloride). IR (Nujol), cm^{-1} : 1550 (C=N) . ^{1}H NMR δ : 3.85 and 3.89 (two s, 6H, N-CH_3, 1-CH_3), 7.20-7.39 (m, 3H, 5,6,7-H), 7.65 (d, 1H, J = 8.0 Hz, 4-H), 7.73 (s, 1H, 2-H), 8.89 (s, 1H, C<u>H</u>=N(O)CH_3). ^{13}C NMR, δ: 33.2 (1-CH_3), 52.1 (N(O)CH_3), 106.5 (C-3), 110.0 (C-7), 117.8, 120.7, 122.8 (C-4, C-5, C-6), 126.7, 129.0 (C-2, C-3a), 133.3 (<u>C</u>H=N(O)CH_3), 136.4 (C-7a). MS m/z: 188 (M^+, 100%). Anal. Calcd for $C_{11}H_{12}N_2O$: C, 70.19; H, 6.43; N, 14.88. Found: C, 69.89; H, 6.28; N, 14.70.

1,3-Dipolar Cycloaddition Reactions. General Procedure. A solution of the nitrone **1** (2mmol) and the dipolarophile **2** (4mmol) in benzene (10ml) was refluxed until the quantity of the unreacted starting nitrone

was not essentially changed, monitored by TLC (8-12h). In the case of methyl acrylate, the solvent was the dipolarophile itself, used in excess (3ml). After evaporation of the solvent, the reaction mixture was separated by column chromatography, using mixtures of hexane / ethyl acetate (3 : 1 - 1 : 1) as the eluent.

Reaction of ***1*** *with* ***2a***. From the column chromatography there were obtained in order of elution: a) *(3R*,4S*,5S*)-4,5-bis(methoxycarbonyl)-2-methyl-3-(1'-methylindol-3'-yl)isoxazolidine (**4a**),* yield 50%, m.p. 93-95°C from hexane / methylene chloride. IR (Nujol) cm^{-1}: 1735 (CO). ^1H NMR, δ: 2.66 (s, 3H, 2-CH_3), 3.68 (s, 3H, $COOCH_3$), 3.77 (s, 3H, 1'-CH_3), 3.89 (s, 3H, $COOCH_3$), 4.07-4.13 (m, 2H, 3-H, 4-H), 4.94 (d, J = 3.9 Hz, 1H, 5-H), 7.11-7.16 (superimposed s and t, 2H, 2'-H, 5'-H), 7.22-7.33 (m, 2H, 6'-H, 7'-H), 7.68 (d, J = 7.9 Hz, 1H, 4'-H). ^{13}C NMR, δ : 32.8 (1'-CH_3), 42.9 (2-CH_3), 52.4 (OCH_3), 52.8 (OCH_3), 58.1 (C-4), 70.0 (C-3), 77.3 (C-5), 108.9 (C-3'), 109.4 (C-7'), 119.5, 119.7, 122.0 (C'-4, C'-5, C'-6), 126.4 (C-3'a), 128.0 (C'-2), 137.3 (C-7'a), 171.9 (two CO). MS m/z: 332 (M^+, 31%), 286 (7), 226(5), 188 (100), 144 (4). Anal. Calcd for $C_{17}H_{20}N_2O_5$: C, 61.43; H, 6.07; N, 8.43. Found: C, 61.64; H, 6.23; N, 8.28. b) *(3R*,4R*,5R*)-4,5-bis(methoxycarbonyl)-2-methyl-3-(1'-methylindol-3'-yl)isoxazolidine (**3a**).* Compound **3a** was obtained as an oily mixture with **4a** (2 : 1) in 5% yield , determined from ^1H NMR. ^1H NMR, δ: 2.75 (s, 3H, 2-CH_3), 3.12 (s, 3H, $COOCH_3$), 3.75 (s, 3H, 1'-CH_3), 3.82 (superimposed s and m, 4H, $COOCH_3$, 4-H), 4.40 (d broad, 1H, 3-H,), 5.21 (d, J = 6.7 Hz, 1H, 5-H), 7.06 (s, 1H, 2'-H), 7.09-7.32 (m, 3H, 5'-H, 6'-H, 7'-H), 7.62 (d, J = 7.9 Hz, 1H, 4'-H). ^{13}C NMR, δ : 32.8 (1'-CH_3), 43.9 (2-CH_3), 51.6 (OCH_3), 52.6 (OCH_3), 56.5 (C-4), 68.2 (C-3), 77.2 (C-5), 106.3 (C-3'), 109.2 (C-7'), 119.1, 119.3, 121.8 (C'-4, C'-5, C'-6), 127.0 (C-3'a), 127.6 (C'-2), 136.7 (C-7'a), 170.4 (two CO).

Reaction of ***1*** *with* ***2b***. From the column chromatography there were obtained in order of elution: a) *(3R*,4S*,5R*)-4,5-bis(methoxycarbonyl)-2-methyl-3-(1'-methylindol-3'-yl)isoxazolidine (**3b**),* yield 46%, m.p. 92-94°C from hexane/ methylene chloride. IR (Nujol) cm^{-1}: 1725 (CO). ^1H NMR, δ: 2.74 (s, 3H, 2-CH_3), 3.62 (s, 3H, $COOCH_3$), 3.76 (s, 3H, 1'-CH_3), 3.79 (s, 3H, $COOCH_3$), 3.98 (t, ΣJ = 18.2 Hz, 1H, 4-H), 4.23 (d broad, 1H, 3-H), 5.02 (d, J = 9.2 Hz, 1H, 5-H), 7.10 (s , 1H, 2'-H), 7.13 (t, ΣJ = 14.6 Hz, 1H, 5'-H), 7.25 (t, ΣJ = 14.8, 1H, 6'-H), 7.31 (d, J = 8.1 Hz, 1H, 7'-H), 7.73 (d, J = 7.9 Hz, 1H, 4'-H). ^{13}C NMR, δ : 32.7 (1'-CH_3), 43.0 (2-CH_3), 52.1 (OCH_3), 52.3 (OCH_3), 58.1 (C-4), 69.7 (C-3), 76.8 (C-5), 108.8 (C-3'), 109.5 (C-7'), 119.5, 119.7, 122.0 (C'-4, C'-5, C'-6), 126.3 (C-3'a), 127.8 (C'-2), 137.3 (C-7'a), 169.1 (CO), 170.8 (CO). MS m/z: 332 (M^+, 100%), 286 (80), 226 (45), 188 (97), 144 (23). Anal. Calcd for $C_{17}H_{20}N_2O_5$: C, 61.43; H, 6.07; N, 8.43. Found: C, 61.60; H, 6.17; N, 8.74. b) *(3R*,4R*,5S*)-4,5-bis(methoxycarbonyl)-2-methyl-3-(1'-methylindol-3'-yl)isoxazolidine (**4b**)* , yield 28%, m.p. 138-142°C from hexane / methylene chloride. IR (Nujol) cm^{-1}: 1740, 1730 (CO). ^1H NMR, δ: 2.73 (s, 3H, 2-CH_3), 3.20 (s, 3H, $COOCH_3$), 3.75 (s, 3H, 1'-CH_3), 3.79 (s, 3H, $COOCH_3$), 4.15 (t broad, 1H, 4-H), 4.33 (d broad, 1H, 3-H), 4.96 (d, J = 8.7 Hz, 1H, 5-H), 7.09 (s , 1H, 2'-H), 7.14 (t, ΣJ = 14.8 Hz, 1H, 5'-H), 7.20-7.32 (m, 2H, 6'-H, 7'-H), 7.62 (d, J = 7.9 Hz, 1H, 4'-H). ^{13}C NMR, δ : 32.5 (1'-CH_3), 43.5 (2-CH_3), 51.2 (OCH_3), 51.9 (OCH_3), 56.9 (C-4), 68.6 (C-3), 75.5 (C-5), 106.1 (C-3'), 109.0 (C-7'), 118.5, 119.1, 121.6 (C'-4, C'-5, C'-6), 127.0 (C-3'a), 127.4 (C'-2), 136.3 (C-7'a), 169.6 (two CO). MS m/z: 332 (M^+, 100%), 286 (50), 226 (89), 188 (49), 144 (23). Anal. Calcd for $C_{17}H_{20}N_2O_5$: C, 61.43; H, 6.07; N, 8.43. Found: C, 61.60; H, 6.06; N, 8.28.

*Reaction of **1** with **2c***. From the column chromatography there were isolated in order of elution a) 240mg mixture of **4c**, **5c**, **6c** in relative ratio 1.3 : 2.2 : 1 (^{1}H NMR integration) b) 93mg mixture of **3c**, **4c**, **6c** in relative ratio 2.6 : 1 : 1.1 (^{1}H NMR integration) c) 167 mg of **3c**. By repeated chromatographies of fraction (a), compounds **5c** and **6c** were separated whereas the assignment of **4c** was made only from its mixture. *(3R*,5R*)-5-methoxycarbonyl-2-methyl-3-(1'-methylindol-3'-yl)isoxazolidine (**3c**)*, yield 40%, brown oil. IR (Neat) cm^{-1}: 1740 (CO). ^{1}H NMR, δ: 2.74 (s broad, 3H, 2-CH_3), 2.75-2.90 (m, 2H, 4-H), 3.75 (s, 3H, 1'-CH_3), 3.81 (s, 3H, $COOCH_3$), 4.07 (broad, 1H, 3-H), 4.77 (dd, J =5.4, 9.2 Hz, 1H, 5-H), 7.06 (s , 1H, 2'-H), 7.13 (t, ΣJ = 14.7 Hz, 1H, 5'-H), 7.24 (t, ΣJ = 15.0 Hz, 1H, 6'-H), 7.31 (d, J = 8.2 Hz, 1H, 7'-H), 7.71 (d, J = 7.9 Hz, 1H, 4'-H). ^{13}C NMR (50°C), δ : 32.6 (1'-CH_3), 41.2 (C-4), 43.5 (2-CH_3), 52.1 (OCH_3), 64.7 (C-3), 75.5 (C-5), 109.4 (C-7'), 111.1 (C-3'), 119.3, 119.5, 122.0 (C'-4, C'-5, C'-6), 126.7 (C-3'a), 127.0 (C'-2), 137.4 (C-7'a), 171.9 (CO). MS m/z: 274 (M^+, 66%), 228 (100), 188 (40). Anal. Calcd for $C_{15}H_{18}N_2O_3$: C, 65.67; H, 6.68; N, 10.21. Found: C, 65.41; H, 6.48; N, 10.11. *(3R*,5S*)-5-methoxycarbonyl-2-methyl-3-(1'-methylindol-3'-yl)isoxazolidine (**4c**)*, yield 18%.. ^{1}H NMR, δ: 2.67 (s, 3H, 2-CH_3), 2.77-3.02 (m, 2H, 4-H), 3.75 (s, 3H, 1'-CH_3), 3.83 (s, 3H, $COOCH_3$), 4.09 (broad, 1H, 3-H), 4.69 (dd, J = 5.1, 9.1 Hz, 1H, 5-H), 7.08 (s , 1H, 2'-H), 7.12-7.33 (m, 3H, 5'-H, 6'-H, 7'-H), 7.68 (d, J = 7.9 Hz, 1H, 4'-H). ^{13}C NMR , δ : 32.7 (1'-CH_3), 41.3 (C-4), 43.1 (2-CH_3), 52.3 (OCH_3), 65.9 (C-3), 74.2 (C-5), 109.4 (C-7'), 110.3 (C-3'), 119.4, 119.8, 121.9 (C'-4, C'-5, C'-6), 127.3 (C'-2), 137.2 (C-7'a), 173.2 (CO). The signal for the C-3'a was not detected. *(3R*,4R*)-4-methoxycarbonyl-2-methyl-(1'-methylindol-3'-yl)isoxazolidine (**5c**)*, yield 21%, yellow oil. IR (Neat) cm^{-1}: 1735 (CO). ^{1}H NMR, δ: 2.65 (s broad, 3H, 2-CH_3), 3.67 (s, 3H, $COOCH_3$), 3.76 (s, 3H, 1'-CH_3), 4.27 (dd, J = 4.5, 8.5 Hz, 1H, 5-H), 4.35 (t, J = 8.5 Hz, 1H, 5-H), 7.12-7.33 (m , 4H, 2'-H, 5'-H, 6'-H, 7'-H), 7.75 (d, J = 7.9 Hz, 1H, 4'-H). The signals of 3-H and 4-H probably broads were not detected.^{13}C NMR , δ : 32.7 (1'-CH_3), 43.4 (2-CH_3), 52.1 (OCH_3), 55.4 (C-4), 68.5 (C-5), 69.5 (C-3), 109.4 (C-7'), 110.2 (C-3'), 119.4, 119.8, 121.9 (C'-4, C'-5, C'-6), 126.3 (C-3'a), 127.6 (C'-2), 137.4 (C-7'a), 173.2 (CO). MS m/z: 274 (M^+, 98%), 228 (95), 188 (100). Anal. Calcd for $C_{15}H_{18}N_2O_3$: C, 65.67; H, 6.68; N, 10.21. Found: C, 65.44; H, 6.41; N, 10.11. *(3R*,4S*)-4-methoxycarbonyl-2-methyl-3-(1'-methylindol-3'-yl)isoxazolidine (**6c**)*, yield 14%, yellow oil. IR (Neat) cm^{-1}: 1730 (CO). ^{1}H NMR, δ: 2.67 (s broad, 3H, 2-CH_3), 3.08 (s, 3H, $COOCH_3$), 3.67-3.97 (superimposed s and m 4H, 1'-CH_3 and 4-H), 4.26 (superimposed t and m, 2H, 3-H, 5-H), 4.46 (t, ΣJ = 16.8 Hz, 1H, 5-H), 7.06 (s, 1H, 2'-H), 7.09-7.29 (m , 3H, 5'-H, 6'-H, 7'-H), 7.63 (d, J = 7.9 Hz, 1H, 4'-H). ^{13}C NMR , δ : 32.8 (1'-CH_3), 43.7 (2-CH_3), 51.2 (OCH_3), 53.1 (C-4), 67.8 (C-5), 67.9 (C-3), 109.1 (C-7'), 109.4 (C-3'), 119.1, 119.2, 121.7 (C'-4, C'-5, C'-6), 127.1 (C-3'a), 127.7 (C'-2), 136.7 (C-7'a), 171.6 (CO). MS m/z: 274 (M^+, 100%), 228 (78), 188 (90). Anal. Calcd for $C_{15}H_{18}N_2O_3$: C, 65.67; H, 6.68; N, 10.21. Found: C, 65.39; H, 6.48; N, 10.11.

*Reaction of **1** with **2d***. From the column chromatography there were isolated in order of elution: a) *(3R*,5R*)-5-Acetyl-2-methyl-3-(1'-methylindol-3'-yl)isoxazolidine (**3d**)*, yield 30%, oil. IR (Neat) cm^{-1}: 1710 (CO). ^{1}H NMR, δ: 2.43 (s, 3H, $COCH_3$), 2.64 (s , 3H, 2-CH_3), 2.66-2.86 (m, 2H, 4-H), 3.69 (s, 3H, 1'-CH_3), 3.75 (t, J = 8.9 Hz, 1H, 3-H), 4.39 (dd, J = 4.9, 9.8 Hz, 1H, 5-H), 6.99 (s , 1H, 2'-H), 7.09 (t, ΣJ = 14.8 Hz, 1H, 5'-H), 7.21 (t, ΣJ = 14.8 Hz, 1H, 6'-H), 7.26 (d, J = 7.9 Hz, 1H, 7'-H), 7.59 (d, J = 7.9 Hz, 1H, 4'-H). ^{13}C NMR , δ : 25.3 ($COCH_3$), 32.5 (1'-CH_3), 40.0 (C-4), 43.0 (2-CH_3), 65.4 (C-3), 80.5 (C-5), 109.3 (C-7'), 110.4 (C-3'), 119.1, 119.2, 121.7 (C'-4, C'-5, C'-6), 126.4 (C-3'a), 127.3 (C'-2), 137.1 (C-7'a), 212.3 (CO). MS m/z: 258 (M^+, 64%), 212 (69), 188 (11). b) *(3R*,5S*)-5-Acetyl-2-methyl-3-(1'-methylindol-3'-yl)isoxazolidine (**4d**)*, yield 42%, brown oil. IR (Neat) cm^{-1}: 1710 (CO).

^{1}H NMR, δ: 2.28 (s,3H, $COCH_3$), 2.55-2.85 (superimposed s and m, 5H, 2-CH_3 and 4-H), 3.69 (s, 3H, 1'-CH_3), 3.83 (broad, 1H, 3-H), 4.64 (broad t, ΣJ = 15.2 Hz, 1H, 5-H), 7.02 (s , 1H, 2'-H), 7.10 (t, ΣJ = 14.7 Hz, 1H, 5'-H), 7.21 (t, ΣJ = 14.9 Hz, 1H, 6'-H), 7.27 (d, J = 8.1 Hz, 1H, 7'-H), 7.70 (d, J = 7.9 Hz, 1H, 4'-H). ^{13}C NMR , δ : 26.3 ($COCH_3$), 32.4 (1'-CH_3), 40.0 (C-4), 43.6 (2-CH_3), 65.2 (C-3), 81.2 (C-5), 109.3 (C-7'), 110.7 (C-3'), 119.1, 119.3, 121.7 (C'-4, C'-5, C'-6), 126.3 (C-3'a), 127.0 (C'-2), 137.0 (C-7'a), 207.1 (CO). MS m/z: 258 (M^+, 12%), 212 (15), 188 (6). c) *(3R*,4S*)-4-Acetyl-2-methyl-3-(1'-methylindol-3'-yl)isoxazolidine* ***(6d)***, yield 20%, m.p 90-92°C (from hexane / methylene chloride. IR (Nujol) cm^{-1}: 1700 (CO). ^{1}H NMR, δ: 2.06 (s, 3H, $COCH_3$), 2.62 (s, 3H, 2-CH_3), 3.79 (s, 3H, 1'-CH_3), 3.80-4.00 (m, 2H, 3-H and 4-H), 4.28-4.31 (m, 2H, 5-H), 7.13-7.34 (m , 4H, 2'-H, 5'-H, 6'-H, 7'-H), 7.77 (d, J = 8.9 Hz, 1H, 4'-H). ^{13}C NMR , δ : 29.9 ($COCH_3$), 32.8 (1'-CH_3), 43.0 (2-CH_3), 63.2, 67.4, 69.0 (C-3, C-4, (C-5), 109.6 (C-7'), 110.7 (C-3'), 119.5, 119.9, 122.2 (C'-4, C'-5, C'-6), 126.3 (C-3'a), 127.8 (C'-2), 137.5 (C-7'a), 206.3 (CO). MS m/z: 258 (M^+, 100%), 212 (40), 188 (88). Anal. Calcd for $C_{15}H_{18}N_2O_2$: C, 69.74; H, 7.02; N, 10.84. Found: C, 69.54; H, 6.90; N, 10.71. Analytical samples for **3d**, **4d** could not be accomplished because of their instability.

Reduction Reactions. General Procedure. To a solution of isoxazolidine (0.5 mmol) in methanol (5ml) a catalytic amount (a spatula tip, estimated 20mg) of W-2 Raney nickel was added. A balloon, filled with hydrogen was adapted to the reaction flask by means of a three way stopcock. After repeated evacuations and flushings with hydrogen gas, the reaction mixture was stirred under hydrogen atmosphere for 1-2 h at room temperature. Nickel was separated by careful filtration through Celite and washed several times with methanol and dichloromethane. The combined filtrate and washings were concetrated under *vacuo* and the residue was dissolved in dichloromethane and dried over sodium sulfate. After filtration and evaporation of the solvent the residue was recrystallized or was subjected to column chromatography with hexane / ethyl acetate 1 : 1 as the eluent.

Reduction of ***4a***. There was obtained *(3R*,4R*,5S*)-3-hydroxy-4-methoxycarbonyl-5-(1'-methylindol-3'-yl)pyrrolidin-2-one* ***(10a)***, yield 90%, m.p. 185-187°C from chloroform / ethyl ether. IR (Nujol) cm^{-1}: 3220 (OH), 1740 (CO), 1655 (CO). ^{1}H NMR, δ: 2.78 (s, 3H, 1-CH_3), 3.55 (dd, J = 7.6, 6.2 Hz, 1H, 4-H), 3.74 (s, 3H, OCH_3), 3.78 (s, 3H, 1'-CH_3), 4.29 (d, J = 4.1 Hz, 1H, OH, removed with D_2O), 4.76 (dd, J = 4.1, 7.6 Hz, 1H, 3-H), 5.30 (d, J = 6.2 Hz, 1H, 5-H), 7.07 (s, 1H, 2'-H), 7.10-7.33 (m , 3H, 5'-H, 6'-H, 7'-H), 7.43 (d, J = 7.9 Hz, 1H, 4'-H). ^{13}C NMR , δ : 28.3 (1-CH_3), 32.9 (1'-CH_3), 51.2, 52.2, 57.8 (C-4, C-5, OCH_3), 70.2 (C-3), 109.9 (C-7'), 110.7 (C-3'), 118.6, 119.9, 122.4 (C'-4, C'-5, C'-6), 125.4 (C-3'a), 128.1 (C'-2), 137.7 (C-7'a), 170.0 (CO), 172.3 (CO). MS m/z: 302 (M^+, 15%). Anal. Calcd for $C_{16}H_{18}N_2O_4$: C, 63.57; H, 6.00; N, 9.27. Found: C, 63.41; H, 5.81; N, 9.11.

Reduction of ***3a***. The reduction was carried out on a mixture of **3a** and **4a** in a ratio 2 : 1. The produced **8a** and **10a** were separated by column chromatography. *(3R*,4R*,5R*)-3-hydroxy-4-methoxycarbonyl-5-(1'-methylindol-3'-yl)pyrrolidin-2-one* ***(8a)*** *was eluted second*, yield 90% (calculated on the amount of **3a**), m.p. 197-199°C from chloroform / ethyl ether. IR (Nujol) cm^{-1}: 3220 (OH), 1730 (CO), 1650 (CO). ^{1}H NMR, δ: 2.81 (s, 3H, 1-CH_3), 3.23 (s, 3H, OCH_3), 3.67 (t, J = 7.1 Hz, 1H, 4-H), 3.78 (s, 3H, 1'-CH_3), 3.95 (d, J = 4.4 Hz, 1H, OH, removed with D_2O), 4.60 (dd, J = 4.4, 7.1 Hz, 1H, 3-H), 5.19 (d, J = 7.1 Hz, 1H, 5-H), 7.10 (s,

1H, 2'-H), 7.12-7.34 (m , 3H, 5'-H, 6'-H, 7'-H), 7.56 (d, J = 7.9 Hz, 1H, 4'-H). ^{13}C NMR , δ : 28.6 (1-CH_3), 33.0 (1'-CH_3), 49.4, 51.6, 55.9 (C-4, C-5, OCH_3), 70.7 (C-3), 108.1 (C-3'), 109.6 (C-7'), 118.8, 119.7, 122.0 (C'-4, C'-5, C'-6), 126.9 (C-3'a), 128.5 (C'-2), 136.9 (C-7'a), 170.7 (CO), 172.3 (CO). MS m/z: 302 (M^+, 25%). Anal. Calcd for $C_{16}H_{18}N_2O_4$: C, 63.57; H, 6.00; N, 9.27. Found: C, 63.83; H, 5.70; N, 8.92.

Reduction of ***3b***. There was obtained *(3R*,4S*,5R*)-3-hydroxy-4-methoxycarbonyl-5-(1'-methylindol-3'-yl)pyrrolidin-2-one* ***(8b)***, yield 90%, m.p. 206-208°C from chloroform / ethyl ether. IR (Nujol) cm^{-1}: 3240 (OH), 1730 (CO), 1665 (CO). ^{1}H NMR, δ: 2.68 (s, 3H, 1-CH_3), 3.50 (t, J = 8.5 Hz, 1H, 4-H), 3.69 (s, 3H, OCH_3), 3.78 (s, 3H, 1'-CH_3), 4.75 (dd, J = 3.3, 8.5 Hz, 1H, 3-H), 4.97 (d, J = 8.5 Hz, 1H, 5-H), 5.27 (d, J = 3.3 Hz, 1H, OH, removed with D_2O), 7.08-7.14 (m, 2H, 2'-H, 5'-H), 7.26 (t, ΣJ = 16 Hz, 1H, 6'-H), 7.34 (d, J = 8.1 Hz, 1H, 7'-H), 7.58 (d, J = 7.9 Hz, 1H, 4'-H). ^{13}C NMR , δ : 28.0 (1-CH_3), 32.8 (1'-CH_3), 52.4, 54.1, 56.4 (C-4, C-5, OCH_3), 72.7 (C-3), 109.7 (C-7'), 110.0 (C-3'), 119.0, 120.0, 122.3 (C'-4, C'-5, C'-6), 125.5 (C-3'a), 128.6 (C'-2), 137.6 (C-7'a), 172.3 (CO), 172.8 (CO). MS m/z: 302 (M^+, 58%). Anal. Calcd for $C_{16}H_{18}N_2O_4$: C, 63.57; H, 6.00; N, 9.27. Found: C, 63.61; H, 6.15; N, 9.34.

Reduction of ***4b*** . There was obtained *(3R*,4S*,5S*)-3-hydroxy-4-methoxycarbonyl-5-(1'-methylindol-3'-yl)pyrrolidin-2-one* ***(10b)***, yield 98%, m.p. 218-220°C from chloroform / ethyl ether. IR (Nujol) cm^{-1}: 3280 (OH), 1730 (CO), 1665 (CO). ^{1}H NMR, δ: 2.84 (s, 3H, 1-CH_3), 3.22 (s, 3H, OCH_3), 3.42 (broad, 1H, OH, removed with D_2O), 3.57 (t, J = 8.6 Hz, 1H, 4-H), 3.75 (s, 3H, 1'-CH_3), 5.02 (d, J = 8.6, 1H, 3-H), 5.23 (d, J = 8.6 Hz, 1H, 5-H), 6.82 (s, 1H, 2'-H), 7.05-7.35 (m, 3H, 5'-H, 6'-H, 7'-H), 7.47 (d, J = 7.7 Hz, 1H, 4'-H). ^{13}C NMR , δ : 28.8 (1-CH_3), 33.0 (1'-CH_3), 51.7, 52.3, 55.3 (C-4, C-5, OCH_3), 69.9 (C-3), 108.5 (C-2'), 109.6 (C-7'), 118.7, 119.8, 122.1 (C'-4, C'-5, C'-6), 126.4 (C-3'a), 127.1 (C'-2), 137.2 (C-7'a), 169.6 (CO), 172.9 (CO). MS m/z: 302 (M^+, 9%). Anal. Calcd for $C_{16}H_{18}N_2O_4$: C, 63.57; H, 6.00; N, 9.27. Found: C, 63.61; H, 6.11; N, 9.31.

Reduction of ***3c***. There was obtained *(3R*,5R*)-3-hydroxy-5-(1'-methylindol-3'-yl)pyrrolidin-2-one* ***(8c)***, yield 92%, m.p. 191-193°C from chloroform / ethyl ether. IR (Nujol) cm^{-1}: 3230 (OH), 1660 (CO). ^{1}H NMR, δ: 2.31 (dt, J = 13.1, 9.0, 1H, 4-H), 2.65 (s, 3H, 1-CH_3), 2.83 (ddd, J = 13.1, 9.0, 6.6 Hz, 1H, 4-H), 3.50 (broad, 1H, OH, removed with D_2O), 3.77 (s, 3H, 1'-CH_3), 4.51 (t, J = 9 Hz, 1H, 3-H), 4.72 (dd, J = 9.0, 6.6 Hz, 1H, 5-H), 7.07 (s, 1H, 2'-H), 7.11 (t, ΣJ = 14.7, 1H, 5'-H,), 7.25 (t, ΣJ = 15 Hz, 1H, 6'-H), 7.33 (d, J = 8.1 Hz, 1H, 7'-H), 7.60 (d, J = 7.8 Hz, 1H, 4'-H). ^{13}C NMR , δ: 27.9 (1-CH_3), 32.7 (1'-CH_3), 36.6 (C-4), 53.7 (C-5), 69.7 (C-3), 109.6 (C-7'), 112.0 (C-3'), 119.1, 119.8, 122.2 (C'-4, C'-5, C'-6), 126.0 (C-3'a), 128.0 (C'-2), 137.5 (C-7'a), 175.2 (CO). MS m/z: 244 (M^+, 22%). Anal. Calcd for $C_{14}H_{16}N_2O_2$: C, 68.83; H, 6.60; N, 11.47. Found: C, 68.89; H, 6.53; N, 11.42.

Reduction of ***4c***. The reduction was carried out on a mixture of **4c, 5c, 6c** in a ratio 1.3 : 2.2 : 1. From the reduction mixture there was separated as the first fraction *(3R*,5S*)-3-hydroxy-5-(1'-methylindol-3'-yl)pyrrolidin-2-one* ***(10c)***, yield 90% (calculated on the amount of **4c**), m.p. 192-194°C from chloroform / ethyl ether. IR (Nujol) cm^{-1}: 3280 (OH), 1665 (CO). ^{1}H NMR, δ: 2.40-2.58 (m, 2H, 4-H), 2.79 (s, 3H, 1-CH_3), 3.77 (s, 3H, 1'-CH_3), 3.95 (broad, 1H, OH, removed with D_2O), 4.66 (t, J = 7.1 Hz, 1H, 3-H), 4.97 (dd, J = 8.0, 4.1 Hz, 1H, 5-H), 6.92 (s, 1H, 2'-H), 7.12 (t, ΣJ = 15.7, 1H, 5'-H,), 7.27 (t, ΣJ = 16 Hz, 1H, 6'-H), 7.33 (d, J = 8.1 Hz, 1H, 7'-H), 7.45

(d, J = 7.8 Hz, 1H, 4'-H). ^{13}C NMR , δ : 28.5 (1-CH_3), 32.8 (1'-CH_3), 36.4 (C-4), 55.1 (C-5), 69.5 (C-3), 109.7 (C-7'), 113.3 (C-3'), 118.5, 119.7, 122.3 (C'-4, C'-5, C'-6), 125.7 (C-3'a), 126.6 (C'-2), 137.6 (C-7'a), 174.9 (CO). MS m/z: 244 (M^+, 42%). Anal. Calcd for $C_{14}H_{16}N_2O_2$: C, 68.83; H, 6.60; N, 11.47. Found: C, 69.00; H, 6.70; N, 11.60.

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