1,3-Dipolar Cycloaddition on Baylis–Hillman Adducts: Novel Synthesis of Pyrrolidines, Spiropyrrolidines, and Spiropyrrolizidines

Manickam Bakthadoss,*[a] Nagappan Sivakumar,[a] Anthonisamy Devaraj,[a] Duddu S. Sharada[b]

[a] Dept. of Organic Chemistry, University of Madras, Guindy Campus, Chennai 600 025, India
Fax +91(44)22352494; E-mail: bhakthadoss@yahoo.com

[b] Organic Chemistry Division, Central Leather Research Institute, Adyar, Chennai 600 020, Tamil Nadu, India

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Abstract: A facile regio- and stereoselective synthesis of functionalized pyrrolidines, spiropyrrolidines, and spiropyrrolizidines using the Baylis–Hillman adducts derived from nitroolefins via intermolecular [3+2]-cycloaddition reaction is reported.

Key words: Baylis–Hillman reaction, intermolecular [3+2] cycloaddition, azomethine ylides, 1,3-dipolar cycloaddition, pyrrolidines, spiro compounds

The Baylis–Hillman reaction has become a useful and popular synthetic tool for obtaining diverse classes of densely functionalized molecules usually referred to as the Baylis–Hillman (BH) adducts; the reaction occurs through an atom-economical carbon–carbon bond-forming reaction which involves coupling of the α-position of an activated alkene with an electrophile under the influence of a catalyst/catalytic system.[1,2] Due to the multifunctionality of Baylis–Hillman adducts they represent valuable starting materials for a variety of novel classes of organic compounds. Applications of Baylis–Hillman adducts in a variety of organic transformations and also in the synthesis of natural products and unnatural bioactive skeletons have been well documented over the last few years.[3,4]

The synthesis of nitrogen- and oxygen-containing heterocycles continues to be an important and challenging area in the field of organic chemistry.[5–8] The 1,3-dipolar cycloaddition reaction is one of the most important and useful methods for the preparation of five-membered heterocycles. Though various methods[9] are available, the 1,3-dipolar cycloaddition of azomethine ylides to alkenes is one of the most efficient and expedient synthetic protocols for the construction of highly substituted pyrrolidine and spiropyrrolidine rings.

The synthesis of pyrrolidine-based heterocycles has been the center of attraction for the past several decades because it constitutes an important class of substances with highly pronounced biological activity.[9] Nitropyrrolidines are effective precursors for the synthesis of cephalotaxus alkaloids and potentially useful as sources of conformationally restricted analogues of dopamine.[10] The pyrrolidine and spiropyrrolidine frameworks are integral part of many natural products such as horsfiline (**1**),[11a] pteropodine (**2**),[11b] strychnofoline (**3**),[11c] spirotryprostatin A (**4**),[11d] gelsemine (**5**),[11e] alstonisine (**6**),[11f] etc. (Figure 1). In addition, oxindoles derivatives, in particular 3-spirooxindoles, are the central skeleton of numerous alkaloids and are elegant targets in organic synthesis due to their significant biological activity.[12] The spiropyrrolidines also possess anticancer, antimicrobial, antibiotic, and antineoplastic properties.[13–15]

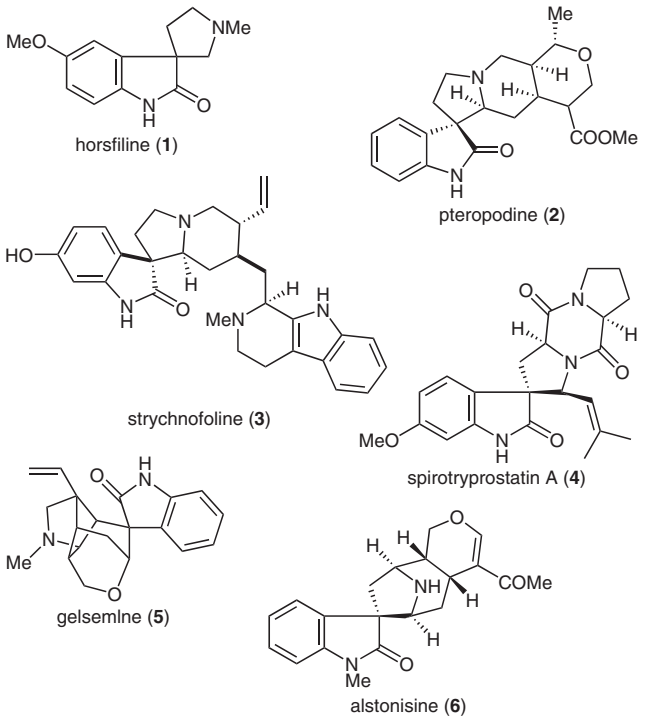

Figure 1

Utilizing the azomethine ylide based [3+2]-cycloaddition reaction, a variety of spiropyrrolidines have been reported in the literature.[16] In the Baylis–Hillman reaction, electron-deficient olefins are utilized although nitroolefins have only been used as the activated olefinic component in a couple of reports.[17]

We envisaged that the novel class of β-substituted Baylis–Hillman adducts **7** derived from β-aryl nitroolefins would be a useful starting material for the construction of pyrrolidine, spiropyrrolidine, and spiropyrrolizidine compounds via an azomethine ylide based [3+2] cycload-

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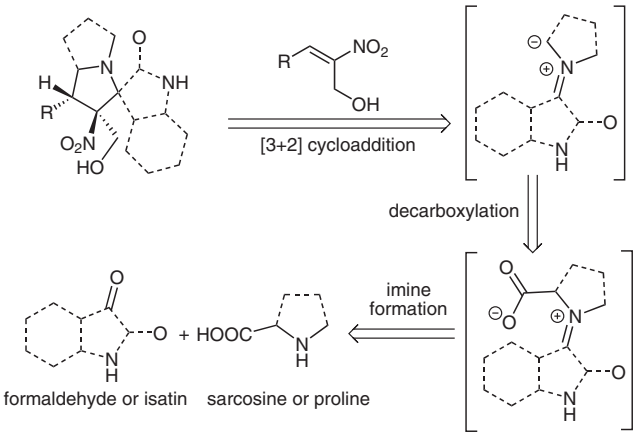
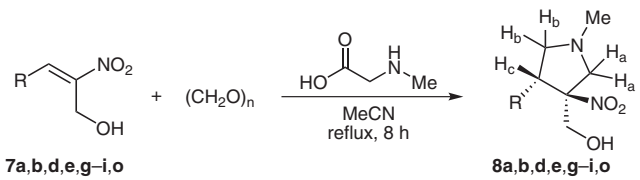
dition. It is well documented in the literature that Baylis–Hillman adducts have been utilized for the synthesis of various heterocycles.[1–4] Even though various reports are available, the synthesis of heterocyclic spiro compounds using Baylis–Hillman adducts derived from nitroolefins was not known to date with the exception of our initial report.[18d]

In continuation of our interest in the field of Baylis–Hillman chemistry,[18] we herein report a simple and convenient route for the regio- and stereoselective synthesis of pyrrolidine, spiropyrrolidine, and spiropyrrolizidine frameworks using the Baylis–Hillman adducts derived from nitroolefins with sarcosine/proline-based dipoles generated via in situ imine formation, decarboxylation, and intermolecular [3+2] cycloaddition as shown below in the retrosynthetic strategy (Scheme 1).



Scheme 1

(*E*)-2-Nitro-3-phenylprop-2-en-1-ol (**7a**), a Baylis–Hillman adduct derived from nitrostyrene, was used as a starting material for the [3+2]-cycloaddition reaction with dipoles generated from sarcosine (*N*-methylglycine) with paraformaldehyde. Best results were obtained when **7a** was treated with paraformaldehyde and sarcosine without a catalyst with acetonitrile as the solvent for eight hours at reflux temperature, which successfully provided the desired pyrrolidine compound **8a** in very good yield (76%) after the usual workup followed by column chromatography. Compound **8a** was characterized by IR, ^{1}H and ^{13}C NMR, mass spectrometry, and elemental analyses (Scheme 2).



7a,**b**,**d**,**e**,**g**–**i**,**o** **8a**,**b**,**d**,**e**,**g**–**i**,**o**

R = Ph, 2-naphthyl, 4-MeC$_6$H$_4$, 4-EtC$_6$H$_4$, 2-MeOC$_6$H$_4$, 4-MeOC$_6$H$_4$, 3,4-(MeO)$_2$C$_6$H$_3$, 2-thienyl

Scheme 2

Encouraged by this result, we prepared a variety of (*E*)-3-aryl-2-nitroprop-2-en-1-ols **7b**,**d**,**e**,**g**–**i**,**o** as starting materials for the preparation of various pyrrolidine compounds. Treatment of these Baylis–Hillman adducts with paraformaldehyde and sarcosine in acetonitrile for eight hours at reflux temperature led to the desired pyrrolidine compounds **8b**,**e**,**g**–**i**,**o** in 69–80% yields (Scheme 2). The results are summarized in Table 1.

Table 1 Synthesis of Pyrrolidine Compounds from Baylis–Hillman Adducts **8a**,**b**,**d**,**e**,**g**–**i**,**o**

BH adduct	R	Product[a,b]	Yield[c] (%)
7a	Ph	**8a**	76
7b	2-naphthyl	**8b**	74
7d	4-MeC$_6$H$_4$	**8d**[d]	80
7e	4-EtC$_6$H$_4$	**8e**	70
7g	2-MeOC$_6$H$_4$	**8g**	75
7h	4-MeOC$_6$H$_4$	**8h**	73
7i	3,4-(MeO)$_2$C$_6$H$_3$	**8i**	69
7o	2-thienyl	**8o**	75

[a] Reaction conditions: Baylis–Hillman alcohol **7a**,**b**,**d**,**e**,**g**–**i**,**o** (2 mmol), sarcosine (3 equiv), paraformaldehyde (6 equiv), MeCN (8 mL), reflux, 8 h.
[b] All products gave satisfactory IR, ^{1}H (300 MHz) and ^{13}C NMR (75 MHz), MS, and elemental analyses.
[c] Yields of the pure products **8a**,**b**,**e**,**g**–**i**,**o** obtained after column chromatography (silica gel, 20% EtOAc–hexanes).
[d] Structure was further confirmed by single-crystal X-ray analysis.

The ^{1}H NMR spectrum of compound **8a** showed a singlet for NCH$_3$ proton at δ = 2.49 ppm and the hydroxy proton showed a broad singlet at δ = 2.85 ppm. The two H$_b$ protons of pyrrolidine ring appeared as triplets at δ = 2.93 and 3.27 ppm. The two H$_a$ protons of pyrrolidine ring appeared as doublets at δ = 3.65 and 3.70 ppm. The benzylic proton (H$_c$) was observed as a triplet at δ = 4.20 ppm. The C*H*$_2$OH protons appeared as doublets at δ = 2.99 and 3.55 ppm. The aromatic protons appeared in the region δ = 7.31–7.35 ppm.

The X-ray crystal structure analysis of compound **8d** showed that the relative stereochemistry (Figure 2) of the phenyl group and CH$_2$OH group in the vicinal positions is *cis*. Similarly the NO$_2$ group and benzylic proton also have a *cis* orientation.

To check the generality of the reaction we treated the nitro alcohols, i.e. (*E*)-3-aryl-2-nitroprop-2-en-1-ols **7a**,**c**–**f**,**h**–**n**, as starting materials for [3+2]-cycloaddition reactions with dipoles generated from sarcosine and isatin. Treatment of **7a**,**c**–**f**,**h**–**n** with isatin and sarcosine without a catalyst with acetonitrile as the solvent for five hours at reflux temperature provided the desired 3-spiropyrrolidine compounds **9a**,**c**–**f**,**h**–**n** in very good yields (60–82%) after usual workup followed by column chromatography (Table 2).

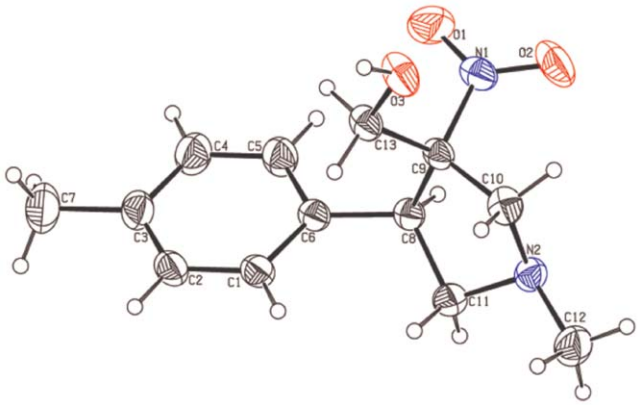


Figure 2 ORTEP diagram of **8d**

Table 2 Synthesis of 3-Spiropyrrolidine Compounds from the Baylis–Hillman Adducts **9a**,**c**–**f**,**h**–**n**

BH adduct	R	Product[a,b]	Yield[c] (%)
7a	H	**9a**[d]	82
7c	2-Me	**9b**	75
7d	4-Me	**9c**	76
7e	4-Et	**9e**	77
7f	4-*i*-Pr	**9f**	60
7h	4-OMe	**9h**	61
7i	3,4-$(OMe)_2$	**9i**	62
7j	3,4-OCH_2O	**9j**	60
7k	4-F	**9k**	64
7l	2-Cl	**9l**	80
7m	3-Cl	**9m**	64
7n	4-Cl	**9n**	70

[a] Reaction conditions: Baylis–Hillman alcohol **7a**,**c**–**f**,**h**–**n** (2 mmol), sarcosine (2 mmol), isatin (2 mmol), MeCN (8 mL), reflux, 5 h.
[b] All products gave satisfactory IR, ^{1}H (300 MHz) and ^{13}C NMR (75 MHz), MS, and elemental analyses.
[c] Yields of the pure products **9a**,**c**–**f**,**h**–**n** obtained after column chromatography (silica gel, 20% EtOAc–hexanes).
[d] Structure was further confirmed by single-crystal X-ray analysis.

It is important to mention here that the high regio- and stereoselectivity obtained in each case was clearly evidenced by ^{1}H NMR data and X-ray crystal analysis.[19] The ^{1}H NMR spectrum of compound **9a** showed a singlet for the NCH_3 protons at δ = 2.18 ppm and a triplet for the benzylic proton at δ = 4.97 ppm. The NCH_2 protons of the pyrrolidine ring appeared as two triplets at δ = 3.53 and 4.04 ppm. The CH_2OH protons appeared as a multiplet in the region δ = 3.78–3.99 ppm. The NH proton of the oxindole ring appeared at δ = 7.74 ppm and the aromatic protons appeared in the region δ = 6.82–7.57 ppm.

Had the other regioisomer been formed, the benzylic proton should have been appeared as singlet which we did not observe in any of the cases (**9a**,**c**–**f**,**h**–**n**). Comparison of the ^{1}H NMR spectra of the crude and recrystallized products showed them to be identical which confirm the stereoselective nature of the reaction. Furthermore the structure **9a** was confirmed by X-ray crystallographic analysis.

The X-ray crystal structure analysis of compound **9a** showed that the relative stereochemistry (Figure 3) of the phenyl group and CH_2OH group in the vicinal positions is *cis*. Similarly the NO_2 group and benzylic proton also have a *cis* orientation.

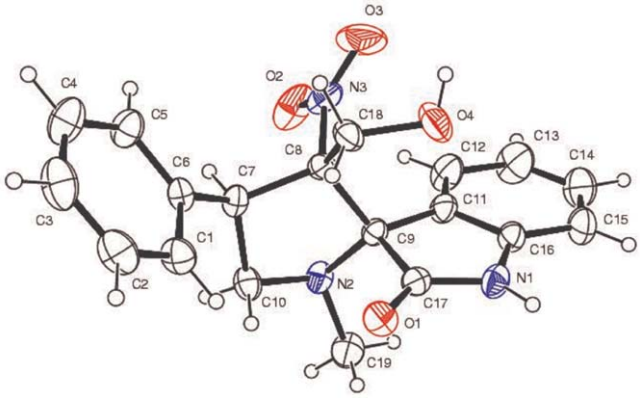
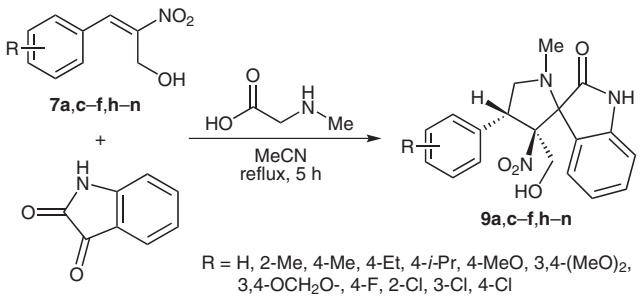


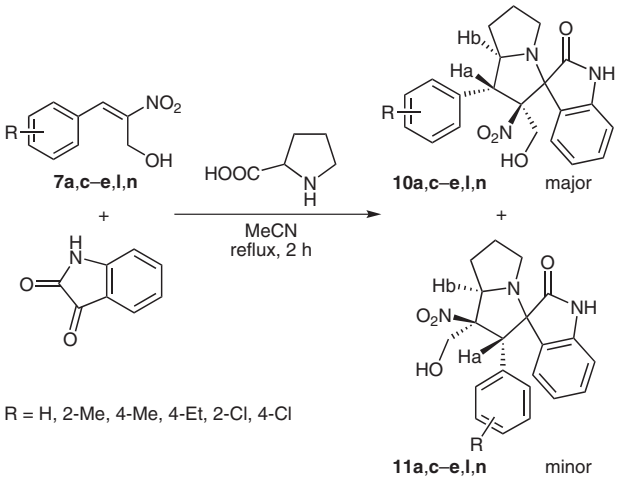
Figure 3 ORTEP diagram of **9a**

To probe further the generality of the reaction, we subjected various Baylis–Hillman adducts **7a**,**c**–**e**,**l**,**n** with the dipole generated from isatin and proline. Treatment of **7a**,**c**–**e**,**l**,**n** with isatin and proline without a catalyst with acetonitrile as the solvent for two hours at reflux temperature, provided the desired 3-spiropyrrolizidine compounds **10a**,**c**–**e**,**l**,**n** in good yields (52–65%) along with the minor regioisomers **11a**,**c**–**e**,**l**,**n** in 20–37% yields (Scheme 3). Compounds **10a**,**c**–**e**,**l**,**n** and **11a**,**c**–**e**,**l**,**n** were characterized by IR, ^{1}H and ^{13}C NMR, mass spectrometry, and elemental analyses (Scheme 4). The results are summarized in Table 3.



Scheme 3

The NMR data and X-ray crystal structure analysis[19] showed that the proline and isatin based [3+2]-cycloaddition reaction with the Baylis–Hillman adducts yielded regioisomeric compounds which were separated by column chromatography. The ^{1}H NMR spectrum of compound



Scheme 4

Table 3 Synthesis of 3-Spiropyrrolizidine Compounds from the Baylis–Hillman Adducts **10a**,**c**–**e**,**l**,**n** and **11a**,**c**–**e**,**l**,**n**

BH adduct	R	Product[a,b]	Yield[c] (%)	Product[a,b]	Yield[c] (%)	Yield (%) (**10** + **11**)
7a	H	**10a**	52	**11a**[d]	33	85
7c	2-Me	**10c**	65	**11c**	25	90
7d	4-Me	**10d**	59	**11d**	35	94
7e	4-Et	**10e**[d]	52	**11e**	37	89
7l	2-Cl	**10l**	60	**11l**	20	80
7n	4-Cl	**10n**	62	**11n**	31	93

[a] Reaction conditions: Baylis–Hillman alcohol **7a**,**c**–**e**,**l**,**n** (2 mmol), proline (2 mmol), isatin (2 mmol), MeCN (8 mL), reflux, 2 h.
[b] All products gave satisfactory IR, ^{1}H (300 MHz) and ^{13}C NMR (75 MHz), MS, and elemental analyses.
[c] Yields of the pure products **10a**,**c**–**e**,**l**,**n** and **11a**,**c**–**e**,**l**,**n** obtained after column chromatography [silica gel, 30% EtOAc–hexanes (**10a**,**c**–**e**,**l**,**n**), 40% EtOAc–hexanes (**11a**,**c**–**e**,**l**,**n**)].
[d] Structure was further confirmed by single-crystal X-ray analysis.

10a showed a doublet for the H_a proton at δ = 4.29 ppm. The H_b proton and one of the CH_2OH protons appeared as a multiplet in the region δ = 4.39–4.53 ppm. The other CH_2OH proton appeared as a doublet of doublets at δ = 4.95 ppm. The pyrrolidine ring protons appeared as multiplets in the region δ = 1.51–2.74 ppm, and the aromatic protons appeared in the region δ = 6.87–7.81 ppm.

The ^{1}H NMR spectrum of compound **11a** showed a singlet for the H_a proton (benzylic proton) at δ = 5.29 ppm and the H_b proton appeared as a doublet of doublets at δ = 4.78 ppm. The pyrrolidine ring protons appeared as multiplets in the region δ = 1.41–3.37 ppm. The CH_2OH protons appeared as two doublet of doublets at δ = 4.15 and 4.49 ppm. The aromatic protons appeared in the region of δ = 6.72–7.52 ppm. The X-ray crystal structure of the compound **10e** showed that the relative stereochemistry (Figure 4) of the aryl and CH_2OH groups to be *cis*. Similarly the NO_2 group and benzylic proton also have a *cis* orientation. The benzylic proton (H_a) and pyrrolidizine proton (H_b) at the ring junction are in a *trans* orientation as shown in Scheme 4.

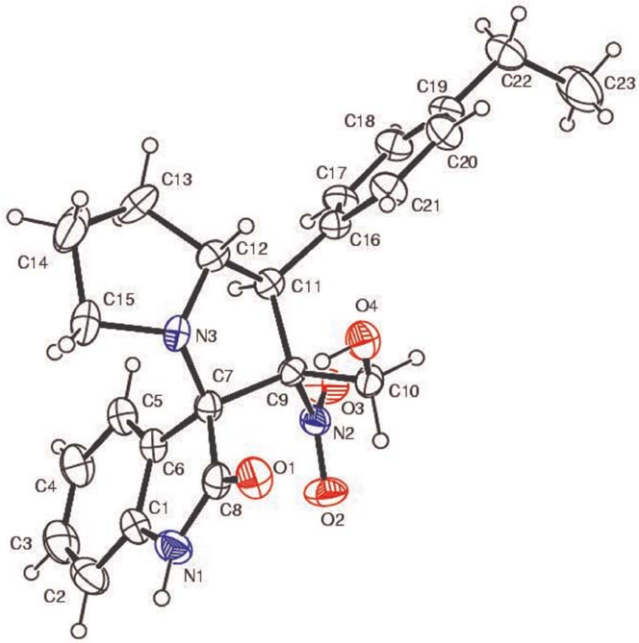


Figure 4 ORTEP diagram of **10e**

The X-ray crystal structure analysis of compound **11a** showed that the relative stereochemistry (Figure 5) of the phenyl group and CH_2OH group in the vicinal positions is *cis*. Similarly the NO_2 group and benzylic proton also have a *cis* orientation.

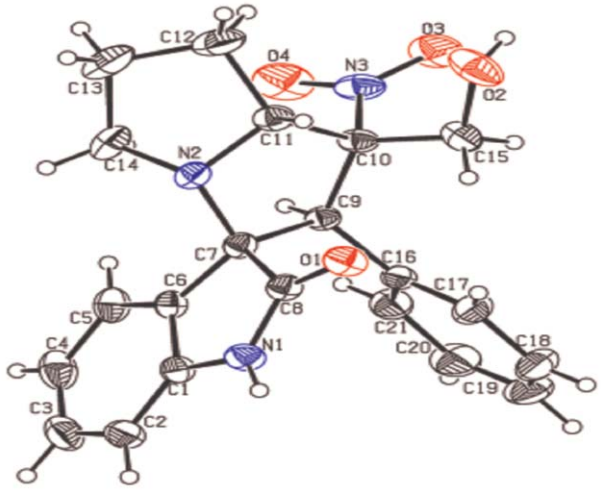


Figure 5 ORTEP diagram of **11a**

In conclusion, we have successfully developed a simple and novel protocol for the facile synthesis of pyrrolidines and functionalized spiropyrrolidines with high regio- and stereoselectivity. We have also demonstrated that this method is useful for making novel spiropyrrolizidine

frameworks using Baylis–Hillman adducts derived from nitroolefins.

All reagents were purchased from commercial sources and used without further purification. Solvents were distilled prior to use. Column chromatography was performed on silica gel. IR spectra were recorded on an FTIR-8300 Shimadzu spectrophotometer. ^{1}H (300 MHz) and ^{13}C NMR (75 MHz) were recorded on Bruker spectrometer using $CDCl_3$ as solvent and TMS as an internal standard. Mass spectra were recorded on a Jeol-JMS-DX 303 HF mass spectrometer. Elemental analyses were recorded on a Perkin-Elmer 240C-CHN analyzer. Melting points are uncorrected. TLC was performed using glass plates coated with silica gel (ACME, 254F); spots were visualized using I_2 vapor and a UV lamp.

(*E*)-2-Nitro-3-phenylprop-2-en-1-ol (7a); Typical Procedure for the Synthesis of Baylis–Hillman Adducts According to the Literature Procedure[17b]

To a stirred soln of nitrostyrene (1.50 g, 10 mmol) in THF (20 mL) at r.t. was added imidazole (0.68 g, 1 equiv) followed by anthranilic acid (0.14 g, 10 mol%). 38% Aq formaldehyde (20 mL, excess) was then added and the mixture was stirred at r.t. for a period of 24 h. After completion of the reaction (TLC analysis), the mixture was acidified with 5 M HCl (20 mL) and the aqueous layer was extracted with EtOAc (3 × 25 mL). The combined organic layers were washed with brine (50 mL), dried (anhyd Na_2SO_4) and concentrated in vacuo. The residue was purified by column chromatography (silica gel, 0–25% EtOAc–hexanes) to afford pure **7a** as a yellow oil; yield: 0.90 g (50%).

IR (KBr): 3423, 1653, 1522, 1326, 1023, 695 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 2.61 (s, 1 H), 4.71 (d, *J* = 4.2 Hz, 2 H), 7.48–7.58 (m, 5 H), 8.22 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 56.62, 129.14, 130.19, 130.96, 131.31, 137.67, 149.44.

MS: *m*/*z* = 179 (M^+).

Anal. Calcd for $C_9H_9NO_3$: C, 60.33; H, 5.06; N, 7.82. Found: C, 60.37; H, 5.08; N, 7.80.

(*E*)-3-(Naphthalen-2-yl)-2-nitroprop-2-en-1-ol (7b)

Yield: 1.60 g (70%); mp 80–82 °C.

IR (KBr): 3425, 1652, 1517, 1339, 1218, 704 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 2.47 (s, 1 H), 4.67 (s, 2 H), 7.53–8.00 (m, 7 H), 8.81 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 56.88, 123.94, 125.50, 126.82, 127.47, 128.29, 128.47, 128.92, 131.38, 131.52, 133.40, 135.72, 150.58.

MS: *m*/*z* = 229 (M^+).

Anal. Calcd for $C_{13}H_{11}NO_3$: C, 68.11; H, 4.84; N, 6.11. Found: C, 68.13; H, 4.87; N, 6.18.

(*E*)-2-Nitro-3-(2-tolyl)prop-2-en-1-ol (7c)

Yellow oil; yield: 0.96 g (52%).

IR (KBr): 3445, 1653, 1528, 1338, 1023, 695 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 2.38 (s, 3 H), 2.68 (s, 1 H), 4.62 (s, 2 H), 7.26–7.46 (m, 4 H), 8.33 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 19.99, 56.54, 126.48, 129.45, 130.55, 130.59, 130.76, 136.32, 138.19, 149.80.

MS: *m*/*z* = 193 (M^+).

Anal. Calcd for $C_{10}H_{11}NO_3$: C, 62.17; H, 5.74; N, 7.25. Found: C, 62.23; H, 5.71; N, 7.30.

(*E*)-2-Nitro-3-(4-tolyl)prop-2-en-1-ol (7d)

Yield: 0.80 g (42%); mp 49–52 °C.

IR (KBr): 3436, 1648, 1521, 1460, 1021, 702 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 2.42 (s, 3 H), 2.57 (t, *J* = 7.2 Hz, 1 H), 4.71 (d, *J* = 7.2 Hz, 2 H), 7.26–7.48 (m, 4 H), 8.20 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 21.55, 56.76, 128.44, 129.92, 130.38, 137.92, 141.83, 148.67.

MS: *m*/*z* = 193 (M^+).

Anal. Calcd for $C_{10}H_{11}NO_3$: C, 62.17; H, 5.74; N, 7.25. Found: C, 62.22; H, 5.78; N, 7.19.

(*E*)-3-(4-Ethylphenyl)-2-nitroprop-2-en-1-ol (7e)

Yellow oil; yield: 0.95 g (46%).

IR (KBr): 3233, 1643, 1590, 1321, 1093, 723 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.27 (t, *J* = 7.5 Hz, 3 H), 2.72 (q, *J* = 7.5 Hz, 2 H), 2.78 (s, 1 H), 4.74 (s, 2 H), 7.26–7.82 (m, 4 H), 8.20 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 15.17, 28.83, 56.53, 128.70, 130.05, 130.55, 137.92, 147.98, 148.75.

MS: *m*/*z* = 207 (M^+).

Anal. Calcd for $C_{11}H_{13}NO_3$: C, 63.76; H, 6.32; N, 6.76. Found: C, 63.82; H, 6.36; N, 6.67.

(*E*)-3-(4-Isopropylphenyl)-2-nitroprop-2-en-1-ol (7f)

Yellow oil; yield: 1.15 g (52%).

IR (KBr): 3300, 1651, 1590, 1310, 1093, 715 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.28 (d, *J* = 6.9 Hz, 6 H), 2.68 (s, 1 H), 2.96 (sept, *J* = 6.9 Hz, 1 H), 4.72 (s, 2 H), 7.26–7.52 (m, 4 H), 8.20 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 23.68, 34.16, 56.77, 127.32, 128.79, 130.52, 137.87, 148.74, 152.60.

MS: *m*/*z* = 221 (M^+).

Anal. Calcd for $C_{12}H_{15}NO_3$: C, 65.14; H, 6.83; N, 6.33. Found: C, 65.19; H, 6.87; N, 6.25.

(*E*)-3-(2-Methoxyphenyl)-2-nitroprop-2-en-1-ol (7g)

Yellow oil; yield: 1.05 g (52%).

IR (KBr): 3430, 1643, 1512, 1305, 1025, 705 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 2.92 (t, *J* = 6.6 Hz, 1 H), 3.89 (s, 3 H), 4.66 (d, *J* = 6.6 Hz, 2 H), 6.94–7.55 (m, 4 H), 8.43 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 55.67, 56.72, 110.85, 120.44, 120.95, 130.70, 132.81, 133.90, 148.96, 158.38.

MS: *m*/*z* = 209 (M^+).

Anal. Calcd for $C_{10}H_{11}NO_4$: C, 57.41; H, 5.30; N, 6.70. Found: C, 57.39; H, 5.24; N, 6.76.

(*E*)-3-(4-Methoxyphenyl)-2-nitroprop-2-en-1-ol (7h)

Yield: 1.17 g (56%); mp 75–77 °C.

IR (KBr): 3427, 1643, 1512, 1460, 1025, 715 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 3.25 (s, 1 H), 3.85 (s, 3 H), 4.72 (s, 2 H), 6.96–7.58 (m, 4 H), 8.15 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 55.49, 56.69, 114.72, 123.67, 132.62, 137.98, 147.37, 162.12.

MS: *m*/*z* = 209 (M^+).

Anal. Calcd for $C_{10}H_{11}NO_4$: C, 57.41; H, 5.30; N, 6.70. Found: C, 57.46; H, 5.33; N, 6.64.

(*E*)-3-(3,4-Dimethoxyphenyl)-2-nitroprop-2-en-1-ol (7i)
Yield: 1.05 g (44%); mp 100–102 °C.

IR (KBr): 3430, 1660, 1528, 1478, 1022, 720 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 3.05 (s, 1 H), 3.92 (s, 3 H), 3.94 (s, 3 H), 4.75 (s, 2 H), 6.94–7.25 (m, 3 H), 8.17 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 55.96, 56.01, 56.79, 111.31, 112.95, 123.95, 124.88, 130.30, 147.55, 149.24, 151.77.

MS: *m*/*z* = 239 (M^+).

Anal. Calcd for $C_{11}H_{13}NO_5$: C, 55.23; H, 5.48; N, 5.86. Found: C, 55.27; H, 5.51; N, 5.81.

(*E*)-3-[3,4-(Methylenedioxy)phenyl]-2-nitroprop-2-en-1-ol (7j)
Yield: 1.12 g (50%); mp 96–98 °C.

IR (KBr): 3420, 2949, 1643, 1512, 1305, 1025, 705 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 2.54 (t, *J* = 6.9 Hz, 1 H), 4.71 (d, *J* = 7.2 Hz, 2 H), 6.07 (s, 2 H), 6.90–7.15 (m, 3 H), 8.13 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 56.74, 63.15, 101.94, 109.04, 109.80, 125.16, 126.56, 128.54, 137.92, 147.85.

MS: *m*/*z* = 223 (M^+).

Anal. Calcd for $C_{10}H_9NO_5$: C, 53.82; H, 4.06; N, 6.28. Found: C, 53.87; H, 4.09; N, 6.30.

(*E*)-3-(4-Fluorophenyl)-2-nitroprop-2-en-1-ol (7k)
Yield: 0.59 g (30%); mp 54–56 °C.

IR (KBr): 3458, 1653, 1560, 1394, 1053, 755 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 2.64 (s, 1 H), 4.68 (s, 2 H), 7.15–7.62 (m, 4 H), 8.18 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 56.48, 116.32, 116.61, 127.43, 127.45, 132.48, 132.59, 136.69, 149.17, 162.58, 165.94.

MS: *m*/*z* = 197 (M^+).

Anal. Calcd for $C_9H_8FNO_3$: C, 54.83; H, 4.09; N, 7.10. Found: C, 54.88; H, 4.12; N, 7.07.

(*E*)-3-(2-Chlorophenyl)-2-nitroprop-2-en-1-ol (7l)
Yellow oil; yield: 1.17 g (55%).

IR (KBr): 3448, 1643, 1528, 1368, 1033, 715 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 3.40 (s, 1 H), 4.67 (s, 2 H), 7.27–7.85 (m, 4 H), 8.11 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 56.30, 128.17, 129.82, 129.87, 130.42, 130.88, 134.49, 135.52, 136.10.

MS: *m*/*z* = 213 (M^+), 215 (M^+ + 2).

Anal. Calcd for $C_9H_8ClNO_3$: C, 50.60; H, 3.77; N, 6.56. Found: C, 50.65; H, 3.70; N, 6.58.

(*E*)-3-(3-Chlorophenyl)-2-nitroprop-2-en-1-ol (7m)
Yellow oil; yield: 0.85 g (43%).

IR (KBr): 3442, 1647, 1530, 1363, 1036, 720 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 3.40 (s, 1 H), 4.62 (s, 2 H), 7.35–8.01 (m, 4 H), 8.36 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 56.60, 126.70, 127.40, 130.01, 130.94, 131.44, 131.95, 132.37, 133.44.

MS: *m*/*z* = 213 (M^+), 215 (M^+ + 2).

Anal. Calcd for $C_9H_8ClNO_3$: C, 50.60; H, 3.77; N, 6.56. Found: C, 50.67; H, 3.72; N, 6.62.

(*E*)-3-(4-Chlorophenyl)-2-nitroprop-2-en-1-ol (7n)
Yellow oil; yield: 0.64 g (30%).

IR (KBr): 3432, 1649, 1536, 1360, 1039, 715 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 2.60 (s, 1 H), 4.67 (s, 2 H), 7.42–7.54 (m, 4 H), 8.16 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 56.51, 128.85, 129.03, 131.49, 136.44, 137.37, 149.65.

MS: *m*/*z* = 213 (M^+), 215 (M^+ + 2).

Anal. Calcd for $C_9H_8ClNO_3$: C, 50.60; H, 3.77; N, 6.56. Found: C, 50.63; H, 3.75; N, 6.58.

(*E*)-2-Nitro-3-(thiophen-2-yl)prop-2-en-1-ol (7o)
Yield: 1.11 g (60%); mp 104–106 °C.

IR (KBr): 3335, 1643, 1518, 1338, 1023, 715 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 2.74 (t, *J* = 6.9 Hz, 1 H), 4.91 (d, *J* = 6.9 Hz, 2 H), 7.18–7.72 (m, 3 H), 8.31 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 56.72, 128.65, 130.39, 133.50, 133.55, 136.27, 146.18.

MS: *m*/*z* = 185 (M^+).

Anal. Calcd for $C_7H_7NO_3S$: C, 45.40; H, 3.81; N, 7.56. Found: C, 45.45; H, 3.76; N, 7.59.

(1-Methyl-3-nitro-4-phenylpyrrolidin-3-yl)methanol (8a); Typical Procedure
A mixture of (*E*)-2-nitro-3-phenylprop-2-en-1-ol (**7a**, 0.36 g, 2 mmol), paraformaldehyde (0.36 g, 12 mmol), and sarcosine (0.53 g, 6 mmol) in MeCN (8 mL) was refluxed for 8 h. After completion of the reaction (TLC), the mixture was concentrated and the resulting crude mass was diluted with H_2O (20 mL) and extracted with EtOAc (3 × 10 mL). The combined organic layers were washed with brine (3 × 10 mL) and dried (anhyd Na_2SO_4). The organic layer was concentrated and purified by column chromatography (silica gel, Acme 100–200 mesh, EtOAc–hexanes, 3:7) to provide **8a** as a colorless solid; yield: 0.36 g (76%); mp 104–106 °C.

IR (KBr): 3373, 3073, 1525, 1349 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 2.49 (s, 3 H), 2.85 (br s, 1 H), 2.93 (t, *J* = 8.7 Hz, 1 H), 2.99 (d, *J* = 11.4 Hz, 1 H), 3.27 (t, *J* = 8.4 Hz, 1 H), 3.55 (d, *J* = 12.3 Hz, 1 H), 3.65 (d, *J* = 11.4 Hz, 1 H), 3.70 (d, *J* = 12.6 Hz, 1 H), 4.20 (t, *J* = 7.4 Hz, 1 H), 7.31–7.35 (m, 5 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 41.75, 51.57, 60.67, 62.71, 65.51, 98.98, 128.15, 128.28, 128.80, 128.88.

MS: *m*/*z* = 237 (M^+ + 1).

Anal. Calcd for $C_{12}H_{16}N_2O_3$: C, 61.00; H, 6.83; N, 11.86. Found: C, 60.97; H, 6.91; N, 11.88.

[1-Methyl-4-(naphthalen-2-yl)-3-nitropyrrolidin-3-yl]methanol (8b)
Yield: 0.42 g (74%); mp 115–117 °C.

IR (KBr): 3364, 3065, 1530, 1356 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 2.45 (s, 3 H), 2.56 (s, 1 H), 3.05 (t, *J* = 6.6 Hz, 1 H), 3.11 (d, *J* = 11.1 Hz, 1 H), 3.24 (t, *J* = 9.3 Hz, 1 H), 3.40 (d, *J* = 12.9 Hz, 1 H), 3.49 (d, *J* = 13.2 Hz, 2 H), 4.97 (t, *J* = 6.9 Hz, 1 H), 7.35–7.93 (m, 7 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 41.75, 46.46, 62.54, 63.90, 64.79, 99.91, 122.96, 125.20, 125.92, 126.08, 127.07, 128.66, 129.04, 132.48, 133.01, 133.83.

MS: *m*/*z* = 287 (M^+ + 1).

Anal. Calcd for $C_{16}H_{18}N_2O_3$: C, 67.12; H, 6.34; N, 9.78. Found: C, 67.14; H, 6.35; N, 9.76.

[1-Methyl-3-nitro-4-(4-tolyl)pyrrolidin-3-yl]methanol (8d)
Yield: 0.40 g (80%); mp 106–108 °C.

IR (KBr): 3374, 3069, 1532, 1351 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 2.02 (s, 1 H), 2.34 (s, 3 H), 2.44 (s, 3 H), 2.80 (d, *J* = 9.00 Hz, 1 H), 2.86 (d, *J* = 10.8 Hz, 1 H), 3.20 (t, *J* = 9 Hz, 1 H), 3.51 (d, *J* = 12.3 Hz, 1 H), 3.62 (d, *J* = 11.4 Hz, 1 H), 3.68 (d, *J* = 12.6 Hz, 1 H), 4.11 (t, *J* = 7.2 Hz, 1 H), 7.15 (d, *J* = 7.2 Hz, 2 H), 7.24 (d, *J* = 11.1 Hz, 2 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 21.05, 41.74, 51.34, 61.17, 63.21, 65.69, 99.29, 128.74, 129.48, 132.74, 137.84.

MS: *m*/*z* = 251 (M^+ + 1).

Anal. Calcd for $C_{13}H_{18}N_2O_3$: C, 62.38; H, 7.25; N, 11.19. Found: C, 62.40; H, 7.24; N, 11.22.

[4-(4-Ethylphenyl)-1-methyl-3-nitropyrrolidin-3-yl]methanol (8e)

Yield: 0.37 g (70%); mp 110–112 °C.

IR (KBr): 3366, 3063, 1529, 1343 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.15 (t, *J* = 8.7 Hz, 3 H), 2.38 (s, 3 H), 2.57 (q, *J* = 9.6 Hz, 2 H), 2.66 (s, 1 H), 2.73 (d, *J* = 7.5 Hz, 1 H), 2.80 (d, *J* = 8.4 Hz, 1 H), 3.14 (t, *J* = 12.30 Hz, 1 H), 3.43 (d, *J* = 12.3 Hz, 1 H), 3.60 (d, *J* = 13.2 Hz, 2 H), 4.03 (t, *J* = 11.1 Hz, 1 H), 7.09 (d, *J* = 7.8 Hz, 2 H), 7.18 (d, *J* = 7.5 Hz, 2 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 15.45, 28.44, 41.78, 51.77, 60.93, 62.82, 65.80, 99.27, 128.16, 128.91, 132.49, 144.10.

MS: *m*/*z* = 265 (M^+ + 1).

Anal. Calcd for $C_{14}H_{20}N_2O_3$: C, 63.62; H, 7.63; N, 10.60. Found: C, 63.65; H, 7.62; N, 10.59.

[4-(2-Methoxyphenyl)-1-methyl-3-nitropyrrolidin-3-yl]methanol (8g)

Yield: 0.40 g (75%); mp 121–123 °C.

IR (KBr): 3364, 3065, 1527, 1344 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 2.05 (s, 1 H), 2.51 (s, 3 H), 2.93 (t, *J* = 9.3 Hz, 1 H), 3.04 (d, *J* = 11.4 Hz, 1 H), 3.25 (d, *J* = 13.2 Hz, 1 H), 3.33 (t, *J* = 8.4 Hz, 1 H), 3.43 (d, *J* = 11.1 Hz, 2 H), 3.72 (s, 3 H), 4.57 (t, *J* = 7.8 Hz, 1 H), 6.83–7.31 (m, 4 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 41.90, 46.82, 54.93, 59.30, 63.98, 64.48, 97.31, 110.24, 120.74, 123.80, 127.65, 129.07, 157.46.

MS: *m*/*z* = 267 (M^+ + 1).

Anal. Calcd for $C_{13}H_{18}N_2O_4$: C, 58.63; H, 6.81; N, 10.52. Found: C, 58.60; H, 6.83; N, 10.55.

[4-(4-Methoxyphenyl)-1-methyl-3-nitropyrrolidin-3-yl]methanol (8h)

Yield: 0.39 g (73%); mp 129–131 °C.

IR (KBr): 3367, 3064, 1531, 1343 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 2.15 (s, 1 H), 2.45 (s, 3 H), 2.80 (t, *J* = 9.00 Hz, 1 H), 2.86 (d, *J* = 11.4 Hz, 1 H), 3.20 (t, *J* = 8.4 Hz, 1 H), 3.51 (d, *J* = 12.6 Hz, 1 H), 3.63 (d, *J* = 11.4 Hz, 1 H), 3.69 (d, *J* = 12.3 Hz, 1 H), 3.81 (s, 3 H), 4.10 (t, *J* = 8.1 Hz, 1 H), 6.88 (d, *J* = 8.4 Hz, 2 H), 7.27 (d, *J* = 8.4 Hz, 2 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 41.77, 51.10, 55.33, 61.31, 63.17, 65.77, 99.30, 114.16, 127.72, 129.95, 159.30.

MS: *m*/*z* = 267 (M^+ + 1).

Anal. Calcd for $C_{13}H_{18}N_2O_4$: C, 58.63; H, 6.81; N, 10.52. Found: C, 58.65; H, 6.80; N, 10.54.

[4-(3,4-Dimethoxyphenyl)-1-methyl-3-nitropyrrolidin-3-yl]methanol (8i)

Yield: 0.41 g (69%); mp 130–132 °C.

IR (KBr): 3363, 3060, 1529, 1338 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 2.49 (s, 3 H), 2.89 (t, *J* = 9.3 Hz, 1 H), 2.96 (d, *J* = 11.7 Hz, 1 H), 3.26 (t, *J* = 8.4 Hz, 1 H), 3.55 (d, *J* = 12.3 Hz, 1 H), 3.72 (d, *J* = 12.6 Hz, 2 H), 3.88 (s, 6 H), 3.95 (s, 1 H), 4.10 (t, *J* = 8.1 Hz, 1 H), 6.81–6.88 (m, 3 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 41.74, 51.33, 55.90, 56.01, 60.76, 62.66, 65.52, 99.04, 111.18, 112.29, 120.73, 127.65, 148.87, 149.06.

MS: *m*/*z* = 297 (M^+ + 1).

Anal. Calcd for $C_{14}H_{20}N_2O_5$: C, 56.75; H, 6.80; N, 9.45. Found: C, 56.77; H, 6.78; N, 9.47.

[1-Methyl-3-nitro-4-(thiophen-2-yl)pyrrolidin-3-yl]methanol (8o)

Yield: 0.36 g (75%); mp 92–94 °C.

IR (KBr): 3362, 3076, 1530, 1352 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 2.45 (s, 3 H), 2.49 (s, 1 H), 2.71 (t, *J* = 9.3 Hz, 1 H), 2.79 (d, *J* = 11.7 Hz, 1 H), 3.36 (t, *J* = 7.5 Hz, 1 H), 3.64 (d, *J* = 12.6 Hz, 1 H), 3.77 (d, *J* = 12 Hz, 1 H), 3.86 (d, *J* = 12.3 Hz, 1 H), 4.48 (t, *J* = 8.7 Hz, 1 H), 7.00–7.29 (m, 3 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 41.48, 47.11, 62.24, 62.64, 65.65, 99.03, 125.55, 127.17, 127.29, 137.97.

MS: *m*/*z* = 243 (M^+ + 1).

Anal. Calcd for $C_{10}H_{14}N_2O_3S$: C, 49.57; H, 5.82; N, 11.56. Found: C, 49.60; H, 5.85; N, 11.58.

3′-(Hydroxymethyl)-1′-methyl-3′-nitro-4′-phenylspiro[indole-3,2′-pyrrolidin]-2(1*H*)-one (9a); Typical Procedure

A mixture of (*E*)-2-nitro-3-phenylprop-2-en-1-ol (**7a**, 0.36 g, 2 mmol), isatin (0.29 g, 2 mmol), and sarcosine (0.18 g, 2 mmol) in MeCN (8 mL) was refluxed for 5 h. After completion of the reaction (TLC), the mixture was concentrated and the resulting crude mass was diluted with H_2O (10 mL) and extracted with EtOAc (3 × 10 mL). The combined organic layers were washed with brine (2 × 10 mL) and dried (anhyd Na_2SO_4). The organic layer was concentrated and the residue purified by column chromatography (silica gel, Acme 100–200 mesh, EtOAc–hexanes, 2:8) to afford **9a** as a colorless solid; yield: 0.58 g (82%); mp 160–162 °C.

IR (KBr): 3484, 3227, 1717, 1544, 1337 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 2.18 (s, 3 H), 2.87 (dd, *J* = 2.7, 11.7 Hz, 1 H), 3.53 (t, *J* = 9.0 Hz, 1 H), 3.78–3.99 (m, 2 H), 4.04 (t, *J* = 9.6 Hz, 1 H), 4.97 (t, *J* = 9.0 Hz, 1 H), 6.82–7.57 (m, 9 H), 7.74 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 34.77, 49.40, 56.78, 64.17, 77.23, 105.05, 110.15, 123.38, 124.46, 125.20, 128.18, 128.78, 129.99, 130.48, 134.75, 141.55, 176.06.

MS: *m*/*z* = 354 (M^+ + 1).

Anal. Calcd for $C_{19}H_{19}N_3O_4$: C, 64.58; H, 5.42; N, 11.89. Found: C, 64.56; H, 5.39; N, 11.94.

3′-(Hydroxymethyl)-1′-methyl-3′-nitro-4′-(2-tolyl)spiro[indole-3,2′-pyrrolidin]-2(1*H*)-one (9c)

Yield: 0.55 g (75%); mp 98–100 °C.

IR (KBr): 3429, 3176, 1716, 1541, 1346 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 2.19 (s, 3 H), 2.14 (s, 3 H), 2.52 (dd, *J* = 3.3, 11.7 Hz, 1 H), 3.52 (t, *J* = 9 Hz, 1 H), 3.62 (dd, *J* = 3.6, 13.8 Hz, 1 H), 3.94 (t, *J* = 12 Hz, 1 H), 4.13 (t, *J* = 9.6 Hz, 1 H), 5.14 (t, *J* = 9.6 Hz, 1 Hz), 6.79–7.89 (m, 9 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 20.37, 34.50, 45.40, 56.95, 63.68, 77.28, 105.62, 110.05, 123.50, 124.24, 125.15, 126.56, 127.90, 129.27, 130.49, 130.67, 133.39, 137.68, 142.00, 175.89.

MS: *m*/*z* = 367 (M^+ + 1).

Anal. Calcd for $C_{20}H_{21}N_3O_4$: C, 65.38; H, 5.76; N, 11.44. Found: C, 65.40; H, 5.70; N, 11.42.

3′-(Hydroxymethyl)-1′-methyl-3′-nitro-4′-(4-tolyl)spiro[indole-3,2′-pyrrolidin]-2(1*H*)-one (9d)
Yield: 0.56 g (76%); mp 122–124 °C.

IR (KBr): 3564, 3151, 1710, 1550, 1331 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 2.17 (s, 3 H), 2.35 (s, 3 H), 2.81 (dd, *J* = 3.6, 11.7 Hz, 1 H), 3.50 (t, *J* = 9 Hz, 1 H), 3.78 (dd, *J* = 3.3, 13.5 Hz, 1 H), 3.91–4.03 (m, 2 H), 4.93 (t, *J* = 9.3 Hz, 1 H), 6.81–7.45 (m, 8 H), 7.67 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 21.08, 34.78, 49.07, 56.86, 64.17, 77.23, 105.07, 110.09, 123.38, 124.47, 125.24, 129.49, 129.83, 130.44, 131.59, 137.98, 141.50, 175.98.

MS: *m*/*z* = 367 (M^+ + 1).

Anal. Calcd for $C_{20}H_{21}N_3O_4$: C, 65.38; H, 5.76; N, 11.44. Found: C, 65.43; H, 5.74; N, 11.49.

4′-(4-Ethylphenyl)-3′-(hydroxymethyl)-1′-methyl-3′-nitrospiro[indole-3,2′-pyrrolidin]-2(1*H*)-one (9e)
Yield: 0.59 g (77%); mp 134–136 °C.

IR (KBr): 3489, 3217, 1746, 1532, 1347 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.23 (t, *J* = 7.5 Hz, 3 H), 2.17 (s, 3 H), 2.64 (q, *J* = 7.5 Hz, 2 H), 2.82 (dd, *J* = 3.0, 11.4 Hz, 1 H), 3.50 (t, *J* = 9 Hz, 1 H), 3.79 (dd, *J* = 3.3, 13.5 Hz, 1 H), 3.91–4.04 (m, 2 H), 4.94 (t, *J* = 9.3 Hz, 1 H), 6.81–7.48 (m, 8 H), 7.69 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 15.44, 28.47, 34.78, 49.14, 56.81, 64.17, 77.64, 105.04, 110.24, 123.34, 124.43, 125.25, 128.28, 129.89, 130.44, 131.83, 141.71, 144.31, 176.29.

MS: *m*/*z* = 381 (M^+ + 1).

Anal. Calcd for $C_{21}H_{23}N_3O_4$: C, 66.13; H, 6.08; N, 11.02. Found, 66.17; H, 6.10; N, 11.07.

3′-(Hydroxymethyl)-4′-(4-isopropylphenyl)-1′-methyl-3′-nitrospiro[indole-3,2′-pyrrolidin]-2(1*H*)-one (9f)
Yield: 0.47 g (60%); mp 127–129 °C.

IR (KBr): 3435, 3213, 1711, 1541, 1330 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.24 (d, *J* = 6.9 Hz, 6 H), 2.17 (s, 3 H), 2.80 (dd, *J* = 3, 11.7 Hz, 1 H), 2.88 (sept, *J* = 6.9 Hz, 1 H), 3.50 (t, *J* = 9 Hz, 1 H), 3.79 (dd, *J* = 3.3, 13.2 Hz, 1 H), 3.90–4.04 (m, 2 H), 4.94 (t, *J* = 9.3 Hz, 1 H), 6.81–7.49 (m, 8 H), 7.58 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 23.90, 33.76, 34.79, 49.06, 56.84, 64.23, 77.21, 105.07, 110.01, 123.39, 124.52, 125.24, 126.83, 129.89, 130.42, 131.90, 141.41, 148.94, 175.90.

MS: *m*/*z* = 395 (M^+ + 1).

Anal. Calcd for $C_{22}H_{25}N_3O_4$: C, 66.82; H, 6.37; N, 10.63. Found: C, 66.80; H, 6.33; N, 10.65.

3′-(Hydroxymethyl)-4′-(4-methoxyphenyl)-1′-methyl-3′-nitrospiro[indole-3,2′-pyrrolidin]-2(1*H*)-one (9h)
Yield: 0.47 g (61%); mp 143–145 °C.

IR (KBr): 3199, 3176, 1731, 1538, 1328 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 2.16 (s, 3 H), 2.91 (d, *J* = 2.7 Hz, 1 H), 3.51 (t, *J* = 9 Hz, 1 H), 3.81 (s, 3 H), 3.81–4.00 (m, 3 H), 4.91 (t, *J* = 9 Hz, 1 H), 6.81–7.50 (m, 8 H), 7.85 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 34.79, 48.77, 55.29, 57.06, 64.17, 77.24, 104.97, 110.15, 114.14, 123.37, 124.45, 125.20, 126.52, 130.45, 131.09, 141.53, 159.39, 179.08.

MS: *m*/*z* = 383 (M^+ + 1).

Anal. Calcd for $C_{20}H_{21}N_3O_5$: C, 62.65; H, 5.52; N, 10.96. Found: C, 62.68; H, 5.50; N, 10.96.

4′-(3,4-Dimethoxyphenyl)-3′-(hydroxymethyl)-1′-methyl-3′-nitrospiro[indole-3,2′-pyrrolidin]-2(1*H*)-one (9i)
Yield: 0.51 g (62%); mp 112–114 °C.

IR (KBr): 3446, 3085, 1717, 1545, 1347 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 2.17 (s, 3 H), 2.84 (d, *J* = 9 Hz, 1 H), 3.49 (t, *J* = 6.9 Hz, 1 H), 3.56 (d, *J* = 9.3 Hz, 1 H), 3.83 (d, *J* = 10.8 Hz, 1 H), 3.89 (s, 3 H), 3.92 (s, 3 H), 3.97 (t, *J* = 5.4 Hz, 1 H), 4.88 (t, *J* = 9.3 Hz, 1 H), 6.81–7.33 (m, 7 H), 7.67 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 34.77, 49.15, 55.89, 55.98, 57.37, 64.04, 76.66, 105.06, 110.06, 111.13, 112.97, 122.49, 123.42, 124.48, 125.16, 127.08, 130.45, 141.37, 148.87, 149.08, 175.85.

MS: *m*/*z* = 414 (M^+ + 1).

Anal. Calcd for $C_{21}H_{23}N_3O_6$: C, 61.01; H, 5.61; N, 10.16. Found: C, 61.05; H, 5.62; N, 10.24.

3′-(Hydroxymethyl)-1′-methyl-4′-[3,4-(methylenedioxy)phenyl]-3′-nitrospiro[indole-3,2′-pyrrolidin]-2(1*H*)-one (9j)
Yield: 0.48 g (60%); mp 117–119 °C.

IR (KBr): 3515, 3305, 1721, 1543, 1356 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 2.16 (s, 3 H), 2.90 (dd, *J* = 3.3, 11.4 Hz, 1 H), 3.50 (t, *J* = 9 Hz, 1 H), 3.83 (dd, *J* = 3.3, 13.5 Hz, 1 H), 3.89–4.02 (m, 2 H), 4.88 (t, *J* = 9.3 Hz, 1 H), 5.97 (s, 2 H), 6.77–7.32 (m, 7 H), 7.74 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 34.73, 49.17, 57.09, 64.03, 76.51, 101.24, 105.05, 108.35, 110.05, 110.12, 123.42, 123.56, 124.47, 125.15, 128.23, 130.47, 141.36, 147.43, 148.04, 175.80.

MS: *m*/*z* = 398 (M^+ + 1).

Anal. Calcd for $C_{20}H_{19}N_3O_6$: C, 60.45; H, 4.82; N, 10.57. Found: C, 60.40; H, 4.88; N, 10.54.

4′-(4-Fluorophenyl)-3′-(hydroxymethyl)-1′-methyl-3′-nitrospiro[indole-3,2′-pyrrolidin]-2(1*H*)-one (9k)
Yield: 0.47 g (64%); mp 154–156 °C.

IR (KBr): 3203, 3145, 1749, 1509, 1327 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 2.17 (s, 3 H), 3.07 (dd, *J* = 3.3, 10.8 Hz, 1 H), 3.53 (t, *J* = 9.3 Hz, 1 H), 3.81 (dd, *J* = 3.9, 13.5 Hz, 1 H), 3.86 (d, *J* = 11.4 Hz, 1 H), 3.96 (t, *J* = 9.3 Hz, 1 H), 4.94 (t, *J* = 9.3 Hz, 1 H), 6.82–7.59 (m, 8 H), 7.81 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 34.79, 48.64, 57.19, 64.14, 76.71, 104.60, 110.25, 115.49, 115.78, 123.44, 124.46, 125.01, 130.50, 130.55, 131.72, 131.83, 141.47, 176.14.

MS: *m*/*z* = 372 (M^+ + 1).

Anal. Calcd for $C_{19}H_{18}FN_3O_4$: C, 61.45; H, 4.89; N, 11.32. Found: C, 61.47; H, 4.87; N, 11.38.

4′-(2-Chlorophenyl)-3′-(hydroxymethyl)-1′-methyl-3′-nitrospiro[indole-3,2′-pyrrolidin]-2(1*H*)-one (9l)
Yield: 0.62 g (80%); mp 116–118 °C.

IR (KBr): 3421, 3157, 1712, 1546, 1337 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 2.89 (s, 3 H), 2.76 (dd, *J* = 6.3, 9.0 Hz, 1 H), 3.54 (t, *J* = 9 Hz, 1 H), 3.72 (t, *J* = 6 Hz, 2 H), 4.14 (t, *J* = 9.6 Hz, 1 H), 5.30 (t, *J* = 9 Hz, 1 H), 6.77–7.93 (m, 9 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 34.42, 45.86, 55.61, 63.51, 76.51, 104.38, 109.99, 123.55, 124.26, 124.93, 127.33, 129.23, 129.60, 130.47, 130.62, 132.96, 135.65, 142.02, 175.72.

MS: *m*/*z* = 389 (M^+ + 2).

Anal. Calcd for $C_{19}H_{18}ClN_3O_4$: C, 58.84; H, 4.68; N, 10.84. Found: C, 58.83; H, 4.70; N, 10.86.

4′-(3-Chlorophenyl)-3′-(hydroxymethyl)-1′-methyl-3′-nitrospiro[indole-3,2′-pyrrolidin]-2(1*H*)-one (9m)
Yield: 0.50 g (64%); mp 122–124 °C.

IR (KBr): 3216, 3097, 1714, 1540, 1330 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 2.17 (s, 3 H), 3.10 (dd, *J* = 3.3, 10.8 Hz, 1 H), 3.52 (t, *J* = 9.3 Hz, 1 H), 3.82 (dd, *J* = 3.0, 12.9 Hz, 1 H), 3.89 (d, *J* = 10.8 Hz, 1 H), 3.98 (t, *J* = 9.3 Hz, 1 H), 4.92 (t, *J* = 9.3 Hz, 1 H), 6.83–7.59 (m, 8 H), 8.08 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 34.75, 48.98, 56.83, 64.05, 76.69, 104.60, 110.38, 123.44, 124.39, 124.94, 128.34, 128.40, 129.93, 130.18, 130.61, 134.64, 136.97, 141.56, 176.25.

MS: *m*/*z* = 389 (M^+ + 2).

Anal. Calcd for $C_{19}H_{18}ClN_3O_4$: C, 58.84; H, 4.68; N, 10.84. Found: C, 58.80; H, 4.65; N, 10.82.

4′-(4-Chlorophenyl)-3′-(hydroxymethyl)-1′-methyl-3′-nitrospiro[indole-3,2′-pyrrolidin]-2(1*H*)-one (9n)
Yield: 0.54 g (70%); mp 143–145 °C.

IR (KBr): 3421, 3156, 1712, 1546, 1337 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 2.19 (s, 3 H), 2.68 (dd, *J* = 5.7, 9.6 Hz, 1 H), 3.55 (t, *J* = 9 Hz, 1 H), 3.72 (t, *J* = 5.7 Hz, 2 H), 4.14 (t, *J* = 9.3 Hz, 1 H), 5.30 (t, *J* = 9.3 Hz, 1 H), 6.78–7.93 (m, 9 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 34.41, 45.82, 55.64, 63.54, 76.42, 104.51, 109.80, 123.58, 124.33, 127.35, 129.20, 129.57, 130.47, 130.64, 132.95, 141.76, 175.27.

MS: *m*/*z* = 389 (M^+ + 2).

Anal. Calcd for $C_{19}H_{18}ClN_3O_4$: C, 58.84; H, 4.68; N, 10.84. Found: C, 58.83; H, 4.64; N, 10.83.

2′-(Hydroxymethyl)-2′-nitro-1′-phenyl-1′,2′,5′,6′,7′,7a′-hexahydrospiro[indole-3,3′-pyrrolizin]-2(1*H*)-one (10a) and 1′-(Hydroxymethyl)-1′-nitro-2′-phenyl-1′,2′,5′,6′,7′,7a′-hexahydrospiro[indole-3,3′-pyrrolizin]-2(1*H*)-one (11a); Typical Procedure
A mixture of (*E*)-2-nitro-3-phenylprop-2-en-1-ol (**7a**, 0.36 g, 2 mmol), isatin (0.29 g, 2 mmol), and L-proline (0.23 g, 2 mmol) in MeCN (8 mL) was refluxed for 2 h. After completion of the reaction (TLC), the mixture was concentrated and the resulting crude mass was diluted with H_2O (20 mL) and extracted with EtOAc (3 × 10 mL). The combined organic layers were washed with brine (3 × 10 mL) and dried (anhyd Na_2SO_4). The organic layer was concentrated and purified by column chromatography (silica gel, Acme 100–200 mesh, EtOAc–hexanes, 3:7 to give **10a** followed by 4:6 to give **11a**) to provide **10a** (0.39 g, 52%) as a colorless solid and **11a** (0.25 g, 33%) as a colorless solid.

Compound 10a
Mp 148–150 °C.

IR (KBr): 3463, 3197, 1709, 1540, 1336 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.51–1.55 (m, 1 H), 1.92–2.08 (m, 3 H), 2.50–2.56 (m, 1 H), 2.69–2.74 (m, 1 H), 3.88 (t, *J* = 12.3 Hz, 1 H), 4.29 (d, *J* = 10.2 Hz, 1 H), 4.39–4.53 (m, 2 H), 4.95 (dd, *J* = 3.6, 12.0 Hz, 1 H), 6.87–7.81 (m, 10 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 27.88, 32.74, 47.89, 56.59, 64.51, 69.88, 78.03, 105.54, 111.22, 122.96, 124.98, 125.52, 127.99, 128.56, 130.70, 130.88, 134.19, 140.86, 179.78.

MS: *m*/*z* = 380 (M^+ + 1).

Anal. Calcd for $C_{21}H_{21}N_3O_4$: C, 66.48; H, 5.58; N, 11.08. Found: C, 66.41; H, 5.46; N, 11.14.

Compound 11a
Mp 170–172 °C.

IR (KBr): 3467, 3185, 1709, 1535, 1345 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.41–1.47 (m, 1 H), 1.86–2.00 (m, 2 H), 2.17–2.22 (m, 2 H), 2.64 (td, *J* = 2.1, 5.4 Hz, 1 H), 3.22–3.27 (m, 1 H), 4.15 (dd, *J* = 4.2, 13.2 Hz, 1 H), 4.49 (dd, *J* = 10.5, 13.2 Hz, 1 H), 4.78 (dd, *J* = 5.4, 8.1 Hz, 1 H), 5.29 (s, 1 H), 6.72–7.52 (m, 10 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 25.04, 27.69, 48.50, 59.23, 65.28, 69.60, 73.67, 104.73, 110.22, 122.73, 125.31, 126.25, 128.33, 128.96, 129.43, 130.01, 131.79, 141.40, 178.87.

MS: *m*/*z* = 380 (M^+ + 1).

Anal. Calcd for $C_{21}H_{21}N_3O_4$: C, 66.48; H, 5.58; N, 11.08. Found: C, 66.42; H, 5.49; N, 11.16.

2′-(Hydroxymethyl)-2′-nitro-1′-(2-tolyl)-1′,2′,5′,6′,7′,7a′-hexahydrospiro[indole-3,3′-pyrrolizin]-2(1*H*)-one (10c)
Yield: 0.51 g (65%); mp 160–162 °C.

IR (KBr): 3255, 3075, 1712, 1543, 1333 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.52–1.59 (m, 1 H), 1.83–2.09 (m, 3 H), 2.58 (s, 3 H), 2.63–2.77 (m, 2 H), 4.15 (t, *J* = 12.0 Hz, 1 H), 4.31–4.89 (m, 2 H), 4.65 (d, *J* = 10.2 Hz, 1 H), 4.77 (s, 1 H), 6.90–8.02 (m, 8 H), 8.34 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 20.60, 27.31, 31.76, 47.88, 51.82, 64.74, 70.91, 77.79, 106.56, 111.19, 123.08, 125.11, 125.26, 126.46, 127.48, 129.52, 130.64, 130.96, 133.18, 138.38, 141.26, 179.36.

MS: *m*/*z* = 394 (M^+ + 1).

Anal. Calcd for $C_{22}H_{23}N_3O_4$: C, 67.16; H, 5.89; N, 10.68. Found: C, 67.20; H, 5.91; N, 10.65.

1′-(Hydroxymethyl)-1′-nitro-2′-(2-tolyl)-1′,2′,5′,6′,7′,7a′-hexahydrospiro[indole-3,3′-pyrrolizin]-2(1*H*)-one (11c)
Yield: 0.20 g (25%); mp 168–170 °C.

IR (KBr): 3457, 3185, 1709, 1535, 1345 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.36–1.49 (m, 1 H), 1.86–2.18 (m, 3 H), 2.20 (s, 3 H), 2.21–2.25 (m, 1 H), 2.68 (dt, *J* = 2.7, 3.0 Hz, 1 H), 3.33 (q, *J* = 8.1 Hz, 1 H), 4.03 (d, *J* = 13 Hz, 1 H), 4.51 (t, *J* = 10.5 Hz, 1 H), 4.82 (q, *J* = 5.7 Hz, 1 H), 5.71 (s, 1 H), 6.69 (d, *J* = 7.5 Hz, 1 H), 7.02–7.63 (m, 8 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 20.37, 25.03, 27.13, 47.40, 54.99, 65.11, 70.60, 74.42, 103.79, 110.10, 122.57, 125.16, 126.44, 126.62, 128.09, 128.66, 129.95, 130.43, 131.27, 138.18, 141.19, 178.79.

MS: *m*/*z* = 394 (M^+ + 1).

Anal. Calcd for $C_{22}H_{23}N_3O_4$: C, 67.16; H, 5.89; N, 10.68. Found: C, 67.20; H, 5.92; N, 10.72.

2′-(Hydroxymethyl)-2′-nitro-1′-(4-tolyl)-1′,2′,5′,6′,7′,7a′-hexahydrospiro[indole-3,3′-pyrrolizin]-2(1*H*)-one (10d)
Yield: 0.46 g (59%); mp 193–195 °C.

IR (KBr): 3461, 3173, 1714, 1535, 1343 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.51–1.61 (m, 1 H), 1.92–2.11 (m, 3 H), 2.36 (s, 3 H), 2.48–2.56 (m, 1 H), 2.70–2.76 (m, 1 H), 3.90 (t, *J* = 12.0 Hz, 1 H), 4.27 (d, *J* = 10.2 Hz, 1 H), 4.40–4.55 (m, 2 H), 4.92 (dd, *J* = 3.6, 12.0 Hz, 1 H), 6.90 (d, *J* = 7.5 Hz, 1 H), 7.07–7.81 (m, 7 H), 8.29 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 21.11, 27.88, 32.71, 47.97, 56.23, 64.51, 69.82, 78.11, 105.50, 111.33, 122.97, 125.03, 125.54, 129.33, 130.73, 131.09, 132.67, 137.76, 140.95, 180.08.

MS: *m*/*z* = 394 (M^+ + 1).

Anal. Calcd for $C_{22}H_{23}N_3O_4$: C, 67.16; H, 5.89; N, 10.68. Found: C, 67.20; H, 5.86; N, 10.65.

1′-(Hydroxymethyl)-1′-nitro-2′-(4-tolyl)-1′,2′,5′,6′,7′,7a′-hexahydrospiro[indole-3,3′-pyrrolizin]-2(1*H*)-one (11d)
Yield: 0.27 g (35%); mp 178–180 °C.

IR (KBr): 3453, 3182, 1709, 1532, 1342 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.42–1.57 (m, 1 H), 1.86–1.99 (m, 2 H), 2.19 (s, 3 H), 2.27–2.42 (m, 2 H), 2.68 (dt, *J* = 1.8, 2.1 Hz, 1 H), 3.27 (dd, *J* = 8.1, 16.2 Hz, 1 H), 4.15 (d, *J* = 13.2 Hz, 1 H), 4.50 (d, *J* = 11.7 Hz, 1 H), 4.79 (dd, *J* = 5.4, 8.4 Hz, 1 H), 5.25 (s, 1 H), 6.75–7.51 (m, 8 H), 8.40 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 20.91, 25.01, 27.66, 48.47, 58.92, 65.32, 69.56, 73.70, 104.69, 110.21, 122.71, 125.30, 126.36, 128.58, 129.30, 129.69, 129.95, 138.13, 141.42, 179.00.

MS: *m*/*z* = 394 (M^+ + 1).

Anal. Calcd for $C_{22}H_{23}N_3O_4$: C, 67.16; H, 5.89; N, 10.68. Found: C, 67.20; H, 5.87; N, 10.71.

1′-(4-Ethylphenyl)-2′-(hydroxymethyl)-2′-nitro-1′,2′,5′,6′,7′,7a′-hexahydrospiro[indole-3,3′-pyrrolizin]-2(1*H*)-one (10e)
Yield: 0.42 g (52%); mp 153–155 °C.

IR (KBr): 3462, 2963, 1723, 1508, 1346 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.25 (t, *J* = 7.5 Hz, 3 H), 1.43–1.55 (m, 1 H), 1.92–2.12 (m, 3 H), 2.47–2.76 (m, 4 H), 3.89 (t, *J* = 12.0 Hz, 1 H), 4.25 (d, *J* = 11.3 Hz, 1 H), 4.38–4.54 (m, 2 H), 4.89 (dd, *J* = 3.9, 12.3 Hz, 1 H), 6.86–7.68 (m, 8 H), 7.71 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 15.35, 27.88, 28.47, 32.75, 47.90, 56.24, 64.50, 69.81, 78.02, 105.54, 111.16, 122.95, 125.04, 125.57, 128.05, 130.67, 130.76, 131.27, 140.82, 143.98, 179.82.

MS: *m*/*z* = 408 (M^+ + 1).

Anal. Calcd for $C_{23}H_{25}N_3O_4$: C, 67.80; H, 6.18; N, 10.31. Found: C, 67.78; H, 6.20; N, 10.29.

2′-(4-Ethylphenyl)-1′-(hydroxymethyl)-1′-nitro-1′,2′,5′,6′,7′,7a′-hexahydrospiro[indole-3,3′-pyrrolizin]-2(1*H*)-one (11e)
Yield: 0.30 g (37%); mp 163–165 °C.

IR (KBr): 3461, 3165, 1732, 1537, 1342 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.13 (t, *J* = 7.5 Hz, 3 H), 1.39–1.50 (m, 2 H), 1.93–2.00 (m, 1 H), 2.17–2.26 (m, 2 H), 2.51 (q, *J* = 7.5 Hz, 2 H), 2.66 (dt, *J* = 2.4, 2.4 Hz, 1 H), 3.26 (q, *J* = 8.4 Hz, 1 H), 4.27 (d, *J* = 12.9 Hz, 1 H), 4.48 (dd, *J* = 9.9, 11.7 Hz, 1 H), 4.77 (dd, *J* = 5.4, 8.1 Hz, 1 H), 5.27 (s, 1 H), 6.75 (d, *J* = 7.5 Hz, 1 H), 6.97–7.52 (m, 7 H), 7.73 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 25.03, 27.60, 28.22, 29.68, 48.25, 59.01, 65.63, 69.55, 73.48, 104.06, 109.98, 122.71, 125.36, 126.44, 128.44, 128.83, 129.38, 129.88, 141.26, 144.31, 178.48.

MS: *m*/*z* = 408 (M^+ + 1).

Anal. Calcd for $C_{23}H_{25}N_3O_4$: C, 67.80; H, 6.18; N, 10.31. Found: C, 67.86; H, 6.15; N, 10.33.

1′-(2-Chlorophenyl)-2′-(hydroxymethyl)-2′-nitro-1′,2′,5′,6′,7′,7a′-hexahydrospiro[indole-3,3′-pyrrolizin]-2(1*H*)-one (10l)
Yield: 0.50 g (60%); mp 178–180 °C.

IR (KBr): 3253, 3182, 1710, 1543, 1335 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.69–2.06 (m, 4 H), 2.70–2.74 (m, 2 H), 4.04 (t, *J* = 12.3 Hz, 1 H), 4.30–4.47 (m, 3 H), 5.04 (d, *J* = 10.2 Hz, 1 H), 6.89–8.09 (m, 8 H), 8.50 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 27.07, 31.29, 47.91, 52.20, 64.74, 70.12, 77.48, 106.03, 11.08, 123.23, 125.18, 127.26, 128.84, 129.83, 130.00, 130.60, 130.93, 132.73, 136.32, 141.32, 179.09.

MS: *m*/*z* = 414 (M^+ + 1), 415 (M^+ + 2).

Anal. Calcd for $C_{21}H_{20}ClN_3O_4$: C, 60.95; H, 4.87; N, 10.15. Found: C, 60.92; H, 4.90; N, 10.12.

2′-(2-Chlorophenyl)-1′-(hydroxymethyl)-1′-nitro-1′,2′,5′,6′,7′,7a′-hexahydrospiro[indole-3,3′-pyrrolizin]-2(1*H*)-one (11l)
Yield: 0.16 g (20%); mp 165–167 °C.

IR (KBr): 3461, 3175, 1759, 1538, 1342 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.43–1.52 (m, 1 H), 1.86–2.33 (m, 4 H), 2.69 (t, *J* = 7.8 Hz, 1 H), 3.47 (dd, *J* = 8.1, 16.8 Hz, 1 H), 4.04 (d, *J* = 13.2 Hz, 1 H), 4.46 (d, *J* = 12.0 Hz, 1 H), 4.91 (dd, *J* = 4.8, 8.4 Hz, 1 H), 6.01 (s, 1 H), 6.75 (d, *J* = 7.8 Hz, 1 H), 7.03–7.66 (m, 7 H), 8.01 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 24.88, 27.24, 48.23, 54.57, 65.00, 70.77, 74.67, 77.20, 103.52, 109.96, 122.77, 125.80, 125.91, 127.04, 129.35, 129.92, 130.10, 130.19, 135.99, 141.07, 178.41.

MS: *m*/*z* = 414 (M^+ + 1), 415 (M^+ + 2).

Anal. Calcd for $C_{21}H_{20}ClN_3O_4$: C, 60.95; H, 4.87; N, 10.15. Found: C, 60.98; H, 4.83; N, 10.13.

1′-(4-Chlorophenyl)-2′-(hydroxymethyl)-2′-nitro-1′,2′,5′,6′,7′,7a′-hexahydrospiro[indole-3,3′-pyrrolizin]-2(1*H*)-one (10n)
Yield: 0.51 g (62%); mp 160–162 °C.

IR (KBr): 3244, 2960, 1711, 1543, 1337 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.68–2.05 (m, 4 H), 2.70–2.74 (m, 2 H), 4.04 (t, *J* = 12.3 Hz, 1 H), 4.29–4.46 (m, 3 H), 5.04 (d, *J* = 10.2 Hz, 1 H), 6.88–8.08 (m, 8 H), 8.17 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 27.08, 31.29, 47.88, 52.17, 64.75, 70.13, 106.04, 110.98, 123.25, 125.22, 127.25, 128.82, 129.99, 130.58, 130.93, 132.72, 136.32, 141.19, 178.93.

MS: *m*/*z* = 414 (M^+ + 1), 415 (M^+ + 2).

Anal. Calcd for $C_{21}H_{20}ClN_3O_4$: C, 60.95; H, 4.87; N, 10.15. Found: C, 60.90; H, 4.83; N, 10.17.

2′-(4-Chlorophenyl)-1′-(hydroxymethyl)-1′-nitro-1′,2′,5′,6′,7′,7a′-hexahydrospiro[indole-3,3′-pyrrolizin]-2(1*H*)-one (11n)
Yield: 0.26 g (31%); mp 168–170 °C.

IR (KBr): 3473, 3162, 1723, 1572, 1342 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.45–1.49 (m, 1 H), 1.84–2.29 (m, 3 H), 2.52 (s, 1 H), 2.69 (dt, *J* = 1.8, 2.1 Hz, 1 H), 3.45 (dd, *J* = 3.3, 12.9 Hz, 1 H), 4.03 (d, *J* = 13.2 Hz, 1 H), 4.46 (d, *J* = 5.4 Hz, 1 H), 4.90 (dd, *J* = 4.8, 8.4 Hz, 1 H), 6.01 (s, 1 H), 6.74 (d, *J* = 7.5 Hz, 1 H), 7.03–7.65 (m, 7 H), 8.05 (s, 1 H).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 24.87, 27.25, 48.26, 54.55, 64.99, 70.76, 74.69, 103.53, 109.98, 122.77, 125.79, 125.91, 127.04, 129.35, 129.91, 130.18, 130.98, 141.10, 178.44.

MS: *m*/*z* = 414 (M^+ + 1), 415 (M^+ + 2).

Anal. Calcd for $C_{21}H_{20}ClN_3O_4$: C, 60.95; H, 4.87; N, 10.15. Found: C, 60.93; H, 4.89; N, 10.14.

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