# The Diterpenoids of Salvia Species

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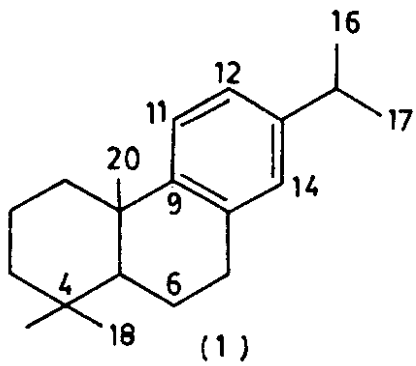
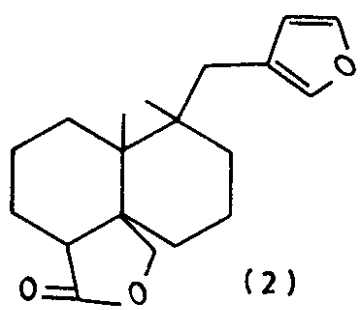
Salvia officinalis, commonly known as sage and its essential oil is used as a flavouring agent in many western countries. In the Arab world, Salvia lanigera, known as "Merremia", is used for a variety of abdominal troubles.

About 60 diterpenes and diterpene-quinones have been isolated from various Salvia species of the family Lamiaceae (Labiateae). These diterpenes may be divided into two groups: abietane (1) and neo-clerodane (2). The latter group usually contains a furan ring.




(1)



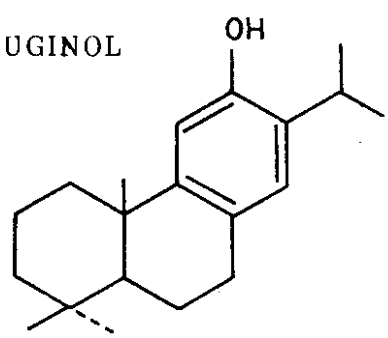

(2)

The diterpene content in Salvia species was found to vary according to the species and to the season. For example, the highest content of tanshinone-I was found in S.castanea. Maximum amounts of royleanones, on the other hand, were found in S. nemorosa and S.deserta in the spring [1]. It is noteworthy that recent investigations have shown a multiplicity of diterpenes; for instance, in S. miltiorrhiza and S.officinalis. Recently, 8 known diterpenes have been isolated from S.phlomoids along with three new compounds. Only the new compounds have been included in this review. Some of these diterpenes have shown anti-tumor activity [16]. Salvin (14) has been reported to have antibacterial activity. The same effect has been shown by the tanshinones [2] isolated from S.miltiorrhiza. Tanshinone-II is sometime used for the treatment of angina pectoris [3].

The occurrence of diterpene-quinones can be used as a taxonomic character of the genus Salvia [4].

$^1$HNMR chemical shift data are in ppm on the $\delta$ scale, using $CDCl_3$ as solvent, unless stated otherwise. UV spectra were obtained in ethanol or methanol solutions.

1. FERRUGINOL



$C_{20}H_{30}O$

MS: 285.23 ($M^+$) (5)

Characterized as its acetate.

MP: 80-81°[5]

$[\alpha]_D^{15}$: +50° (EtOH) [5]

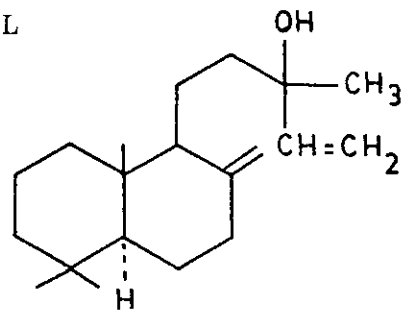
IR: ($CHCl_3$) 1745, 1160, 1360, 1365 $cm^{-1}$.

MS: Ref. [6]

$^1$H-NMR: 0.94 (S,3H), 0.97 (s,3H), 1.2 (s,3H), 1.19 (3H, d, J=7Hz), 1.21 (3H, d, J=6Hz), 2.32 (s, 3H, OAc), 2.89 (m,allylic H), 6.82 (s,1H), 6.93 (s,1H) [5].

SOURCE: S.miltiorrhiza (5)

2. MANOOL




$C_{20}H_{34}O$

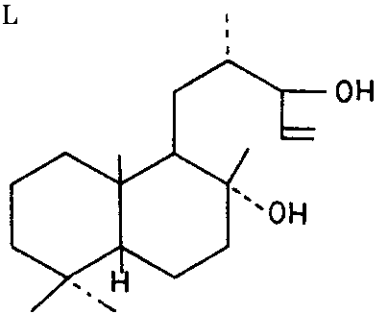
MP: 53° [7]

[α]:+ 30.4° (EtOH) [7]

The original literature was not available to the reviewers.

SOURCE: S.sclarea L. [7]

3.SCLAREOL




$C_{20}H_{36}O_2$

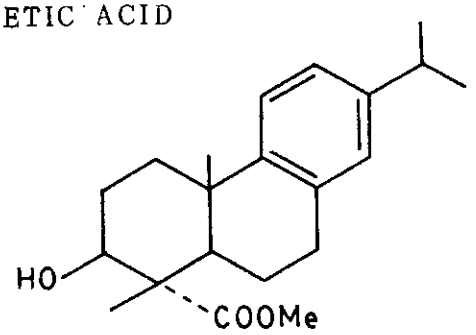
MP: 104-106°[8]

$[\alpha]_D$:-6.2°(EtOH) [8]

The original literature was not available to the reviewers.

SOURCE: S.sclarea L. [8]

4. 3β-HYDROXYDEHYDRO-ABIETIC ACID




Isolated from the plant as the free acid.

($C_{20}H_{28}O_3$) [Acetyl derivatives, [4a], OAc].

M.P.: 160-161° (Hexane-EtOAc) [9]

$[\alpha]_D^{22}$ =+53.7°($CHCl_3$) [9]

IR: (Nujol) 1740, 1610, 1600, 1240, 1125, 1050, 1038, 102,980, 880, 827 $cm^{-1}$ [9].

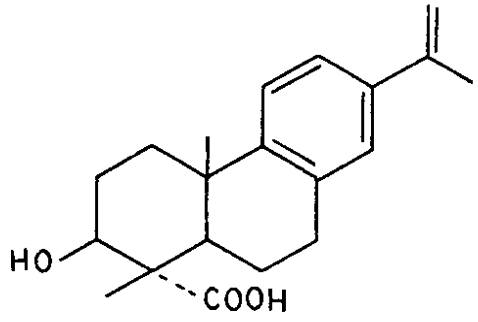
MS: 327($M^+$) (14), 357 (1.5), 330 (3.3), 312 (7.5), 297 (90), 253 (13), 237 (100), 195 (10) [9].

$^1$H-NMR: ($CDCl_3$), 1.17 (6H,d,J=6 Hz,H-16,H-17), 1.15 (3H,s,H-19), 1.20(3H,2,H-20),2.0(3H,s,H-20),2.0 (3H,s,OAc), 2.6-2.9 (3H,complex signal), 3.6(3H, s, OMe), 5.2 (1H,m, H-3), 5.8-7.1(3H,m,aromatic protons) [9]

$^{13}$C NMR: Table 1

SOURCE: S. oxyodon [9]

5.3β -01-8,11,13(14)-ABIETATETRAEN-18-OIC ACID



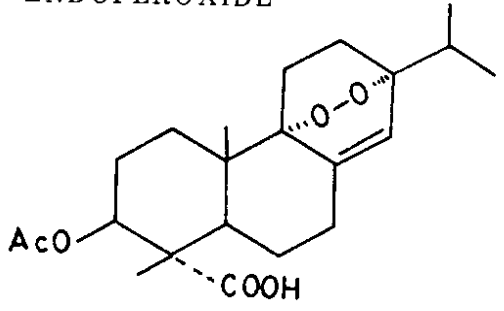

$C_{20}H_{26}O_3$
MP: 182-184° (EtOH) [10]
$[\alpha]_D$ : + 86.6° (EtOH) [10]

UV: 251 nm (log =3.2) [10].

IR: (KBr) 3440, 330, 3000, 2920, 2880, 1707, 1625,1490, 1060, 885, 828 $cm^{-1}$ [10]
MS: 314(100), 299 (20), 269 (12), 281 (40), 254 (25), 236 (60) [10].
$^1$H-NMR: ($C_5D_5N$), 1.29 (s,H-10), 1.73 (s,H-4), 2.14 (br,s, C15-$CH_3$), 1.8 (2H,m), 2.2(2H,m), 2.5 (2H,dd). 2.9(2H,br,t,benz.-$CH_2$), 4.7(1H, dd,s,), 5.50 (1H,b,rs, C=$CH_2$), 7.2-7.4 (3H,phenyl protons) [10]
$^{13}$CNMR: (Me ester, 5a, Table 1)
SOURCE: S.tomentosa [10].

6. 3β-ACETOXY ABIETA-8[14]-EN-18-OIC ACID

9α,13 -ENDOPEROXIDE




Isolated from the plant as the free acid.
and identified as the methyl ester (5).
MP: 153-155° (Hexane-EtOAc) [9].

$[\alpha]^{22}_D$ =-54.6° ($CHCl_3$) [9]

IR: (KBr) 1735, 1500, 1470, 1385, 1370, 1245, 1280, 1180, 1125, 1040, 995, 920, 890, 850 $cm^{-1}$ [9]

MS:406(6.7), 388 (12.5), 374 (100), 320 (45), 314 (14), 303 (45), 299 (79), 243 (75), 215 (50), 201 (25), 187 (45), 180 (62) [9].

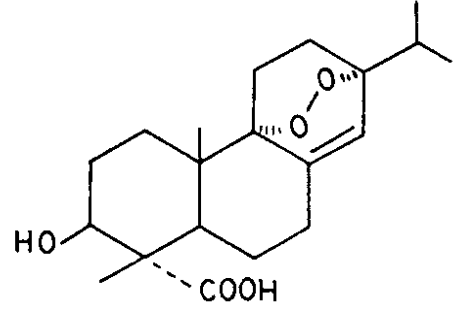
$^1$H-NMR: ($CDCl_3$) 0.95 (6H,d,J=6Hz, H-16,H-17), 1.1 (3H, s, H-19), 1.3 (3H,s, H-20), 2.0 (3H,s,OAc), 2.3-2.6(complex signal), 3.6 (3H, s,OMe), 5.2 (1H,q, $J_a$=10.5 Hz, $J_b$=4.5 Hz, H-3), 6.2 (1H,br,H-14) [9].

$^{13}$C NMR: 6.2(1H,b,H-14) [9].

$^{13}$C NMR: Table 1

SOURCE: S.oxyodon [9]

7. 3β-HYDROXY-ABIETA-8 (14)EN-18-OIC ACID 9α,13α-ENDOPEROXIDE




Identified as methyl ester (7a,-COOMe)

MP: 158-161° (Hexane-EtOAc) [9].

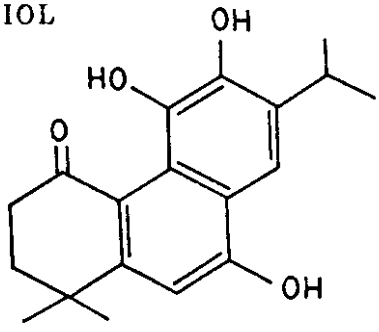
$^1$H-NMR: ($CDCl_3$) 0.95 (6H, d, J=6

Hz, H-16,H-17), 1.1 (3H, s, H-19), 1.3 (3H,s,H-20), 3.6 (3H, s, OMe), 3.95 (1H, m, H-3), 6.1 (1H,br,s, H-14) [9]

$^{13}C$ NMR: Table 1

SOURCE: S.oxyodon [9]

8. ARUCATRIOL

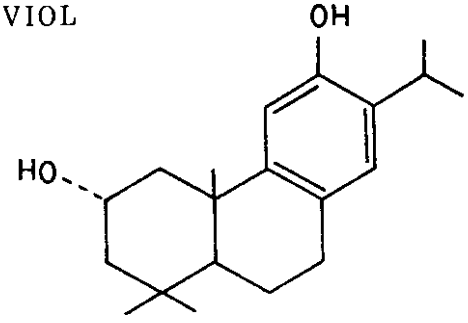



$C_{19}H_{22}O_4$

MP: 207-210° [11] Literature not avilable to the reviewers.

SOURCE: S.canariensis [11]

9. SALVIOL




$C_{20}H_{30}O_2$

MP: 108° (benzene) [12].

UV: (EtOH) 220 (log 3.93), 283 nm (3.62) [12]

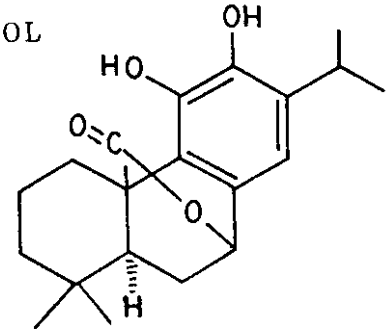
IR: (KBr) 3400, 1620, 1505 $cm^{-1}$ [12].

$^1$HNMR: ($CDCl_3$) 0.95, 0.99 (6H, $Me_2C$), 1.23 (3H, MeC), 1.22 (6H, d, J=7Hz, H-15), 2.8(2H,br,t,H-7), 4.09 (1H,dd,H-2), 6.78 and 6.83 (2H, each s, H-11 and H-14) [12].

MS: 302 ($M^+$), 287 ($M^+-CH_3$), 269 ($M^+-CH_3-H_2O$) [12].

SOURCE: S.miltiorrhiza Bge [12]

10. CARNOSOL




$C_{20}H_{26}O_4$

MP: 235-237° [13]
UV: (EtOH) 226 (12), 288 (3120) nm [13]

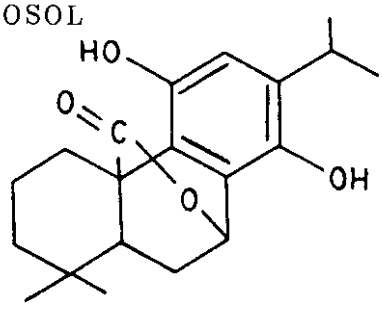
IR: (KBr) 2570, 3330, 2980, 2890, 1170 $cm^{-1}$ [13].

$^1$H NMR: ($C_5D_5N$) 0.8-1.05 (2Me, H-16,17), 1.3-1.5(methyl groups in the nucleus), 6.93 (H-14),5.62 (1H, H-7), 1.65-1.41 (10 protons in the hydrogenated nucleus) [13]

$^1$H NMR: ($CDCl_3$) 0.88, 0.93, 1.15, 1.26 (4 Me, -15, 17,18,19), 5.4 (1H, H-7) [14]

SOURCES: S.triloba [13] S.officinalis [14]

11. ISOCARNOSOL



$C_{20}H_{26}O_4$

MP: 216° (MeOH) [15].

$[\alpha]_D^{20}$ -80 ($CHCl_3$)

UV: (MeOH) 235, 295, 320 nm [15].
IR: 1500, 1450, 1400, 1350, 1205, 1050, 870 $cm^{-1}$ [15].

$^1H$ NMR: ($CDCl_3$),

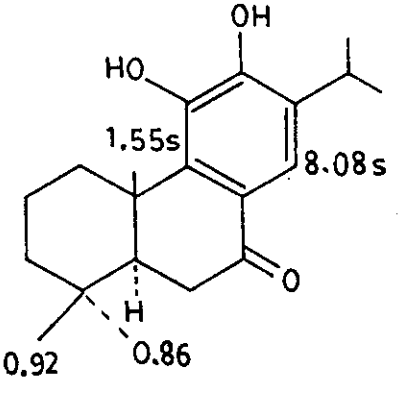
0.85 (s,3H), 0.89 (s,3H), 1.18 (d, J=5.7Hz,2x3H), 2.48 (dd, J=5 and 8 Hz, 1H), 2.8 (br,d,1H), 5.35 (br.d, H-7), 6.63 (s, H-12), 1.4-2.3 ppm (complex signal) [15]

$^{13}C$ NMR: Table 1

MS: 330 ($M^+$), 286 (100), 271, 230, 218, 216, 204 [44]

SOURCE: S.lanigera [15]

12. DEMETHYLCRYPTOJAPONOL




$C_{20}H_{28}O_3$

MP: 184-187° [16]

$[\alpha]_D^{26}$:+ 31.2° (c, 0.635, $CHCl_3$) [16]

UV: (EtOH), 216.5 (4.1), 235 (3.96), 290 (3.9), 264 sh (3.36) [16]: 218.5 (4.29), 259 (4.00), 364 (4.21) (NaOMe) [16].

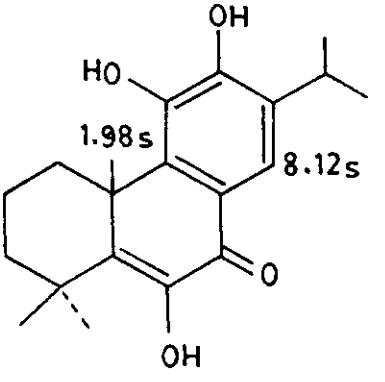
IR: (KBr), 2590, 3380 br, 3020, 3010, 2970, 2880, 1655, 1635, 1570, 1465, 1330, 1250, 1205, 1145, 1110, 995, 895, 890, 790, 780 $cm^{-1}$ [16]

MS: 316 $[M]^+$ (100), 301 (79), 260 (49), 205 (40), 189 (22), 91 (30), 77 (29), 69 (51), 55 (47) [16].

$^1H$ NMR: ($C_5D_5N$): 2.67 (dd, H-6β), 2.7 (dd,H-6 α), 3.81 (dd, J=12.3Hz, H-1 β), 1.28, 1.27 (each d, 16 and 17-$CH_3$), 3.59 (sept., H-15) [16]

SOURCE: S.phlomoides [16]

13. 14-DEOXY-COLEON U




$C_{20}H_{26}O_4$

MP: 205-207° [16]

$[\alpha]_D$:+26.8°(c,0.62,$CHCl_3$) [16]

UV: (EtOH), 215 (4.1), 251.5 (3.99), 288 (3.91), 343 (3.95) [16]: 221 (4.21), 270 (4.16), 295 (3.76), 412 (NaOMe) [16].

:224 (4.22), 270 (4.12), 280 (4.20), 329 (4.00), 380 (3.7), 464 (4.09) ($AlCl_3$) [16]

IR: (KBr), 3350, 3390, 3240-2500 br, 3030, 3000, 2940, 1630, 1585, 1555, 1415, 1345, 1275, 1190, 915, 880, 790 $cm^{-1}$ [16].

MS: 330 [$M^+$] (47), 315 (12), 287 (15), 261 (68), 260 (100), 91 (6), 83 (7), 69 (5), 55 (7) [16].

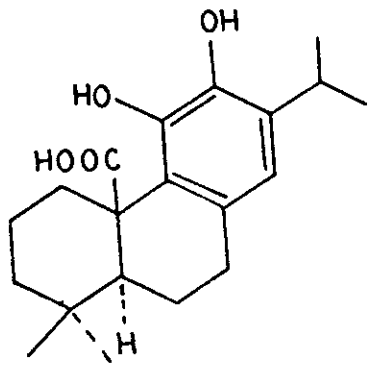
$^1H$-NMR : ($C_5D_5N$), 1.28 (d,6H,16 and 17-$CH_3$), 3.5 (H-1β ), 3.53 (sept. H-15), 1.59 and 1.63 (each 3H, 18

and 19-$CH_3$) [16]

$^{13}C$ NMR: see Table 1.

SOURCE: S.phlomoides [16]

14. SALVIN




$C_{20}H_{28}O_4$ isolated as diacetate.

MP: 196-215° (EtOH) [17].

$[\alpha]_D^{22}$:+139.8°($CHCl_3$) [17]

UV: 221 (10620), 268 (44), 276 (400) [17].

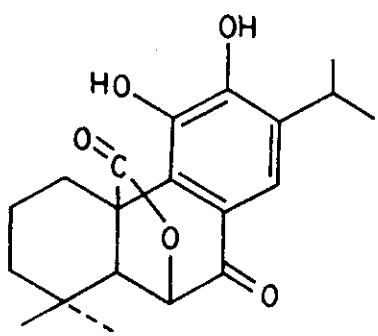
IR: ($CHCl_3$) 3400-2600 ($CO_2H$,-OH), 1775, 1700 $cm^{-1}$ [17]

Diacetyl, methyl ester

$^1H$ NMR: 0.73, 0.97, (s, $C(CH_3)_2$, 1.08, 1.15, 1.2, 1.25, (d,2x$CH_3$ of isopropyl), 2.25 (s, 2x $COCH_3$), 3.52 (s,3H, OMe) 6.97 (s,H-14) [3]

SOURCE: S.officinalis [17]

15. GALDOSOL




$C_{20}H_{23}O_5$

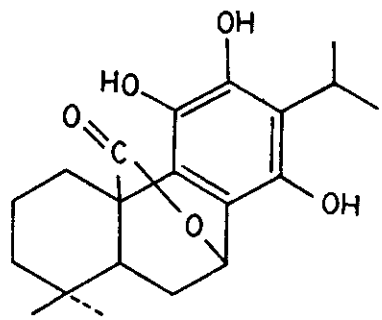
IR: ($CHCl_3$) 3350, 1780, 700 $cm^{-1}$ [18]

$^1H$ NMR: ($CDCl_3$) 7.65 (1H, s, aromatic), 4.65 (1H, s, H-6), 2.4 (1H, s, H-5), 0.9-1.2 (4-methyl groups) [18].

$^{13}C$ NMR: Table 1 (dimethyl derivative).

SOURCES: S.canariensis 1 [18,11] S.lavandulifolia 1 [9]

16. 12-HYDROXYISOCARNOSOL




$C_{20}H_{26}O_5$

MP: 245° (MeOH) [15]

IR: (KBr), 3400, 3000, 1720, 1620, 1480, 1360, 1375, 1210, 1010 $cm^{-1}$ [16].

MS: 346 ($M^+$), 302 (17), 287 (6), 246 (8), 234 (5), 232 (9), 220 (5), [15].

$^1H$ NMR: 0.9 (s,3H), 0.94 (s,3H), 1.1 (d, J=11.7 Hz, 2x3H), 2.5 (d, J=5Hz,1H), 3.14 (d,J=5.6Hz,1H), 5.27 (brd,H-7) [15].

SOURCE: S.lanigera [15].

17. MILTIRONE

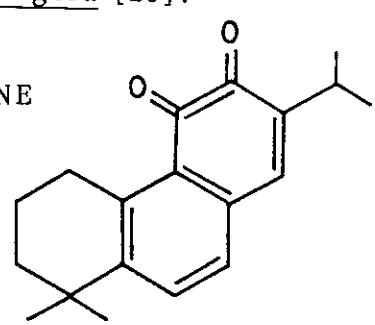


Table-1: $^{13}C$ NMR data for some naturally occurring abietane type diterpenoid in Salvia species.

| Carbon No. | 4a[9] | 5a[10] | 6a[9] | 7a[9] | Galdosol[9] | Aethiopinone[21] | Isocarnosol[15] | 14-Deoxy-coleon U[16] |
|---|---|---|---|---|---|---|---|---|
| 1 | 36.1(t) | 36.9(t) | 24.9(t) | 25.0(t) | 27.6(t) | 26.9 | 29.8(t) | 30.4(t) |
| 2 | 23.8(t) | 30.2(t) | 23.0(t) | 26.0(t) | 19.0(t) | 30.0 | 18.8(t) | 18.2(t) |
| 3 | 76.7(d) | 75.6(d) | 77.1(d) | 74.8(d) | 37.9(t) | 38.4 | 41.0(t) | 37.0(s) |
| 4 | 52.0(s) | 53.6(s) | 51.3(s) | 53.0(s) | 32.5(s) | 145.3 | 28.9(s) | 36.6(s) |
| 5 | 45.4(d) | 45.-(d) | 39.3(d) | 39.2(d) | 60.9(d) | 139.8 | 45.4(d) | 143.8(s) |
| 6 | 21.0(t) | 21.3(t) | 22.0(t) | 22.0(t) | 80.6(d) | 136.4 | 34.4(t) | 143.9(s) |
| 7 | 29.8(t) | 27.3(t) | 28.9(t) | 29.2(t) | 189.4(s) | 127.9 | 77.4(d) | 180.5(s) |
| 8 | 133.7(s) | 134.6(s) | 143.8(s) | 143.8(s) | 125.5(s) | 134.7 | 131.9(s) | 121.3(s) |
| 9 | 146.9(s) | 148.1(s) | 80.5(s) | 80.6(s) | 143.9(s) | 134.7 | 122.2(s) | 142.3(s) |
| 10 | 36.5(s) | 36.5(s) | 38.8(s) | 39.0(s) | 49.6(s) | 144.5 | 48.4(s) | 41.3(s) |
| 11 | 123.7(d) | 124.4(d) | 17.0(t) | 17.0(t) | 151.4(s) | 181.2 | 142.61(s) | 139.9(s) |
| 12 | 123.7(d)) | 123.3(d) | 24.2(t) | 24.2(t) | 157.2(s) | 182.1 | 111.78(d) | 149.7(s) |
| 13 | 145.7(s) | 143.1(s) | 79.3(s) | 79.4(s) | 136.0(s) | 148.4 | 134.55(s) | 135.4(s) |
| 14 | 126.3(d) | 126.2(d) | 127.3(d) | 127.1(d) | 122.7(d) | 140.0 | 142.78(s) | 116.4(d) |
| 15 | 33.3(d) | 138.7(s) | 32.1(d) | 32.1(d) | 27.1(d) | 26.8 | 26.8(s) | 27.6(d) |
| 16 | 23.8(q) | 111.9(t) | 19.2(q) | 19.6(q) | 22.8(q) | 21.4 | 22.7(q) | 22.8(q) |
| 17 | 23.8(q) | 21.7(q) | 19.3(q) | 19.3(q) | 23.0(q) | 21.4 | 22.7(q) | 23.0(q) |
| 18 | 175.7(s) | 177.8(s) | 176.0(s) | 177.2(s) | 31.6(q) | 22.3 | 19.7(q) | 28.1(q) |
| 19 | 11.6(q) | 10.7(q) | 12.3(q) | 11.3(q) | 22.0(q) | 110.0 | 31.7(q) | 27.6(q) |
| 20 | 24.4(q) | 25.1(q) | 17.4(q) | 17.4(q) | 176.3(s) | 19.7 | 176.3(s) | 28.4(q) |
| OMe | 52.0(q) | 52.2(q) | 52.3(q) | 52.2(q) | 60.6,60.4 | | | |
| OCOMe | 169.4(s) | - | 169.9(s) | | | | | |
| OCOMe | 21.0(q) | - | 21.1(q) | | | | | |

$C_{19}H_{22}O_2$

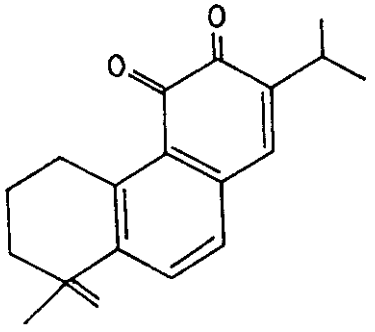
MP: 100° [19]

UV: (EtOH) 260 (4.55), 362 (3.36), 436 (3.5), nm [19].

IR: (KBr) 1660, 1635 $cm^{-1}$ [19]

SOURCES: S.miltiorrhiza Bge [19], S.drobovi [20].

18. AETHIOPINONE



$C_{20}H_{24}O_2$

Red thick oil [21]

UV: 250 (15000), 345 (145), 420 nm (1400) [21].

IR: 3030, 2960, 2940, 1680 (sh), 1660, 1450, 950, 890, 930 $cm^{-1}$ [21].

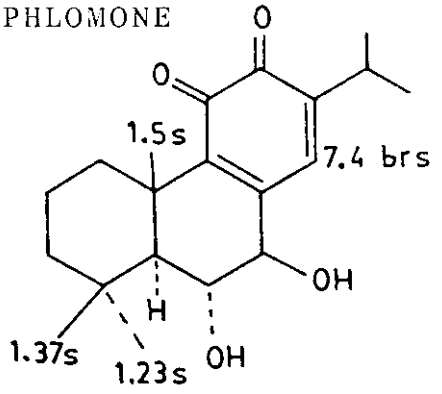
MS: 296(43), 295 (32), 294(75), 279 (17), 253 (25), 240 (89), 220(71),227 (107), 200 (75), 146 (100),130 (43), 118 (75), [21].

$^1H$ NMR: ($CDCl_3$) 1.15 (6H,d,J=7Hz), 1.76 (3H,brs,H-18), 2.33 (3H, s, H-20), 4.7 (2H,H-19), 6.96 (1H, s, H-14), 6.95 (1H,d,J=7Hz, H-6), 7.27 (1H,d,J=7Hz, H-7), 2.8-3.1(2H,m,H-1 and H-15), 1.4-1.7 (1H, m,H-2) [21].

$^{13}C$ NMR: Table 1

SOURCE: S.aethiopis [21]

19. SALVIPHLOMONE




$C_{20}H_{28}O_4$

MP: 163-165° [16]

$[\alpha]_D^{25}$ : - 330.4 (c,0.232, MeOH) [16]

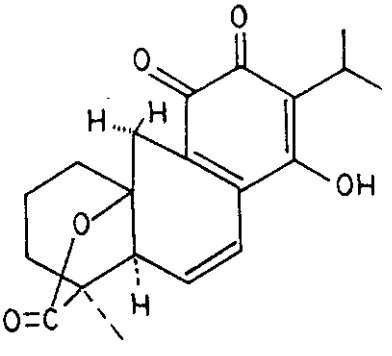
UV (EtOH): 217 (3.99), 256sh (3.52), 422 (3.48), 582 (1.9) [16].

IR (KBr): 3570,3460, 3020,2930,1665, 1653,1580,1465,1258,1120,1020,990, 890, 760, [16].

MS:334 $[M+2]^+$ (18), 332 $(M)^+$ (37), 317 (14), 91 (66), 77(63), 55 (100) [16].

$^1H$ NMR ($C_5D_5N$): 1.03, 1.04 (each s, 16 and 17-$CH_3$), 1.37 (s, 19-$CH_3$), 2.9 (br sept., H-15), 2.76(dd,H-1β) 4.35 (dd, H-6β), 4.58 (brd, H-7a) [16].

20. ROMULOGARZONE



SOURCE: S.phlomoides [16]

$C_{20}H_{22}O_5$

M.P.: 276° (dec.) [22].

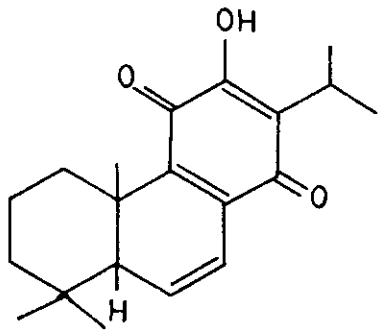
$[\alpha]^{26°}_{289}$ = - 26.5° [22]

UV: (EtOH) 205 (11207), 234 (9482), 262(7586), 271 (6652), 315 (6552), 440 (913) [22].
IR: (KBr): 3360, 3100, 2970, 2870, 1770, 1640, 1625, 1520, 1380, 1360, 1120, 730 $cm^{-1}$ [22].

MS: 334 (10%) ($M^+$+2), 342 (99) ($M^+$), 327 [15], 314 (8), 297 (53), 296 (65), 295 (80), 280 (50), 255 (85), 90 (52), 82 (77), 76 (54), 44 (77), 41 (100) [22].

$^1H$ NMR: 1.22 (6H,d,J=6.5-H), 1.29 (3H,s), 2.68 (2H,s),2.68 (1H,s) 3.1 (1H,m), 5.12 (2H,m,H-6,H-7) [22].
SOURCE: S.ballotaeflora [22].

21. 6,7-DEHYDROROYLEANONE

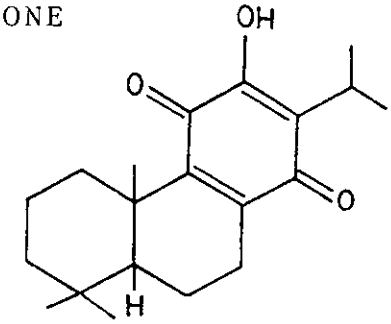



$C_{20}H_{26}O_3$

Identified by comparison of its spectral properties (IR, UV) and its TLC behaviour with those of authentic 6,7-dehydroroyleanone prepared by elimination of acetoxy group of acetoxyroyleanone [23,14].

SOURCE: S.officinalis [14].

22.ROYLEANONE

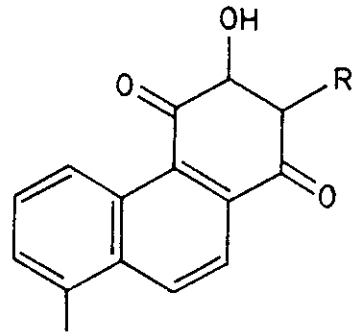



$C_{20}H_{28}O_3$

Identified by direct comparison with material prepared by hydrogenolysis of acetoxyroyleanone [19].

SOURCES: S.bucharica [24] S.lanata [25] S.nemorosa [26] S.officinalis [14] S.phlomoides [16]

23. DANSHEXINKUN (A,B,C)




A,R, = $-CHMeCH_2OH$

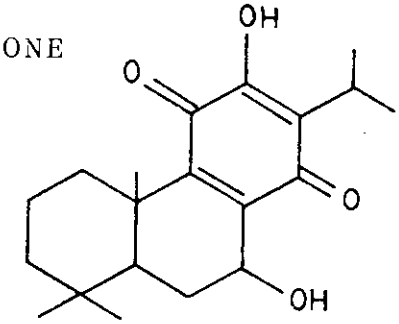
B,R = $-CH(Me)_2$

C,R = -Me

Full report given in Chinese [2]; the original literature was not available

SOURCE: S.miltiorrhiza [2].

24. HORMINONE



$C_{20}H_{28}O_4$($M^+$,m/e = 332) [30]

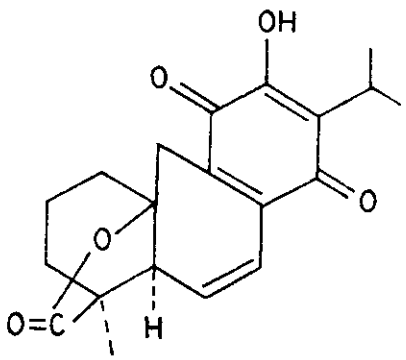
MP: 178-180° [30]
MP: 172-174° [27]

$[\alpha]_D^{20}$ :- 130.5° [27]

Identified by conversion to royleanone upon hydrogenation followed by oxidation [28,29].

SOURCES: S.carduacea [26], S.deserta [26], S.dracocephaloides [24], S.lanata [30], S.Korolkovii [24], S.pratensis [26,27,31], S.verbenaca [26]

25. ICETEXONE



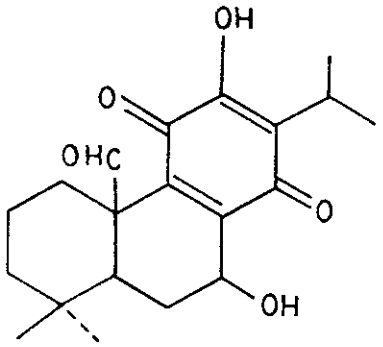

$C_{20}H_{22}O_5$

MP: 226-227° [32]
MP: 227° (dec.) [22].

$[\alpha]_D^{26}$ +33.3° ($CHCl_3$) [32]

UV: (EtOH) 213 (13900), 260 (sh), 315 (79), 430 (750) nm [32].
IR: 3600, 1770, 1640, 1620, 1600, 1450, 1420, 1380, 1370, 1320, 1240, 1195, 1145, 1105 $cm^{-1}$ [24].
MS: 342 ($M^+$, 99), 314 (73), 289 (53), 274 (60), 261 (33), 246 (40), 227 (12), 205 (30), 95 (67), 82(7), 78 (53),55(50), 43(100) [32].
SOURCE: S.ballotaeflora bench [32,22].

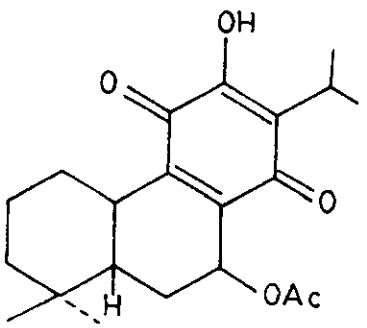
26. DESACYLNEMORONE




$C_{20}H_{26}O_5$ ($M^+$,m/z =346) [30]

MP: 222° [30]
Identified by comaprison of its IR absorption and $^1H$ NMR signals [28,18]
SOURCES: S.lanata [30] S.nemorosa [26], S.lanigera [33].

27. 7α-ACETOXY-ROYLEANONE




$C_{22}H_{30}O_5$ ($M^+$,m/z = 374) [30]

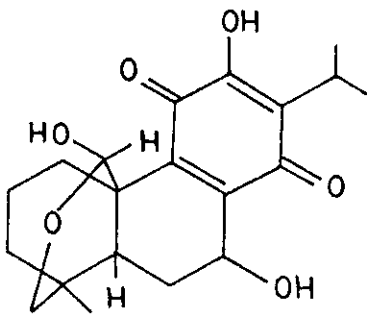
MP: 212° [30]
MP: 211-213° [14]
MP:195-8° [34]
MP:211-214 [26]

$[\alpha]_D^{20}$ - 12.4° ($CHCl_3$) [26]

UV: (MeOH) 272 (log 4.07), 406 (8.88) nm [14]
IR: (KBr) 3.05, 3.83, 6.05, 6.18, 6.22 [14]

SOURCES: S.bucharica [35], S. carduacea [26], S. deserta [26], S. lanata [30], S. lanigera [33], S. nemorosa [34], S. officinalis [14], S. phehystachya [26], S. phlomoides [16], S.pratensis [26,27], S. verbenaca [26].

28. CONACYTONE



$C_{20}H_{26}H_6$

MP:240° [32]

MP: 210-212° (dec.) [22]

$[\alpha]^{25}_{589}$:-36.5° ($CHCl_3$) [32]

UV: (EtOH) 204 (24000), 272 (12600) 380 (579)nm [32]

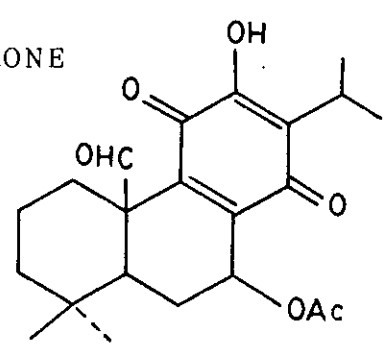
IR: 3350, 3320 (br), 2970, 2940, 2880, 1660, 1625, 1610, 1460, 1395, 1370, 1330, 1250 $cm^{-1}$ [32].

MS: 362 ($M^+$), 344 ($M^+$-18), 316, 298, 283, 269, 255, 244, 230 [24].

$^1H$ NMR: 1.17 (6H, d, J=7Hz), 1.26 (3H, s,H-4), 1.5-2.3 (9H,m,H 1,2,3, 5,6), 3.0(1H, m, H-15), 3.98 (2H, s, H-19), 4.85 (1H,m,H-7), 5.62 (1H, s,H-20), 8.24 and 7.30 (2H,OH) [32].

SOURCE: S.ballotaeflora Bench [32,22].

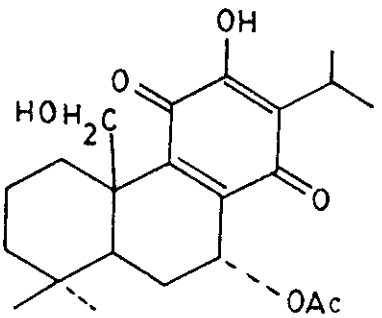
29. NEMORONE



UV,IR,MS,$^1H$ NMR and its alkaline hydrolysis [36]

SOURCE: S.nemorosa [36]

30. 20-HYDROXY-7 - ACETOXYROYLEANONE



$C_{22}H_{30}O_6$

MP: 160-162° [25]

UV: (MeOH), 280 (12000), 407 (600) [25]

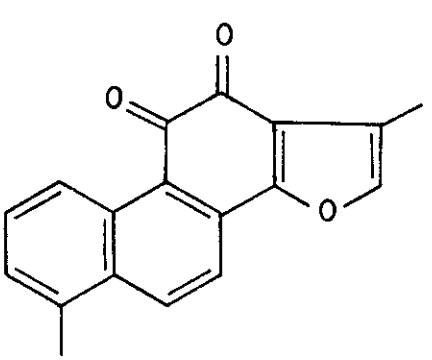
IR: (KBr), 3440 (OH), 1735, 1665, 1625 $cm^{-1}$ [25]

MS: 390 [$M^+$] [25].

$^1H$ NMR: 0.9 (6H,s, 2x$CH_3$), 1.10 and 1.15 (6H, d, J=6Hz), 2.05 (3H,s, $OCOCH_3$), 3.25 (1H, sept., J=7Hz,-$CHMe_2$), 3.6 (2H,d,J=10Hz, $CH_2$-OH), 5.7(brs, H-7), 7.2 (brs, OH) [25]

SOURCE: S. lanata [25]

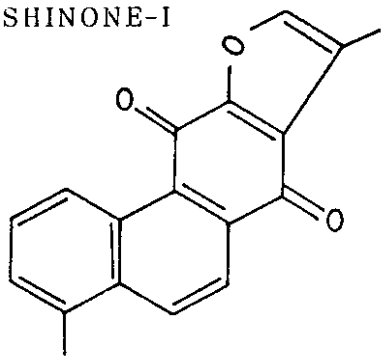
31. TANSHINONE-I



$C_{18}H_{12}O_3$

MP : 233-234° [37]
UV: (EtOH) 244.5 (log 4.62), 266 sh, (4.31), 325 (3.68), 417 nm (3.70) [37].
IR: (KBr) 1688(sh), 1660, 1593 $cm^{-1}$ [37]
SOURCES: S.miltiorrhiza [37,38,39,2] S.castanea [36], S.sclarea [40], S. triloba [34], S.karabarhensis [20].

32. ISOTANSHINONE-I

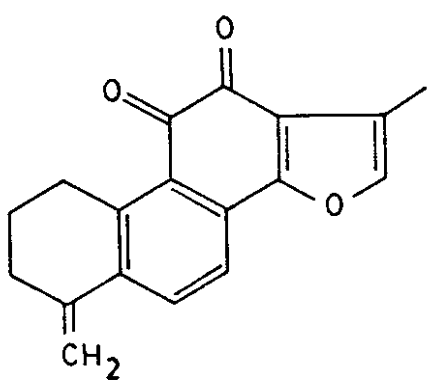


$C_{18}H_{12}O_3$ ($M^+$ 276)

MP:219° [41]
UV: 234 (4.58), 293 (4.45), 346 (3.78), 450 nm (3.28) [41]
IR (KBr) : 3150, 1660,1585,1530, 1030,845,$cm^{-1}$ [41]

$^1H$ NMR: 2.70(3H,s), 7.45 (1H,q, J=2Hz), 8.25 (2H,q,J=8Hz) [41].
SOURCES: S.miltiorrhiza Bge [41], S. sclarea [40].

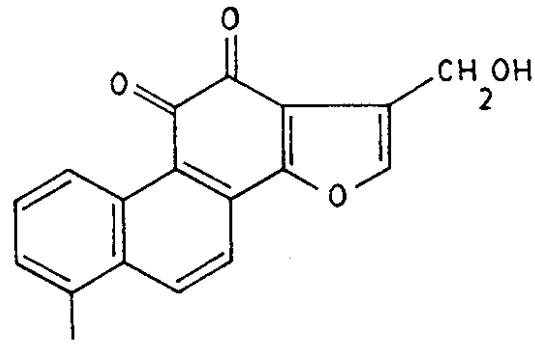
33. METHYLENETANSHINQUINONE



MP:196-8° [42]

SOURCE: S.miltiorrhiza [38,39], S.triloba [3], S. trijuga [43].

34. PRZEWAQUINONE B

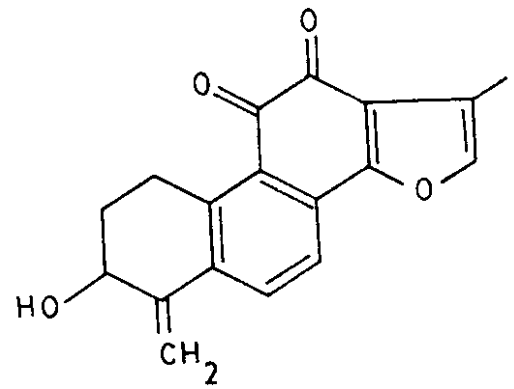


$C_{18}H_{12}O_4$

MP: 242-3° [44]

SOURCE: S. przewalskii var. mandarenorum [44]

35. HYDROXYMETHYLENETANSHIN—QUINONE

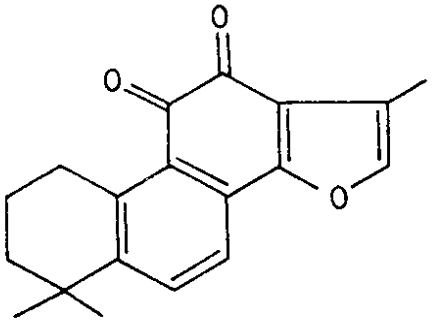


$C_{18}H_{14}O_4$

Chemical and spectral data [43].The original literature was not avilable to the reviewers.

SOURCE: S. trijuga [43].

## 36. TANSHINONE-II



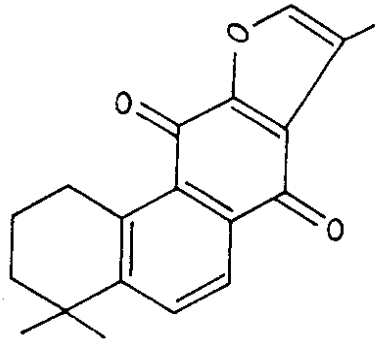
$C_{19}H_{18}O_3$

MP: 198-200° [43]
UV: (EtOH) 225 (log 4.29), 251 (4.3), 268 (4.42), 272 sh, (3.24) 348 nm (3.47) [43]

IR (KBr) : 190, 1670, 1583, 1535 $cm^{-1}$ [45]

SOURCES: S. miltiorrhiza [20,43,29, 30,31,39] S.trijuga [43], S.castanea [46] S.triloba [3]

## 37. ISOTANSHINONE-II



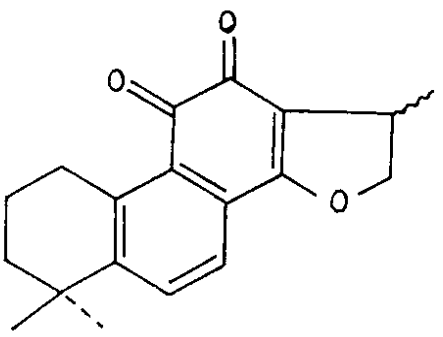
$C_{19}H_{18}O_3$ ($M^+$ 294)

MP: 208° [41]
UV: (EtOH) 227 (4.02) 253 (4.33), 256 (4.34), 303 (359), 361 nm (3.63) [41].
IR: (KBr) 3150, 1655, 1585, 1530, 1030, 840 $cm^{-1}$ [41].

$^1H$ NMR: 1.30 (6H,s), 2.32 (3H, J=1.7Hz), 7.50 (1H,q,J=1.7Hz), 1.7 (4H,m), 3.35 (2H,m) [41].

SOURCE: S. miltiorrhiza Bge [41].

## 38. CRYPTOTANSHINONE



$C_{19}H_{20}O_3$

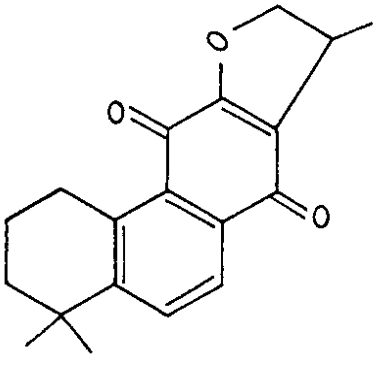
MP: 184-185° [45]
$[\alpha]_D^{21}$:-91.4° ($CHCl_3$) [45]

UV: (EtOH) 221, (log 4.26), 263 (4.471), 272 (4.41), 290 (3.96), 3.55 (3.41), 447 nm (3.42) [45]

IR (KBr) : 1680, 1648, 1620 $cm^{-1}$ [45].

SOURCES: S. miltiorrhiza [20, 38, 39, 47], S. trijuga [43], S. drabori [20], S. karabachensis [13], S.trautvetteri [20].

## 39. ISOCRYPTOTANSHINONE



$C_{19}H_{20}O_3$ ($M^+$ 296)

MP: 121° [41]
UV: (EtOH) 251 (3.97), 258 (4.10), 299 (3.79), 365 nm (3.30) [41].

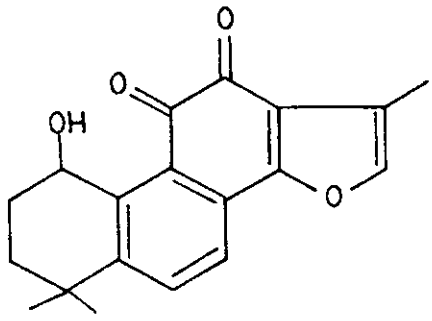
IR: 1665, 1645 $cm^{-1}$ [41].

$^1H$ NMR: 1.30 (6H,s), 1.35 (3H,d, J=7Hz), 1.65 (4H,m) 3.25 (2H,m), 3.65

(1H,m), 4.54 (2H,dd, J=10.9 and 6Hz), 7.75 (2H,ABq, J=8Hz) [41].

SOURCE: S. miltiorrhiza Bge [41].

40. HYDROXYTANSHINONE



$C_{19}H_{20}O_3$ ($M^+$ 310)

MP: 187° [35]

[α]: O° ($CHCl_3$) [35].

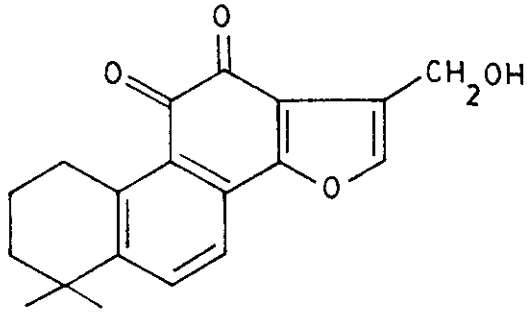
UV: (EtOH) 222, 252, 273, 348, 462 nm [35]

IR: (KBr) 3525, 3150, 1685, 1670, 1580, 1535 $cm^{-1}$ [35].

$^1H$ NMR: ($CDCl_3$) 1.28 (3H,s), 1.40 (3H,s), 2.04 (4H,brm), 2.25 (3H,d), 4.38 (1H, brs), 4.98 (1H, brs), 7.20 (1H, q), 7.62 (2H,q) [35].

SOURCES: S. miltiorrhiza Bge [35,2], S.Sclarea [40], S. trijuga [43].

41. PREZWAQUINONE A.



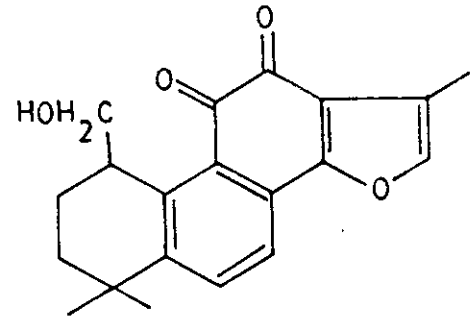
$C_{19}H_{18}O_4$

MP: 173-5° [44].

SOURCE: S.prezewaiskii var mandarinorum [44]

Original literature was not available to the reviewers.

42. TANSHINONE-IIB.



$C_{20}H_{20}O_4$

MP : 200-204° [47]

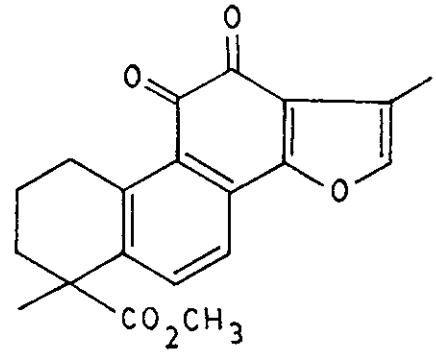
$[\alpha]_D^{20}$ : - 48.8° ($Me_2CO$) [47]

UV : (EtOH) 226, 252, 269, 276 (sh), 248, 465 nm [47]

IR (KBr) : 3558, 3465, 1690, 1665, 1638 $cm^{-1}$ [47]

SOURCES: S. miltiorrhiza [48, 47, 39,2], S. trijuga [43].

43. METHYLTANSHIONATE



$C_{20}H_{18}O_5$ ($M^+$, 338).

MP : 175-176° [35]

$[\alpha]_D$ : - 139° [35]

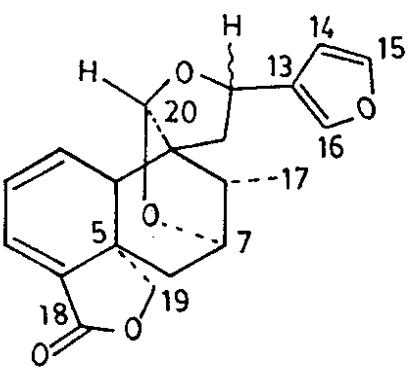
UV : (EtOH) 223, 252, 269, 352, 465 nm [35].

IR : (KBr) 3150, 1725, 1690, 1670, 1580, 1540 $cm^{-1}$ [35].

$^1H$ NMR : ($CDCl_3$) 1.62 (3H,s), 1.8 (4H,brm), 2.26 (3H,d), 3.25 (2H, brt), 3.66 (3H,s), 7.25 (1H,q), 7.52 (2H,q) [35].

SOURCES: S. miltiorrhiza Bge [35,39, 2], S. sclarea [40], S. trijuga [43].

## 44. SALVIFARICIN




$C_{20}H_{20}O_5$ [49]

MP : 214-215° (MeOH) [49].

$[\alpha]_D$ -155.2 ($CHCl_3$, c, 0.2 g)

UV : (EtOH) 207 (3.83), 297.5 nm (3.67) [49].

IR : (KBr) 3160, 1500, 880 (furan ring), 3040, 3020, 1743,1585(α βγ δunsaturated γ-lactone), 2970, 2950, 2925, 2870, 1465, 1375, 1265, 1240, 1165, 1055, 1030, 1010, 980, 940, 900, 800, 730, 700, 650 $cm^{-1}$ [49].

MS : m/e 340 ($M^+$), 282, 259, 216, 200, 189, 173, 163, 135, 115, 105, 95 (100), 94,55, 41 [49].

$^1H$ NMR : 5.83 (H-1, dd, $J_{1,10}$=10Hz; $H_{1,10}$=2Hz), 6.24 (H-2,ddd), 6.87 (H-3,d), 2.07 (H-6 α,dd), 1.26, (H-6β ,dd), 4.35 (H-7, br. d), 2.76 (H-10, dd), 2.77 (H-11α, dd), 1.88 (H-11, dd), 5.28 (H-12,t), 6.29 (H-14,m), 7.35 (H-15, m), 7.35 (H-15,m), 7.35 (H-16,m), 1.37 (Me-17,d) 4.93(H-19α d) 4.03 (H-19β,d), 5.19 (H-20,s) [49].

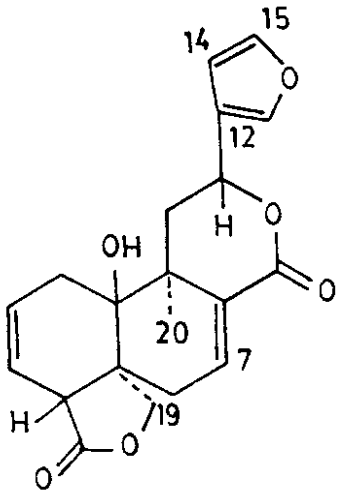
$^{13}C$ NMR : Table II [49]

SOURCE: S. farinacea [49].

Table-II: $^{13}C$ NMR data for some neoclerodane type diterpenes in Salvia species.

| Carbon No. | Slavifaricin (44) | Salviacoccin (45) | Salvifarin (46) |
|---|---|---|---|
| 1 | 126.9(d) | 29.2(t) | 58.7(d) |
| 2 | 123.5(d) | 126.8(d) | 46.2(d) |
| 3 | 132.3(d) | 121.1(d) | 130.0(d) |
| 4 | 129.7(s) | 51.2(d) | 137.8(s) |
| 5 | 57.8(s) | 45.8(s) | 58.6(s) |
| 6 | 37.9(d) | 34.3(t) | 40.6(t) |
| 7 | 83.9(d) | 132.6(d) | 87.3(d) |
| 8 | 41.5(d) | 135.9(s) | 39.2(d) |
| 9 | 34.3(s) | 41.2(s) | 38.3(s) |
| 10 | 48.9(d) | 72.5(s) | 45.7(d) |
| 11 | 38.8(t) | 40.6(t) | 38.8(t) |
| 12 | 75.1(d) | 72.9(d) | 75.6(d) |
| 13 | 128.1(s) | 124.7(s) | 127.5(s) |
| 14 | 107.8(d) | 109.2(d) | 108.3(d) |
| 15 | 143.3(d) | 143.8(d) | 143.8(d) |
| 16 | 138.1(d) | 140.3(d) | 138.6(d) |
| 17 | 14.4(q) | 169.2(s) | 14.8(q) |
| 18 | 164.9(s) | 175.4(s) | 169.1(s) |
| 19 | 80.2(t) | 73.7(t) | 79.8(t) |
| 20 | 109.3(d) | 28.1(q) | 110.2(d) |

## 45. SALVIACOCCIN




$C_{20}H_{20}O_6$ [50].

MP : 242-244° (MeOH) [50]

$[\alpha]_D^{30}$ : -139.8° (Py,c 0.49) [50].

UV: (EtOH) 215 (3.83), 220 sh (3.76), 23 nm (2.90) [50]

IR : (KBr) 3460 (OH), 3160, 3120, 1505, 880 (furan), 3040, 3030, 3010, (olefinic H), 1770 ( γ-lactone), 1708, 1655 (α,β-unsat.δ-lactone), 2980, 2950, 2920, 1430, 1380, 1365, 1280, 1260, 1230, 1180, 1165, 1140, 1050, 1035, 1015, 995, 850, 810, 800, 755, 690, 675 $cm^{-1}$ [50].

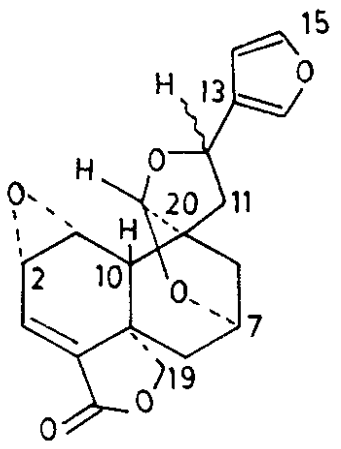
MS : m/z 356 ($M^+$), 338, 310, 245, 229 (100), 141, 129, 128, 124,107, 95, 91, 81,79, 77 [50].

$^1H$ NMR : (Py-d5) 1.0 (3Hs,), 7.57, 6.58 (2H, furan), 6.70, (1H, dd, J=4.2Hz and 5Hz), 5.92 and 5.75 (dd, J=11 Hz and 3 Hz) 5.33 (dd, 1H, J=12 Hz and 3 Hz), 4.13 and 4.03 (d, J=9 Hz), 3.21, 2.85, 1.75 and 6.48 [50].

$^{13}C$ NMR : Table II [50]

SOURCE: S. coccinea J. [50].

## 46.SALVIFARIN




$C_{20}H_{20}O_6$

MP: 220-222° (MeOH) [49]

$[\alpha]_D^{20}$ : - 53.9 ($CHCl_3$, c, 0.93) [49]

UV: (EtOH), 208 (3.70), 236.5 (3.45) [49].

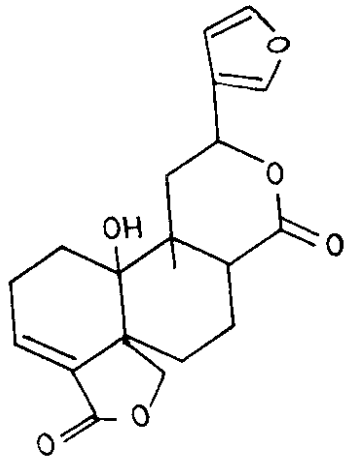
IR : (KBr) 3155, 3135, 1605, 1508, 885 (furan ring), 3065, 1755, 1675, (α,βunsat. γ-lactone) 3050, (epoxide), 3000, 2980, 2960, 2920, 2895, 2875, 1570, 1440, 1385, 1270, 1235, 1225, 1205, 1165, 1050, 1020, 1005, 960, 840, 795, 740, 715 $cm^{-1}$ [49].

MS : 356 ($M^+$,30), 340, 327, 325, 309, 256, 205, 203, 187, 171, 157, 150 (100), 145, 131, 115, 105, 95, 94, 91, 81, 77, 65, 55. [49].

$^1H$ NMR : 3.56 (m,H-1), 3.56 (m,H-2), 7.03 (m, H-3), 2.07 (dd,H-6), 1.44 (br. dd, H-6), 4.49 (brd, H-7), 2.67 (d,H-8), 2.1 (br, s, H-10), 2.91 (H-11α,dd), 2.0 (H-11β, dd) [49].

SOURCE: S. farinacea [49].

## 47. BITTER PRINCIPLE



$C_{20}H_{20}O_6$

MP : 229° [51]

$[\alpha]_D$ + 45 (c, 0.2 in acetone) [51].

UV : (MeOH) 213 nm (15000) [51]

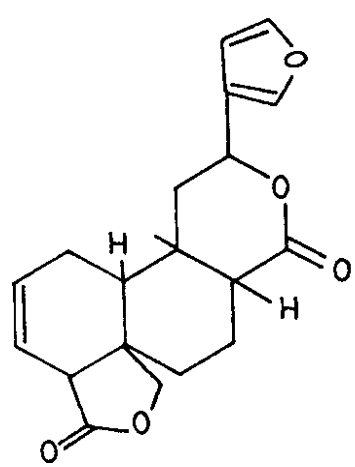
IR : (KBr) 3000 (OH), 1755 (CO), 1715 (CO), 1680 (C=C), 3140, 1500, 880 $cm^{-1}$ (furan) [51].

MS : m/z 358 ($M^+$) [51]

$^1H$ NMR : 1.15 (s, 3H) 4.3 (dd, 2H), 4.77(s, 1H), 5.65 (dd,1H), 6.53 (m, 1H), 6.7 (t,1H), 7.7 (m,2H). [51].

SOURCE: S. rubescens [51].

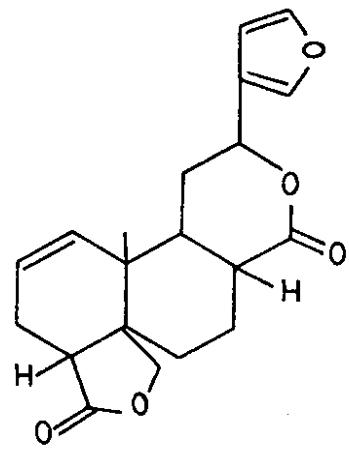
## 48. SALVIARIN



Literature not available to the reviewers.

SOURCE: S. splendens [52]

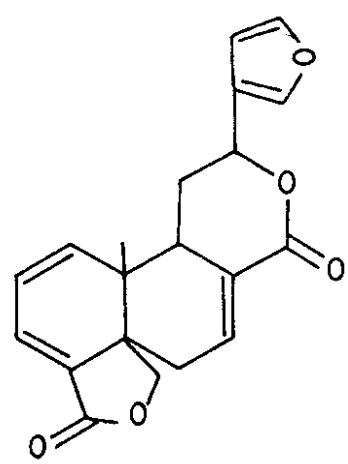
## 49. GENSNEROFLINS A



Literature not available to the reviewers

SOURCE: S. gensneraefolia [53].

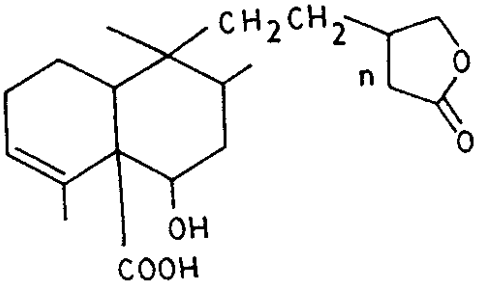
## 50. GENSNEROFLINS B :



Literature not avilable to the reviewers

SOURCE: S. gensneraefolia [53].

## 51. MELISSODORIC ACID




:Literature not available to the reviewers
Chem. and Spectral data [54].
SOURCE: S. mellisodora [54].

Botanical Sources of Diterpenes

| | Diterpene No |
|---|---|
| Salvia aethiopis | |
| Aethopinone | (18) |
| Salvia ballotaeflora | |
| Conacytone | (28) |
| Icetexone | (25) |
| Romulogarzone | (20) |
| Salvia bucharica | |
| 7 α-Acetoxy-royleanone | (27) |
| Royleanone | (22) |
| Salvia canariensis | |
| Arucatriol | (8) |
| Galdosol | (15) |
| Salvia carducea | |
| 7 α-Acetoxy-royleanone | (27) |
| Horminone | (24) |
| Slavia castanea | |
| Tanshinone-I | (31) |
| Tanshinone-II | (36) |
| Salvia coccinea | |
| Salviacoccin | (45) |
| Salvia deserta | |
| 7 α-Acetoxy-royleanone | (27) |
| Horminone | (24) |
| Salvia farinacea | |
| Salvifaricine | (44) |
| Salvifarin | (46) |
| Salvia dracocepholoides | |
| Horminone | (24) |
| Salvia drobovi | |
| Cryptotanshinone | (38) |
| Milterone | (17) |
| Salvia gensneraefolia | |
| Gensneroflins A | (49) |
| Gensneroflins B | (50) |
| Salvia karabochensis | |
| Cryptotanshinone | (38) |
| Tanshinone I | (31) |
| Salvia korolkovii | |
| Horminone | (24) |
| Salvia lanata | |
| 7 α-Acetoxy-royleanone | (27) |
| Horminone | (24) |
| 20-hydroxy-7α-acetoxyroyleanone | (30) |
| Royleanone | (22) |
| Salvia lanigera | |
| Desacylnemorone | (26) |
| 12-Hydroxyisocarnosol | (16) |
| Isocarnosol | (11) |
| Salvia lavandulifolia | |
| Galdosol | (15) |
| Salvia mellisodora | |
| Mellisodoric acid | (51) |
| Salvia miltiorrhiza | |
| Cryptotanshinone | (38) |
| Danshexinkun | (23) |
| Ferruginol | (1) |
| Hydroxytanshinone | (40) |
| Isocryptotanshinone | (39) |
| Isotanshinone-I | (32) |
| Isotanshinone-II | (37) |
| Methylenetanshinquinone | (33) |
| Methyl tanshinonate | (43) |
| Miltirone | (17) |
| Slaviol | (9) |

Tanshinone-I (31)
Tanshinone-II (36)
Tanshinone-IIB (42)

Salvia nemorosa
Desacylnemoron (26)
Nemorone (29)
Royleanone (22)

Salvia officinalis
7 α-Acetoxy-royleanone (27)
Carnosol (10)
6,7-Dehydroroyleanone (21)
Horminone (24)
Royleanone (22)
Salvin (14)

Salvia oxyodon
3β-Acetoxy abieta-8(14)-en-18-oic acid, 9α, 13, -endo peroxide (6)
3 β-Hydroxy abieta-8(14) -en-18-oic acid, 9α, 13α-endo peroxide (7)
3 β-Hydroxydehydro abietic acid (4)

Salvia oxyodon
3 -Acetoxy abieta-8(14)-en-18-oic acid, 9 ,13, -endo peroxide (6)
3 -Hydroxy abieta-8(14)-en-18-oic acid, 9 , 13 -endo peroxide (7)
3 -Hydroxydehydro abietic acid (4)

Salvia pachyastochya
7 α-Acetoxy-royleanone (27)
Horminone (24)

Salvia pratensis
7 α-Acetoxy-royleanone (27)
Horminone (24)

Salvia phlomoides
Demethylcryptojaponol (12)
14-Deoxy-coleon u (13)
Salviphlomone (19)

Salvia przewalskii
Przewaquinone A (41)
Przewaquinone B (34)

Salvia rubescens
Bitter principle (47)

Salvia sclarea
Hydroxytanshinone (40)
Isotanshinone-I (32)
Methyltanshinonate (43)
Sclareol (3)
Tanshinone-I (31)

Salvia splendens
Salviarin (48)

Salvia tomentosa
3β-ol-8,11,13(14)-Abietatetraen-18-oic acid (5)

Salvia trijuga
Cryptotanshinone (38)
Hydroxymethylenetanshinquinone (35)
Hydroxytanshinone (40)
Methylenetanshinquinone (33)
Methyl tanshinonate (43)
Tanshinone-II B (42)

Salvia triloba
Carnosol (10)
Methylenetanshinquinone (33)
Tanshinone-I (31)
Tanshinone-II 36

Salvia trautvetteri
Cryptotanshinone (38)

Salvia verbenacea
7 α-Acetoxy-royleanone (27)
Horminone (24)

## References


1. A.V.Patudin, A.S.Romanova and E.F.Tropova, *Rastit.Resur*, **12**, *531 (1976)*, *Chem.Abstr.*, **86**, *13828h.*
2. F.Chi-Nein, C.Pei-Ling and Hau Tsong-Pei, *Hua Hseuh Hsueh Pao*, **34**, *197 (1976)*, *Chem.Abstr.*, **8**, *177078z.*
3. H.Xiu-Ian, Y,Bao-Hin, H.Hui-Zhu, Xu YIN and HU Zhi-Bi, *Chih Wu Hseuh Pao*, **22**, *98 (1980)*

4. A.V.Patudin, A.S.Romanova, V.S.Sokolov and G.I.Pribylova, *Planta Medica.*, **26**, *201 (1974)*
5. T.Nakanishi, H.Miyasaka, M. Nasu, H.Hashimoto and K. Yoneda, *Phytochemistry*, **22**, *721 (1983)*
6. C.R. Enzell and R.Ryhage, *Ark.Kemi*, **26**, *425 (1966).*
7. B.L.Buchwalter, I.R. Burfitt, A.A.Nagel, E.Wenkert and F. Nair, *Helv.Chim.Acta*, **58**, *1567 (1975).*
8. O.Jeger, O.Durst and G.Buchi, *Helv.Chim.Acta*, **30**, *1853 (1947).*
9. J.Escudero, L.Perez, R.M. Rabanal and S.Valverde, *Phytochemistry*, **22**, *585 (1983)*
10. A.Ulublen and M.Miski, *J.Natural Products*, **44**, *119, (1980)*
11. A.G.Gonzalez, B.M. Fraga, J.G. Luis and A.G.Ravelo, *An.Quim.*, **71**, *701 (1975)*, *Chem. Abstr.*, **85**, *2505 x.*
12. T.Hyashi, T.Hanada, M.Ohashi and H.Kakisawa, *Chm.Comm.*, *541 (1971).*
13. A.Ulubelen, S.Ozturk and S.Isildatici, *J.Pharm.Sci.*, *1037 (1963)*
14. C.H.Brieskorn, A.Fuchs, J.B. Bredenberg, J.D. McChesney and E.Wenkert, *J.Org.Chem.*, **29**, *2293 (1964)*
15. a) H.M.G.AL-Hazimi, M.S.H. Deep and G.Miana, *Phytochemistry*, **23**, *919 (1984)* b) M.S.H. Deep, *M.Sc. Thesis (1981), King Saud University, Riyadh.*
16. J.A.H-Rodriguez, M.L.Jimeno, B.Rodriguez, G.Savona and M. Bruno, *Phytochemistry*, **22**, *2005 (1983).*
17. Horst Linde, *Helv.Chim.Acta*, **47**, *1234 (1964).*
18. A.G.Gonzalez, B.M.Fraga, J.G. Luis and A.G.Ravelo, *Experientia*, **29**, *1471 (1973)*
19. T.Hayashi, H.Kakisawa, H.Y.Hsu and Y.P.Chem, *Chem.Comm.*, *299 (1970)*
20. A.S. Romanova, A.V.Patudin and A.I. Ban 'Lovskii, *Khim.Prir.Soedin.*, **3**, *414 (1977)*, *Chem.Abstr.*, **87**, *114654t.*
21. M.Teresa Boya and S.Valverde, *Phytochemistry*, **20**, *1367 (1981).*
22. X.A.Domingueez, H.Gonzalez, R.Aragon, M.Gutierrez, J.S. Marroquin and W.Watson, *Planta Med.*, **30**, *237 (1976).*
23. Y.Okumura, H.Kakisawa, M.Kato and .Y.Hirata, *Bull.Chem.Soc.Japan*, **34**, *895 (1961)*
24. A.S.Romanova, A.V.Patudin, A.M.Makhemedov and L.N. Pervykh, *Khim.Prir.Soedin*, **4**, *564 (1980)*
25. K.S.Mukherjee, P.K.Ghosh and R.K.Mukherjee, *Phytochemistry*, **22**, *1296 (1983).*
26. A.S.Romanova, G.S.Pribylova, P.I.Zakharow, V.I.Sheichenko and A.I.Ban,lovskii, *Khim.Prir.Soedin*, **2**, *237 (1972).*
27. C.H.Brieskorn and I.Buchberger, *Planta Medica*, **24**, *190 (1973).*
28. M.Hensch, P.Rnedi and C.H.J. Eugster, *Helv.Chim.Acta*, **58**, *1921 (1975)*
29. F.Yoshizaki, P.Rnedi and C.H. Eugster, *Helv.Chim.Acta*, **62**, *2754 (1979)*
30. K.S.Mukherjee, P.K.Ghosh and S.Badruddoza, *Phytochemistry*, **20**, *1441 (1981)*
31. G.F.Vlasova, A.S.Romanova and A.J.Ban'lovskii, *Chem.Abstr.*, **76**, *138185 (1972)*
32. W.H.Watson and Z.Taira, *Tetrahedron Lett.*, *2501 (1976).*
33. M.R.I.Saleh, N.Sabri and S.E.-Masry, *Egypt.J.Pharm.Sci.*, **19**, *313 (1978)*

34. G.F.Vlasova, A.S.Romanova, M. E. Perelson and A.I.Ban lovskii, *Khim.Prir.Soedin, 317 (1969).*
35. H.Kakisawa, T.Hayashi, I. Okazaki and M.Ohashi, *Tetrahedron Lett., 3231 (1968).*
36. A.S.Romanova, G.F. Pribylova, P.J. Zakharov, V.I. Sheichenko and A.I.Ban'lovskii, *Khim.Prir.Soedin, **7**, 199 (1971), Chem.Abstr., **75**, 36375p.*
37. M.Nakao and T.Fukushima, *J.Pharm.Soc.Japan, **54**, 154 (1934).*
38 H.Xiulan, Zhu Xiuzha, Huzhibi and Y.Baojiin, *Yaoxue Tongbae, **16**, 22 (1981).*
39. C.Ming-kun, Y.Pao-Tsin, Ku Wen-Hua C.Zhen-Xion, C.Hsing -Te and Yeh Hsiu-Chin, *Hua Hsueh Hsueh Pao, **36**, 199 (1978), Chem.Abstr., **90**, 138047k (1978).*
40. A.V.Patudin, L.N.Pervykh and L.P.Zobenko, Khim.Prir. Soedin., (4), 5151 (1978).
41. H.Kakisawa, T.Hayashi and T. Yamazaki, *Tetrahedron Lett., 301 (1969).*
42. Y.Baojiin, H.Tiulan, Hu Zhibi and C.Zhengxiong, *Yaoxue Tongbao, **17**, 517 (1982)*
43. Y.Baojiin, H.Tiulan, Hu Zhibi and C.Zhengxiong, *Yaoxue Tongbao, **17**, 242 (1982), Chem.Abstr., **97**, 141677r.*
44. Y.Baojiin, Q.Mingkun, Q.Guowei and C.Zhengxiong, *Yaoxue Xuebao, **16**, 837 (1981), Chem.Abstr., **96**, 177900b (1982).*
45. K.Takiura, *J.Pharm.Soc.Japan, **61**, 475 (1941)*
46. H.Xiu-Lan, Y.Bao-Jin and Hu Zhi-Bi, *Chih Wu Hsueh Pao, **23**, 70 (1981).*
47. K.Takiura and K.Koizumi, *Chem.Pharm.Bull. **10**, 112 (1962).*
48. A.C.Baillie and R.H.Thomson, *J.Chem.Soc.(c), 48 (1968).*
49. G.Savona, D.Raffa, M.Bruno and B.Rodriguez, *Phytochemistry, **22**, 784 (1983).*
50. G.Savona, M.Bruno, M.Patermostro, J.L.Marco and B.Rodriguez, *Phytochemistry, **21**, 2563 (1982).*
51. C.H.Brieskorn and T.Stehle, *Chem.Ber., **106**, 922 (1973).*
52. G.Savona, M.Pattermostro, F. Piozzi, J.R.Hanson, P.B. Hitchcock and S.A. Thomas, *J.Chem.Soc., Perkin Trans. I, 643 (1978) Chem.Abstr., **93**, 8324z (1980)*
53. M.Jimenez, E.D.Moreno and E. Diaz, *Rev.Latinoam.Quim., **10**, 166 (1979).*
54. L.Rodriguez-Hahn, G.C.Martinez, and J.Romo., *Rev.Latinoam.Quim., **4**, 93 (1973).*