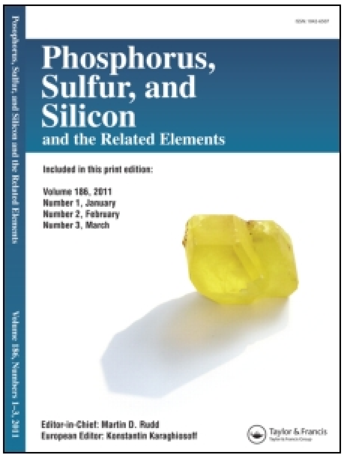

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Reaction of Hydrazonoyl Halides 55[1]: Synthesis of 2,3-Dihydro[1,3,4]-Thiadiazoles Containing Steroid Moiety

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Reaction of Hydrazonoyl Halides 55[1]: Synthesis of 2,3-Dihydro[1,3,4]-Thiadiazoles Containing Steroid Moiety

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2,3-Dihydro-1,3,4-thiadiazolylsteroids were synthesized from the appropriate hydrazonoyl halides and alkyl carbodithioates containing steroid moiety. The newly-synthesized compounds were elucidated by elemental analysis, spectral data, and alternative synthetic route whenever possible.

Keywords 2,3-dihydro-1,3,4-thiadiazoles; alkyl carbodithioate; hydrazonoyl halides; steroid

INTRODUCTION

Attention has been devoted in the literature to the synthesis of several steroidal heterocyclic derivatives that exhibit marked medicinal activities.[2–4] Heterocyclic steroids have been found to possess a variety of interesting pharmacological and biological activities.[5–8] Hydrazonoyl halides are versatile reagents have been extensively utilized in the synthesis of numerous heterocycles.[9–13]

RESULTS AND DISCUSSION

Treatment of the appropriate progesterone, androsterone, or epiandrosterone with each of methyl hydrazinecarbodithioate or benzyl hydrazinecarbodithioate in isopropyl alcohol at room temperature,

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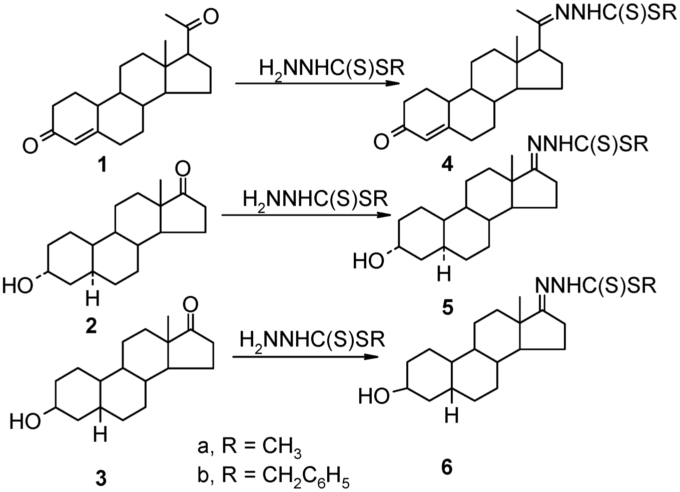
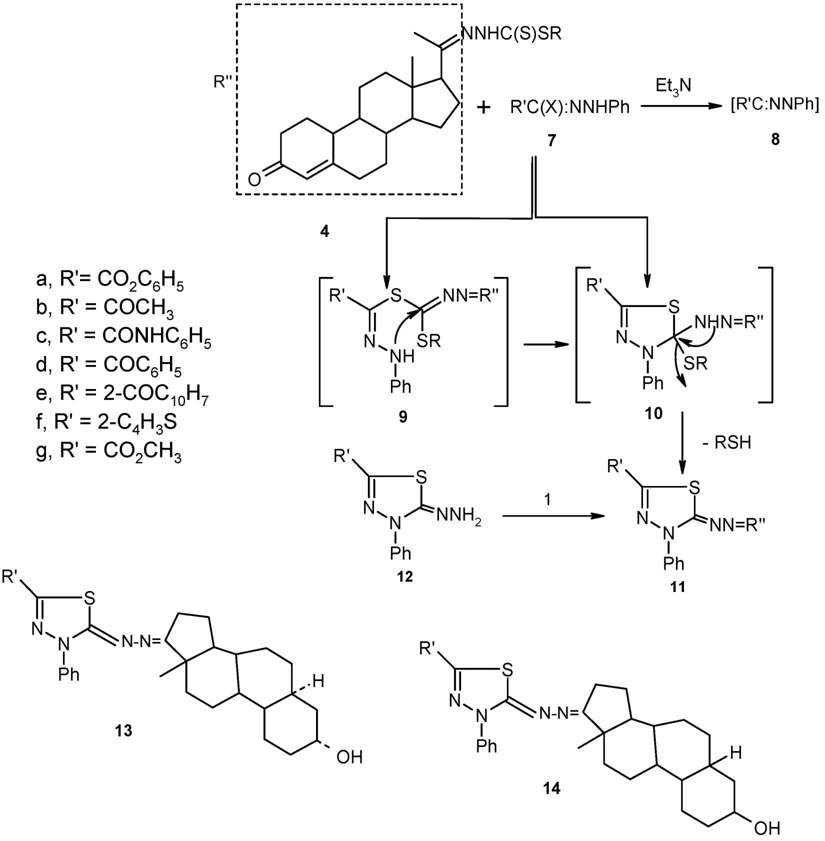
afforded the corresponding dithioate **(4–6)a**,**b**, respectively. Structures **4–6** were confirmed on the basis of elemental analysis; spectral data and chemical transformation (Scheme 1). Thus, treatment of methyl carbodithioate **4a** with ethoxycarbonyl-*N*-phenylhydrazonyl chloride **7a** in ethanolic triethylamine gave Ethyl 5-{[1-(10a,11b-dimethyl-3-oxo-2,3,5,6,6a,7,7a,8,9,10,10a,-11,11a,11b-tetradecahydro-1H-cyvlopenta[*a*]phenanthren-10-yl)ethylidene]hydrazono}-4-phenyl-2,3-dihydro[1,3,4]thiadiazol-2-carboxylate (**11**). Structure **11** was elucidated by elemental analysis, spectral data and alternative synthesis (Scheme 2).



SCHEME 1

Also, treatment of **7a** with benzyl carbodithioate **4b,** under the same experimental conditions, gave product identical in all respects (m.p., mixed m.p., and spectra) with **11a**. More evidence on the structure **11** came from the reaction of ethyl 2-hydrazino-3-phenyl-1,3,4-thiadiazoline-5-carboxylate[14] (**12**) with **1** to give product identical in all respects (m.p., mixed m.p., and spectra) with **11a** (Scheme 2).

The formation of **11** can be explained via elimination of alkyl mercaptan from cycloadduct **10**, which is assumed to be formed from 1,3-dipolar cycloaddition of nitrile imide **8** (prepared in situ from **7** with triethylamine) to C=S double bond with the appropriate **4**. Alternatively, the formation of **11** can be also explained by stepwise path involving substitution or 1,3-addition to give a cyclic hydrazone **9**. Cyclization of the latter is achieved by elimination of alkyl mercaptan. Similarly, treatment of the appropriate hydrazonoyl halides **7b–h** with appropriate amount of alkyl carbodithioates **4a,b** in ethanolic triethylamine afforded the corresponding unsymmetrical azines **11b–h**, respectively (Scheme 2).



SCHEME 2

Analogously, the appropriate hydrazonoyl halides **7a–h** reacted with the alkyl carbodithioates (**5**,**6**)**a**,**b** in ethanolic triethylamine at room temperature to give 2,3-dihdro-1,3,4-thiadiazoles **13a–h** and **14a–h**, respectively (Scheme 2).

EXPERIMENTAL

All melting points were uncorrected. IR spectra were recorded (KBr disc) on a Shimadzu FT-IR 8201 PC Spectrophotometer.^{1} H-NMR spectra were recorded in $CDCl_3$ or $(CD_3)_3SO$ on a Varian Gemini 200 MHz Spectrometer, and chemical shifts were expressed in units using TMS as an internal reference. Elemental analyses were carried out at the Microanalytical Center, Cairo University, Giza, Egypt and National Research Centre. Hydrazonoyl halides **7a–g** were prepared as previously reported in literature.[15−20]

Synthesis of Alkyl Carbothioate Derivatives 4–6—General Procedure

A mixture of the appropriate of progesterone or androsterone or epiandrosterone (10 mmol) and alkyl hydrazinecarbodithioate[21,22] (1.98 g, 10 mmol) in 1-propanol (20 mL) was stirred at room temperature for 2 h. The solid, so formed, was collected and crystallized from ethanol to give (**4–6**)**a**,**b**, respectively.

Methyl N^1-[1-(13-methyl-3-oxo-2,3,6,7,8,9,10,11,12,13,14,15,16,17-tetradecahydro-1H-cyclopenta[a]phenanthren-17-yl)ethylidene]hydrazinecarbodithioate (4a)

This compound was obtained as colorless (ethanol), m.p. 156–158°; yield 3.6 g (86%); IR: 1699 (CO) and 1622 (C=N). ^{1}H NMR ($CDCl_3$) δ 0.93 (s, 3H), 1.14 (s, 3H), 1.27 (s, 3H), 2.47 (s, 3H), 9.6 ppm (s, H, NH) and characteristic signals of cyclopentanoperhydrophenanthrene moiety.[23,24] Anal., Calcd. For $C_{23}H_{34}N_2OS_2$: C, 65.95; H, 8.18; N, 6.69; S, 15.34. Found: C, 65.51; H, 8.09; N, 6.41; S, 15.12.

Benzyl N1-[1-(13-methyl-3-oxo-2,3,6,7,8,9,10,11,12,13,14,15,16,17-tetradecahydro-1H-cyclopenta[a]phenanthren-17-yl)ethylidene]hydrazinecarbodithioate (4b)

This compound was obtained as colorless (ethanol), m.p. 105–107°, yield 3.8 g (79%); IR: 2931, 2830 (CH_3, CH_2), 1700 (CO) and 1617 (C=N); ^{1}H NMR ($CDCl_3$) δ 0.92 (s, 3H), 1.16 (s, 3H), 1.26(s, 3H), 4.23 (s, 2H, 7.01$^-$7.36 (m, 5H, ArH's), 9.6 ppm (s, H, NH) and characteristic signals of cyclopentanoperhydrophenanthrene moiety. Anal. Calc. for $C_{29}H_{38}N_2OS_2$: C, 70.40; H, 7.74; N, 5.66; S, 12.96. Found: C, 70.11; H, 7.52; N, 5.62; S, 13.12.

Methyl N^1-[(3R,5S)-3-hydroxy-13-methylhexadecahydrocyclopenta[a]-phenan-thren-17-yliden] hydrazinecarbodithioate (5a)

This compound was obtained as colorless (ethanol), m.p.1 38–140°C; yield 3.45 g (87%); IR: 3384 (OH), 2923 (CH-vinyl), and 1625 (C=N). ^{1}H NMR($CDCl_3$) δ 0.92 (s, 3H), 1.14 (s, 3H), 2.12 (s, 3H), 4.23 (s, br., 1H), 9.8 ppm (s, H, NH) and characteristic signals of cyclopentanoperhydrophenanthrene moiety .Anal. Calcd. for $C_{21}H_{34}N_2OS_2$: C, 63.88; H, 8.68; N, 7.00; S, 16.27. Found: C, 63.70; H, 8.67; N, 7.01; S, 16.10.

Benzyl N¹-[(3R,5S)-3-hydroxy-13-methylhexadecahydrocyclopenta[a]phenan-thren-17-yliden] hydrazinecarbodithioate (5b)

This compound was obtained as colorless (ethanol), m.p. 171–72°C; yield 3.9 g (82%); IR: 3350 (OH), 2923, 2850 (CH_3, CH_2) and 1638 (C=N). ^{1}H NMR ($CDCl_3$) δ 0.92 (s, 3H), 1.12 (s, 3H), 4.14 (s, 2H), 4.5 (s, 1H, OH), 7.3–7.9 ppm (m, 4H, ArH's) and characteristic signals of cyclopentanoperhydrophenanthrene moiety. Anal. Calcd. for $C_{27}H_{38}N_2OS_2$: C, 68.96; H, 8.07; N, 5.95; S, 13.64. Found: C, 68.90; H, 8.67; N, 5.87; S, 13. 41.

Methyl N¹-[3-hydroxy-13-methyl-hexadecahydrocyclopenta[a] phenanthren-17-yliden] hydrazinecarbodithioate (6a)

This compound was obtained as colorless; m.p. 220–223°C; yield 3.19 g (80%); IR: 3307 (OH), 2925, 2852 (CH3, CH2) and 1648 (C=N). 1H NMR ($CDCl_3$) δ 0.83 (s, 3H), 0.9 (s, 3H), 2.21 (s, 3H), 4.52 (s, 1H), 9.6 ppm (s, H, NH) and 0.92 (s, 3H), 1.14 (s, 3H), 2.12 (s, 3H), 4.23 (s, br., 1H), 9.8 ppm (s, H, NH) and characteristic signals of cyclopentanoperhydrophenanthrene moiety; Anal. Calcd. for $C_{21}H_{34}N_2OS_2$: C, 63.88; H, 8.68; N, 7.09; S, 16.27. Found: C, 63.70; H, 8.68; N, 6.91; S, 16.11.

Benzyl N¹-[(3R,5S)-3-hydroxy-13-methyl-hexadecahydrocyclopenta[a]phenanthren-17-yliden] hydrazinecarbodithioate (6b)

This compound was obtained as colorless (ethanol), m.p. 133–135°; yield 3.85 g (81%); IR: 3320 (OH). ^{1}H NMR ($CDCl_3$) δ 0.6 (s, 3H, CH_3), 0.8 (s, 3H, CH_3), 4.14 (s, 2H), 4.5 (s, 1H, OH), 7.1–7.4 (m, 4H, ArH's), 9.5 ppm (s, 1H, NH) 0.92 (s, 3H), 1.14 (s, 3H), 2.12 (s, 3H), 4.23 (s, br., 1H), 9.8 ppm (s, H, NH) and characteristic signals of cyclopentanoperhydrophenanthrene moiety. Anal. Calcd. for $C_{27}H_{38}N_2OS_2$: C, 68.86; H, 8.14; N, 5.95; S, 13.64. Found: C, 68.61; H, 8.10; N, 5.62; S, 13.42.

Synthesis of 2,3-dihydro-1,3,4-thiadizoles (11, 13, 14)a—g—General Procedure

Triethylamine (1.5 ml, 10 mmol) was added to mixture of the appropriate of carbodithioates (**4–6**)**a**,**b** (10 mmol) and the appropriate hydrazonyl halides **7a–h** (10 mmol) in ethanol (20 ml), while stirring at room temperature. The reaction mixture was stirred for 2 h, the solid, so formed was collected and crystallized from ethanol to give 1,3,4-thiadiazole derivatives.

Ethyl 5-{[1-(10a,11b-dimethyl-3-oxo-2,3,5,6,6a,7,7a,8,9,10,10a,11,11a,11b-tetradecahydro-1H-cyvlopenta[a]phenanthren-10-yl)ethylidene]hydrazono}-4-phenyl-2,3-dihydro [1,3,4]thiadiazol -2-carboxylate (11a)

This compound was obtained as yellow crystals (ethanol), m.p. 108–110°; yield 3.7 g (66%); IR: 2993 (CH_2), 1716 (CO) and 1671(C=N); ^{1}H NMR ($CDCl_3$) δ 1.15 (s, 3H), 1.26 (s, 3H), 1.32 (t, 3H), 2.12 (s, 3H), 4.22 (q, 2H), 5.86 (s, 1H), 7.12–7.53 ppm (m, 5H, ArH's) and characteristic signals of cyclopentanoperhydrophenanthrene moiety. Anal. Calcd. for $C_{32}H_{40}N_4O_3S$: C, 68.54; H, 7.19; N, 9.99; S, 5.72. Found: C, 68.48; H, 7.15; N, 9.95; S, 5.68.

10-(1-{[5-Acetyl-3-phenyl-3H-2,4-dihydro[1,3,4]thiadiazole] hydrozono}ethyl)-10a,11b,dimethyl-1,2,5,6,6a,7,7a,8,9,10,10a,11b-tetradecahydrocyclopenta[b]-phenanthren-3-one (11b)

This compound was obtained as yellow crystals (ethanol) m.p.. 270–273°; yield 3.2 g (60%); IR: 3448, 2933 (CH_3, CH_2), 1689 (CO), 1625 (C=N); ^{1}H NMR($CDCl_3$) δ 0.92 (s, 3H), 116 (s, 3H). 2.0 (s, 3H), 2.21 (s, 3H), 5.85 (s, 1H), 7.2–7.5 ppm (m, 5H) and characteristic signals of cyclopentanoperhydrophenanthrene moiety. Anal. Calcd. $C_{31}H_{38}N_4SO_2$: C, 70.16; H, 7.22; N, 10.56; S, 6.04. Found: C, 70.13; H, 7.10; N, 10.30; S, 6.20.

5-{[1-(10a,11b-Dimethyl-3-oxo-2,3,5,6,6a,7,7a,8,9,10,10a,11,11a,11b-tetradeca-hydro-1H-cyclopenta[b]phenanthren-10-yl)-ethylidene]hydrazono}-4-phenyl-4,5-dihydro-[1,3,4]thiadiazole-2-benzamide (11c)

This compound was obtained as yellow crystals (ethanol) m.p.. 117–120°; yield 4.2 g (66%); IR 3448 (NH), 2927 (CH_2), 1685 (CO) and 1625 (C=N). ^{1}H NMR ($CDCl_3$) δ 0.78 (s, 3H), 0.95 (s, 3H), 2.00 (s, 3H), 5.85 (s, 1H), 7.2–7.5 (m, 10H), 9.23 ppm (s, 1H) and characteristic signals of cyclopentanoperhydrophenanthrene moiety. Anal. Calcd. for $C_{36}H_{41}N_5O_2S$: C, 71.14; H, 6.80; N, 11.52; S, 5.28. Found: C, 71.10; H, 6.70; N, 10.90; S, 5.00.

10-(1-{[5-Benzoyl-3-phenyl-3H-[1,3,4]thiadiazol-2-ylidene] hydrazono}ethyl)-10a,11b-dimethyl-1,2,5,6,6a,7,7a,8,9,10,10a,11,11a,11b-tetradecahydrocyclo-penta[b]phenanthren-3-one (11d)

This compound was obtained as yellow crystals (ethanol) m.p. 170–171°; yield 3.95 g (68%); IR: 2933 (CH_2), 1741 (CO) and 1671 (C=N). ^{1}H NMR ($CDCl_3$) δ 1.16 (s, 3H), 1.21 (s, 3H), 2.12 (s, 3H), 5.84 (s, 1H), 7.12–7.75 ppm (m, 10H. ArH's) and characteristic signals of cyclopentanoperhydro-phenanthrene moiety. Anal. Calcd. for $C_{36}H_{40}N_4O_2S$: C, 72.94; H, 6.88; N, 9.45; S, 5.40. Found: C, 72.82; H, 6.60; N, 9.65; S, 5.30.

10a,11b-Dimethyl-10-(1-{[5-(naphthalene-2-carbonyl)-3-phenyl-3H-1,3,4-thia-diazolylidene]-hydrazono}ethyl)-s1,2,5,6,6a,7,7a,8,9,10,10a,11,11a,11b-tetradecahydrocyclopenta[b] phenanthren-3-one (11e)

This compound was obtained as yellow crystals (ethanol) m.p.. 136–139°C; yield g (%); IR: 3423, 2925 (NH, CH_2) and 1623 (C=N); ^1H NMR ($CDCl_3$) δ 1.16 (s, 3H), 1.21 (s, 3H), 2.12 (s, 3H), 5.84 (s, 1H), 7.12–7.84 ppm (m, 12H. ArH's) and characteristic signals of cyclopentanoperhydro-phenanthrene moiety. Anal. Calcd. for $C_{40}H_{42}N_4O_2S$: C, 74.73; H, 6.59; N, 8.72; S, 4.99. Found: C, 74.20; H, 6.30; N, 9.00; S, 5.10.

10a,11b-Dimethyl-10-(1-{[3-phenyl-5-(thiophene-2-carbonyl)-3H-1,3,4-thiadi-azol-ylidene]hydrazono}ethyl)-1,2,5,6,6a,7,7a,8, 9,10,10a,11,11a,11b-tetradecahydro-cyclopenta[b] phenanthren-3-one (11f)

This compound was obtained as yellow crystal (ethanol), m.p. 146–149°; yield 3.39 (55%); IR: 3448, 2931 (NH, CH_2), 1700 (CO) and 1623 (C=N). ^1H NMR ($CDCl_3$): δ 1.11 (s, 3H), 1.18 (s, 3H), 2.00 (s, 3H), 5.84 (s, 1H), 7.12-7.65 ppm (m, 8H. ArH's) and characteristic signals of cyclopentanoperhydro-phenanthrene^1H NMR ($CDCl_3$) δ 0.74 (s, 3H), 0.94 (s, 3H), 3.9 (s, 3H, CH_3), 4.58 (s, 1H), 7.2–7.8 ppm (m, 5H. ArH's) and characteristic signals of cyclopentanoper-hydrophenanthrene moiety moiety. Anal. Calcd. for $C_{34}H_{38}N_4O_2S_2$: C, 68.20; H, 6.40; N, 9.36; S, 10.71. Found: C, 68.30; H, 5.90; N, 9.30; S, 10.50.

Methyl 5-{[1-(10a,11b-dimethyl-3-oxo-2,3,5,6,6a,7,7a,8,9,10, 10a,11,11a,11b-tetradecahydro-1H-cyvlopenta[a]phenanthren-10-yl)ethylidene]hydrazono}-4-phenyl-2,3-dihydro[1,3,4] thiadiazol-2-carboxylate (11g)

This compound was obtained as yellow crystal (ethanol), m.p. 157–160°C; yield 3.7 g (67%); IR 2931 (CH_3), 1747 (CO), 1725 (C=N) and 1577 (C=C). ^1H NMR ($CDCl_3$): 1.16 (s, 3H), 1.21 (s, 3H), 2.12 (s, 3H), 3.76 (s, 3H), 5.84 ppm (s, 1H) and characteristic signals of cyclopentanoperhydrophenanthrene moiety. Anal. Calcd. for $C_{31}H_{38}N_4O_3S$: C, 68.10; H, 7.01; N, 10.25; S, 5.86. Found: C, 67.65; H, 6.91; N, 10.12; S, 5.71.

Ethyl 5-{[(3R, 4aS)-3-Hydroxy-4a,10a-dimethyl-hexadecahydro-cyclopenta[b]phen-anthren-10-ylidene]hydrazono}-4-phenyl-2,5-dihydro-[1,3,4]-thiadiazole-2-carboxylate (13a)

This compound was obtained as yellow crystal (ethanol); m.p. 115–117°C; 3.1 g (57%); IR: 3750 (OH), 3384, 2921 (CH_3, CH_2), 1714 (CO) and 1625 (C=N). ^{1}H NMR ($CDCl_3$) δ 0.78 (s, 3H), 1.12 (s, 3H), 1.33 (t, 3H), 4.12 (q, 2H), 4.77 (s, 1H), 6.89–7.32 ppm (m, 5H. ArH's) and characteristic signals of cyclopentanoperhydro-phenanthrene moiety. Anal. Calcd. for $C_{30}H_{40}N_4O_3S$: C, 67.13; H, 7.51; N, 10.44; S, 5.97. Found: C, 67.00; H, 7.30; N, 10.30; S, 5.80.

1-(5-{[(3R,4aS)-3-Hydroxy-4a,10a-dimethyl-hexadecahydrocycl-openta[b]phen-anthren-10-ylidene]-hydrazono}-4-phenyl-2,5-dihydro-[1,3,4]thiadiazol-2-yl)-ethanone (13b)

This compound was obtained as yellow crystal (ethanol); m.p. 129–131°C; yield 3.4 g (67%); IR: 3448 (OH), 2925, 2860 (CH_3, CH_2), 1679 (CO) and 1627 (C=N). ^{1}H NMR ($CDCl_3$) δ 0.79 (s, 3H), 0.98 (s, 3H,), 2.22 (t, 3H), 4.73 (s, 1H), 7.03–7.45 ppm (m, 5H. ArH's) and characteristic signals of cyclopentanoperhydro-phenanthrene moiety. Anal. Calcd. for $C_{29}H_{38}N_4O_2S$: C, 68.74; H, 7.56; N, 11.06; S, 6.33. Found: C, 68.50; H, 7.30; N, 11.00; S, 6.10.

5-{[(3R,4aS)-3-Hydroxy-4a,10a-dimethyl-hexadecahydrocyclop-enta[b]phenanthren-10-ylidene]-hydrazono}-4-phenyl-2,5-dihydro-[1,3,4]thiadiazole-2-benzamide (13c)

This compound was obtained as yellow crystal (ethanol); m.p. 155–157°C; yield 3.6 g (58%); IR: 3392 (OH), 2925 (CH_2), 1683 (CO) and 1625 (C=N). ^{1}HNMR ($CDCl_3$) δ 0.85 (s, 3H), 0.92 (s, 3H), 4.72 (s, 1H), 7.2–7.7 ppm (m, 10H. ArH's), 9.23 ppm (s, 1H) and characteristic signals of cyclopentanoperhydro-phenanthrene moiety. Anal. Calcd. for $C_{34}H_{41}N_5O_2S$: C, 69.95; H, 7.08; N, 12.00; S, 5.49. Found: C, 69.40; H, 6.50; N, 11.60; S, 5.10.

5-{[(3R,4aS)-3-Hydroxy-4a,10a-dimethyl-hexadecahydro-cyclopenta[b]phenanthren-10-ylidene]hydrazono}-4-phenyl-2,5-dihydro-[1,3,4]thiadiazol-2-yl)-phenyl-methanone (13d)

This compound was obtained as yellow crystal (ethanol); m.p. 168–170°C; yield 3.5 g (61%); IR: 3363 (OH), 2927, 2840 (CH_3, CH_2), 1683 (CO) and 1625 (C=N). ^{1}HNMR ($CDCl_3$) δ 0.85 (s, 3H), 0.92 (s, 3H), 4.72 (s, 1H), 7.01–7.84 ppm (m, 10H. ArH's) and characteristic signals of cyclopentanoperhydrophenanthrene moiety. Anal. Calcd: for $C_{34}H_{40}N_4O_2S$: C, 71.77; H, 7.09; N, 9.85; S, 5.64. Found: C, 71.50; H, 7.00; N, 9.70; S, 5.50.

5-{[(3R,4aS)-3-Hydroxy-4a,10a-dimethylhexadecahydrocyclop-enta[b]phenanthren-10-ylidene]-hydrazono}-4-phenyl-2,5-dihy-dro-[1,3,4]thiadiazol-2-yl)-naphthalen-2-yl-methanone (13e)

This compound was obtained as yellow crystal (ethanol); m.p. 209–211°C; 3.01 g (52%); IR: 3380 (OH), 2927 (CH_2), 1665 (CO) and 1625 (C=N). ^1H NMR ($CDCl_3$) δ 0.76 (s, 3H), 0.93 (s, 3H), 4.57 (s, 1H) and 7.2–8.1 ppm (m, 12H. ArH's) and characteristic signals of cyclopentanoperhydrophenanthrene moiety. Anal. Calcd. for $C_{38}H_{42}N_4O_2S$: C, 73.75; H, 6.84; N, 9.05; S, 5.18. Found: C, 73.56; H, 6.40; N, 9.30; S, 5.30.

5-{[(3R,4aS)-3-Hydroxy-4a,10a-dimethylhexadecahydrocyclop-enta[b]phenanthren-10-ylidene]hydrazono}-4-phenyl-2,5-dihy-dro-[1,3,4]thiadiazol-2-yl)-thiophen-2-yl-methanone (13f)

This compound was obtained as yellow crystal (ethanol); m.p. 129–131°C; yield 3.4 g (59%): IR: 3364 (OH), 2923 (CH_2), 1672 (CO) and 1623 (C=N). ^1H NMR ($CDCl_3$), δ 0.77 (s, 3H), 0.92 (s, 3H), 4.65 (s, 1H), 7.08–7.81 ppm (m, 8H. ArH's) and characteristic signals of cyclopentanoperhydrophenanthrene moiety. Anal. Calcd. for $C_{32}H_{38}N_4O_2S_2$: C, 66.87; H, 6.66; N, 9.75; S, 11.16. Found: C, 66.60; H, 6.40; N, 9.60; S, 11.00.

Methyl 5-{[(3R, 4aS)-3-Hydroxy-4a,10a-dimethylhexadecahyd-rocyclopenta[b]-phenanthren-10-ylidene] hydrazono}-4- phenyl-2,5-dihydro-[1,3,4]thiadiazole-2-carboxylate (13g)

This compound was obtained as yellow crystal (ethanol); m.p. 122–125°C; yield 3.5 g (66%); IR: 3374 (OH), 2922 (CH_2), 1681 (CO) and 1623 (C=N); ^1H NMR ($CDCl_3$) δ 0.74 (s, 3H), 0.94 (s, 3H), 3.9 (s, 3H, CH_3), 4.58 (s, 1H), 7.2–7.8 ppm (m, 5H. ArH's) and characteristic signals of cyclopentanoperhydrophenanthrene moiety. Anal. Calcd. for $C_{29}H_{38}N_4O_3S$: C, 66.64; H, 7.33; N, 10.72; S, 6.13. Found: C, 66.40; H, 7.10; N, 10.50; S, 6.00.

Ethyl 5-{[3-Hydroxy-4a,10a-dimethylhexadecahydrocyclopenta [b]phenanthren-10-ylidene]hydrazono}-4-phenyl-2,5-dihydro [1,3,4]-thiadiazole-2-carboxylate (14a)

This compound was obtained as yellow crystal (ethanol); m.p. 162–164°C; yield 3.1 g (57%); IR: 3409 (OH), 2927, 2856 (CH_3, CH_2), 1720 (CO) and 1648 (C=N); δ ^1H NMR ($CDCl_3$) δ 0.78 (s, 3H), 1.12 (s, 3H), 1.33 (t, 3H), 4.12 (q, 2H), 4.77 (s, 1H), 6.89–7.32 ppm (m, 5H. ArH's) and characteristic signals of cyclopentanoperhydro-phenanthrene moiety. Anal. Calcd. for $C_{30}H_{40}N_4O_3S$: C, 67.11; H, 7.51; N, 10.44; S, 5.98. Found: C, 67.00; H, 7.39; N, 10.32; S, 5.67.

1-(5-{[-3-Hydroxy-4a,10a-dimethyl-hexadecahydrocyclopenta[b]phenanthren-10-ylidene]hydrazono}-4-phenyl-2,5-dihydro-[1,3,4]thiadiazol-2-yl)ethanone (14b)

This compound was obtained as yellow crystal (ethanol); m.p. 134–136°C; yield 2.8 (55%); IR: 3328 (OH), 2931, 2862 (CH_3, CH_2), 1685 (CO) and 1635 (C=N); ^{1}H NMR ($CDCl_3$) δ 0.79 (s, 3H), 0.98 (s, 3H,), 2.22 (t, 3H), 4.73 (s, 1H), 7.03–7.45 ppm (m, 5H. ArH's) and characteristic signals of cyclopentanoperhydrophenanthrene moiety. Anal. Calcd. for $C_{29}H_{38}N_4O_2S$: C, 68.71; H, 7.56; N, 11.05; S, 6.33. Found: C, 68.70; H, 7.61; N, 11.15; S, 6.23.

5-{[(3R,4aS)-3-Hydroxy-4a,10a-dimethylhexadecahydrocyclopenta[b]phen-anthren-10-ylidene]-hydrazono}-4-phenyl-2,5-dihydro-[1,3,4]thiadiazole-2-benzamide (14c)

This compound was obtained as yellow crystal (ethanol); m.p. 205–208°C; yield 4.5 g (73%); IR: 3478 (OH), 2915, 2852 (CH_3, CH_2), 1865 (CO) and 1654 (C=N). ^{1}HNMR ($CDCl_3$) δ 0.85 (s, 3H), 0.92 (s, 3H), 4.72 (s, 1H), 7.2–7.7 ppm (m, 10H. ArH's), 8.56 ppm (s, 1H) and characteristic signals of cyclopentanoperhydro-phenanthrene moiety. Anal. Calcd: for $C_{34}H_{41}N_5O_2S$: C, 69.95; H, 7.07; N, 11.99; S, 5.49. Found: C, 69.51; H, 6.59; N, 11.61; S, 5.11.

5-{[3-Hydroxy-4a,10a-dimethyl-hexadecahydro-cyclopenta[b]-phenanthren-10-ylidene]hydrazono}-4-phenyl-2,5-dihydro-[1,3,4]thiadiazol-2-yl)phenylmethanone (14d)

This compound was obtained as yellow crystal (ethanol); m.p. 179–181°C; yield 3.1 g (54%); IR: 3448 (OH), 2917, 2852 (CH_3, CH_2), 1678 (CO) and 1639 (C=N); ^{1}HNMR ($CDCl_3$) δ 0.85 (s, 3H), 0.92 (s, 3H), 4.72 (s, 1H), 7.01-7.84 ppm (m, 10H. ArH's) and characteristic signals of cyclopentanoperhydrophenanthrene moiety. Anal. Calcd. for $C_{34}H_{40}N_4O_2S$: C, 71.77; H, 7.09; N, 9.85; S, 5.64. Found: C, 71.52; H, 7.10; N, 9.91; S, 5.41.

5-{[3-Hydroxy-4a,10a-dimethyl-hexadecahydro-cyclopenta[b]-phenanthren-10-ylidene]-hydrazono}-4-phenyl-2,5-dihydro-[1,3,4]thiadiazol-2-yl)-naphthalen-2-yl-methanone (14e)

This compound was obtained as yellow crystal (ethanol); m.p. 262–264°C; yield 4.1 g (70%); IR: 3586 (OH), 2937, 2840 (CH_2, CH_3), 1668

(CO) and 1635 (C=N); ^{1}H NMR ($CDCl_3$) δ 0.76 (s, 3H), 0.93 (s, 3H), 4.57 (s, 1H) and 7.2–8.1 ppm (m, 12H. ArH's) and characteristic signals of cyclopentanoperhydrophenanthrene moiety. Anal. Calcd. for $C_{38}H_{42}N_4O_2S$: C, 75.75; H, 6.84; N, 9.05; S, 5.18. Found: C, 73.50; H, 6.81; N, 9.39; S, 5.31.

5-{[3-Hydroxy-4a,10a-dimethyl-hexadecahydrocyclopenta[b]phenanthren-10-ylidene]-hydrazono}-4-phenyl-2,5-dihydro-[1,3,4]thiadiazol-2-yl)-thiophen-2-yl-methanone (14f)

This compound was obtained as yellow crystal (ethanol); 170–173°C; yield 3.8 g (66%); IR: 3448 (OH), 2917, 2852 (CH_2, CH_3), 1668 (CO) and 1617 (C=N); ^{1}H NMR ($CDCl_3$), δ 0.77 (s, 3H), 0.92 (s, 3H), 4.65 (s, 1H), 7.08–7.81 ppm (m, 8H. ArH's) and characteristic signals of cyclopentanoperhydrophenanthrene moiety. Anal. Calcd. for $C_{32}H_{38}N_4O_2S_2$: C, 66.84; H, 6.66; N, 9.74; S, 11.17. Found: C, 66.75; H, 6.51; N, 9.49; S, 11.09.

Methyl 5-{[3-Hydroxy-4a,10a-dimethyl-hexadecahydrocyclopenta[b]phenanthren-10-ylidene]hydrazono}-4-phenyl-2,5-dihydro-[1,3,4]thiadiazole-2-arboxylate (14g)

This compound was obtained as yellow crystal (ethanol); 153–155°C; yield 2.9 g (55%); IR: 3384 (OH), 2915, 2846 (CH_2, CH_3), 1718 (CO) and 1641 (C=N); ^{1}H NMR ($CDCl_3$) δ 0.74 (s, 3H), 0.94 (s, 3H), 3.9 (s, 3H, CH_3), 4.58 (s, 1H), 7.2-7.8 ppm (m, 5H. ArH's) and characteristic signals of cyclopentanoperhydrophenanthrene moiety. Anal. Calcd. for $C_{29}H_{38}N_4O_3S$: C, 66.61; H, 7.33; N, 10.72; S, 6.14. Found: C, 66.40; H, 7.10; N, 10.50; S, 5.90.

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