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THE WITHANOLIDES OF *WITHANIA SOMNIFERA* CHEMOTYPES I AND II*

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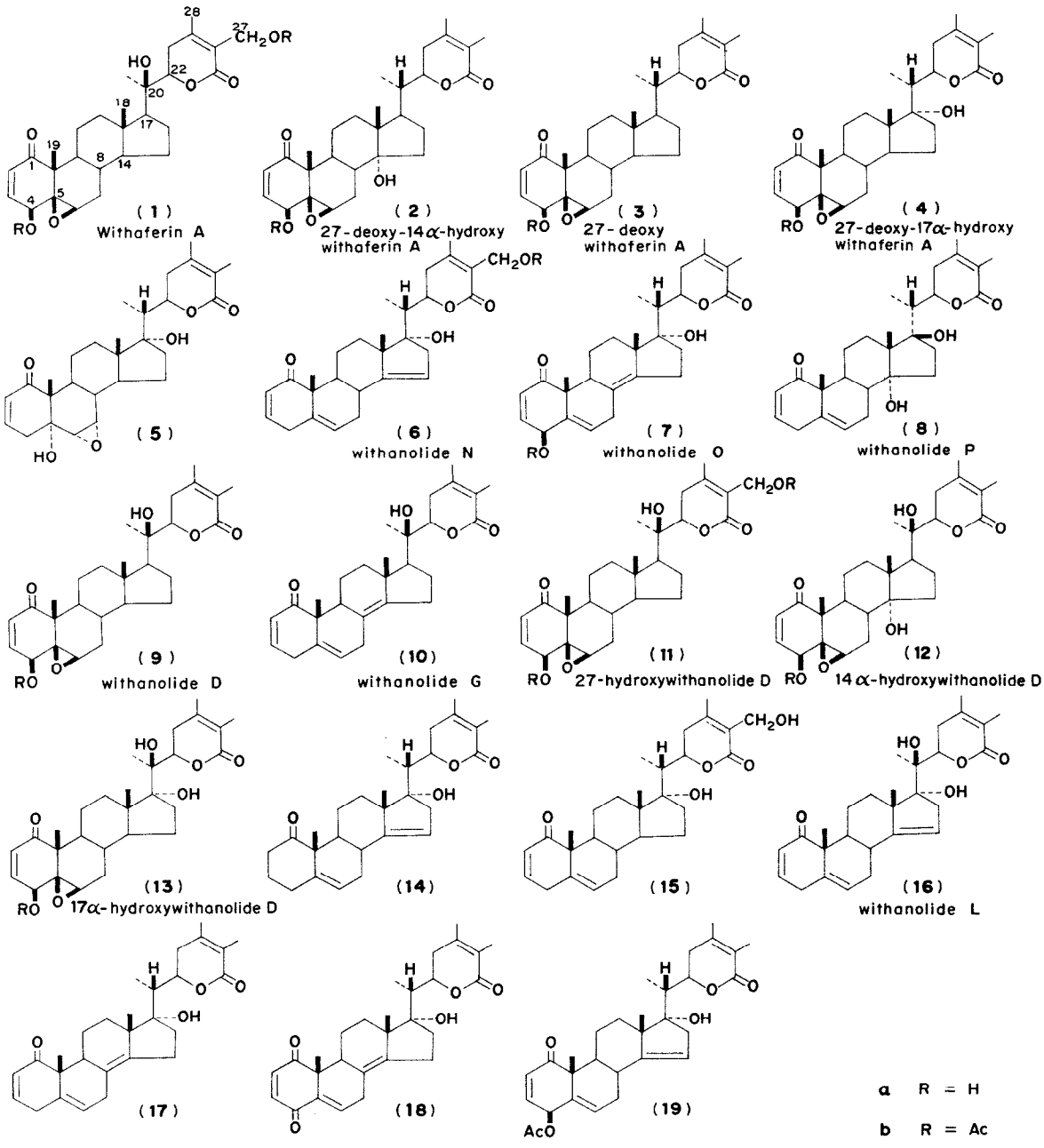
Key Word Index—*Withania somnifera*; Solanaceae; steroidal lactones; withanolides; structure determination and correlation.

Abstract—Seven steroidal lactones of the withanolide series have been isolated as minor constituents of the leaves of *Withania somnifera* Dun. (Solanaceae) chemotype I, along with the major component withaferin A. Structures have been assigned to the new compounds: withanolide N (17α,27-dihydroxy-1-oxo-20*R*,22*R*-witha-2,5,14,24-tetraenolide) (**6a**) and withanolide O (4β,17α-dihydroxy-1-oxo-20*R*,22*R*-witha-2,5,8(14),24-tetraenolide) (**7a**). Similarly the leaves of *W. somnifera* chemotype II afforded three new withanolides along with the major component withanolide D (**9a**) and trace amounts of withanolide G (**10**). The new compounds are: 27-hydroxywithanolide D (4β,20α,27-trihydroxy-1-oxo-5β,6β-epoxy-20*R*,22*R*-witha-2,24-dienolide) (**11a**), 14α-hydroxywithanolide D (4β,14α,20α-trihydroxy-1-oxo-5β,6β-epoxy-20*R*,22*R*-witha-2,24-dienolide) (**12a**) and 17α-hydroxywithanolide D (4β,17α,20α-trihydroxy-1-oxo-5β,6β-epoxy-20*S*,22*R*-witha-2,24-dienolide) (**13a**). Whereas all the withanolides of chemotype I are unsubstituted at C-20 (20α-H), those of chemotype II possess an OH at this position (20α-OH).

Withania somnifera, a plant of the Solanaceae family growing in Israel, contains three distinct genotypes, differing in their content in the leaves of variously substituted steroidal lactones of the withanolide series [1–3]. The steroidal lactones found in the chemotypes growing in South Africa [3] and India [4] have already been investigated. The components of chemotype III, which grows in the southern coastal plane of Israel, have been described previously [1]. The present work is concerned with the constituents of chemotypes I and II, the former growing in the central, and the latter in the northern region of the country [2]. For research purposes, the plants have been raised under uniform conditions.

Chromatographic separation of the crude extract of the leaves of chemotype I afforded eight withanolides (**1a**–**8a**): withaferin A (**1a**) [5] and 27-deoxy-14α-hydroxywithaferin A (**2a**) [6] have been previously reported in a population of *W. somnifera*, now identified as chemotype I. Compound **3a** was identified by direct comparison with the known 27-deoxywithaferin A, previously isolated from the African [3] and Indian [4] chemotypes; compounds **4a** and **5a** were identified as 27-deoxy-17α-hydroxywithaferin A and 5α,17α-dihydroxy-1-oxo-6α,7α-epoxy-20*R*,22*R*-witha-2,24-dienolide, respectively, both isolated from the Indian chemotype. The structures of the new withanolides N (**6a**) and O (**7a**) are hereby analysed. The last new compound in this series, withanolide P (**8**), was found to possess the unusual 17α- oriented side chain [7]; since the proof of its structure rests on arguments developed during the structure elucidation

* Part XIV in the series "Constituents of *Withania Somnifera*". For Part XIII see Glotter, E., Kirson, I., Abraham, A. and Lavie, D. (1973) *Tetrahedron* **29**, 1353.



of the related withanolides E and F [7] both occurring in chemotype III, we prefer to discuss these compounds together in a forthcoming publication.

Separation of the steroidal lactones of chemotype II afforded the known [8] withanolide D (**9**)* as the predominant component, and small amounts of withanolide G (**10**) [1], previously isolated from chemotype III. Acetylation and separation of the more polar fractions from the chromatography of the mixture, resulted in the isolation and characterization of 27-hydroxy-(**11**), 14α-

* Inadvertently, in the formula of withanolide D, in ref. 8, the 20α-OH group has been erroneously drawn with a dotted line; according to the usual designation of the stereochemistry at C-20, the formula should have been drawn as in **9**.

Table 1. NMR signals of relevant protons in new withanolides and their derivatives

Compound	2-H	3-H	4-H	6-H	15-H	22-H	Methyl groups 19-H	18-H	21-H	27 & 28-H	Other signals
6b	5·90*dq*	6·83*dq*		5·62*t*	5·25	4·66*dt*	1·25	1·03	1·15*d*		27-methylene 4·93*s* 28-H and acetate 2·07
7a	6·60*d* (10)	6·83*dd* (10; 4·7)	4·66*d* (4·7)	6·00		4·68	1·50	0·98	1·09*d* (7)	1·83 1·97	
11b	6·29*d* (10)	7·09*dd* (10; 6)	4·69*d* (6)	3·26 ($w\frac{1}{2}$ 4)		4·29*dd* (12; 6)	1·39	0·86	1·26		27-methylene 4·90*s* 28-H and acetate 2·06; 2·10
12b	6·26*d* (10)	7·06*dd* (10; 6)	4·68*d* (6)	3·31 ($w\frac{1}{2}$ 4)		4·21*dd* (12; 6)	1·41	1·00	1·26	1·95	
13b	6·27*d* (10)	7·08*dd* (10; 6)	4·68*d* (6)	3·26 ($w\frac{1}{2}$ 4)		4·51*dd* (14·5; 3·5)	1·38	0·83	1·25	1·95	
14				5·57*t*	5·23	4·60*dt*	1·30	0·99	1·08*d*	1·86 1·91	
17	5·85*dq*	6·81*dq*		5·62*t*		4·68*dt*	1·25	0·96	1·09*d*	1·86 1·91	
18	6·73*s*	6·73*s*		6·90*t* (3·5)		4·68*dt*	1·41	0·96	1·10*d* (7)	1·91	
19	6·04*d* (10)	6·73*dd* (10; 4·7)	5·82*d* (4·7)	6·15	5·28 ($w\frac{1}{2}$ 5)	4·66*dt*	1·43	1·05	1·07*d* (7)	1·91	

Spectra were recorded at 60 MHz in $CDCl_3$ solution; chemical shifts are in δ units; coupling constants (in Hz) are in parentheses. Abbreviations: *s* = singlet; *d* = doublet; *t* = triplet; *dd* = double doublet; *dt* = double triplet; *dq* = double quartet.

hydroxy-(**12**) and 17α-hydroxywithanolide D (**13**), as the corresponding acetates.

Withanolide N, (17α,27-dihydroxy-1-oxo-20*R*,22*R*-witha-2,5,14,24-tetraenolide), $C_{28}H_{36}O_5$ (**6a**) could be isolated only as the noncrystalline monoacetate (**6b**) following acetylation of certain fractions from the main chromatography and subsequent rechromatography. The monoacetate (**6b**) exhibited three bands in the carbonyl region of the IR, at 1739 (acetate), 1704 (α,β-unsaturated lactone) and 1695 cm^{-1} (α,β-unsaturated ketone). In the UV maximum absorption was at 217 nm (ε 18000) followed by strong end absorption. The outstanding features of the NMR spectrum of **6b** (Table 1) were the low field position of the 18-Me (δ 1·03) and a vinylic H signal at δ 5·25. Other signals were almost superimposable with those exhibited by a withanolide (**15**) isolated as its monoacetate from the Indian chemotype I and characterized as 17α,27-dihydroxy-1-oxo-20*R*,22*R*-witha-2,5,24-trienolide [4].

Catalytic hydrogenation (Pd–$CaCO_3$) of **6b** proceeded with the rapid absorption of two moles of hydrogen (reduction of Δ^2 and hydrogenolysis of the 27-acetate) to give the crystalline dihydrodeoxy-derivative **14**, ν_{max} 1706 and 1695 cm^{-1}; λ_{max} 220 nm (ε 10000). The only significant differences between the NMR of this compound (**14**) and that of the dihydrodeoxy-derivative of **15** were again the low field position of the 18-Me and an additional vinylic H (δ 5·23). The deshielding of the 22-H signal in these two compounds (δ 4·70 and 4·71, respectively) and its similar multiplicity indicated the presence of a 17α-OH. The Δ^{14} location of the trisubstituted double bond in **6** was substantiated by comparison of the 15-H signal (δ 5·25) in this compound, with that present in the withanolide L (**16**, δ 5·26) [1].

The only discrepancy observed in the above assignments is when the chemical shift of the 18-Me in **14** is compared with that found for dihydrodeoxy- **15**. According to Zürcher [9], the increment due to the influence of the Δ^{14} bond should be 0·25 ppm, whereas the observed value was 0·17 ppm only (the 18-Me signal in dihydro-deoxy-**15** is at δ 0·82, whereas in **14** it is at δ 0·99). Possibly this disagreement is due to the fact that Zürcher's calculations are based on experimental data obtained with 5β-steroids.

The identity of **14** was recently confirmed by direct comparison with a derivative of another withanolide (**17**) [10] isolated from specimens of plants obtained during cross-breeding experiments performed between chemotype I and III. Catalytic

hydrogenation of **17** afforded the 2,3-dihydroderivative which was isomerized under mild acidic conditions to **14** ($\Delta^{8(14)} \rightarrow \Delta^{14}$). The configuration at C-22 in **6** is (22*R*) the one usually found in the withanolides. This assignment is based on the positive Cotton effect at 251 nm ($\Delta\epsilon$ + 4·21) [1f] in the CD measurement of **14**.

Withanolide O, (4β,17α-dihydroxy-1-oxo-20*R*, 22*R* witha-2,5,8(14),24-tetraenolide) $C_{28}H_{36}O_5$ (**7a**), exhibited one band in the carbonyl region of the IR, at 1690 cm^{-1} (overlap of both α,β-unsaturated ketone and lactone) and a strong end absorption in the UV with a shoulder at 214 nm (ϵ18000). The presence of two OH groups in **7a** was inferred by formation of a bistrichloroacetyl carbamate [12], characterized by two low field NMR signals at δ 9·28 and 9·46. Acetylation of **7a** afforded the monoacetate **7b**. The NMR signals of the A and B ring protons in **7a** were almost identical with those found for the recently prepared [13] 4β-hydroxy-1-oxo-cholesta-2,5-diene.

The final proof for the location of the secondary OH was adduced by oxidation of **7a** with MnO_2 to the diene-dione **18**, λ_{max} 225 (ϵ 20800) and 278 nm (ϵ 2100) (the high intensity of the 225 nm band is due to overlap with the unsaturated lactone band of the side chain). The structure of **18** was confirmed by the NMR signals of its vinylic protons: a two proton singlet at δ 6·74 for 2-H and 3-H and a one proton triplet at δ 6·91 (J 4 Hz) for 6-H. The A_2 system due to the identical chemical shifts of the 2-H and 3-H, is well known from similar steroidal systems, for instance 1,4-dioxocholest-2-ene in both the 5α and 5β series [14].

In view of the above data and the empirical formula of **7**, a tetrasubstituted double bond should be present in the molecule, the two alternatives being Δ^8 and $\Delta^{8(14)}$. Indeed, treatment of **7b** with acid induced the migration of the double bond to the Δ^{14} position (**19**) characterized by a new NMR signal for a vinylic H at δ 5·28. The assignment of the original double bond to $\Delta^{8(14)}$ rather than Δ^8, is supported by the downfield shift of the 18-Me following the isomerization of **7b** into **19** (from δ 0·96 to δ 1·03). A similar shift was observed following the transformation of 2,3-dihydro-**17** into **14**.

The 17α-OH position of the tertiary OH in **7** was supported by the low field position of the 22-H (δ 4·68) and its pyridine induced shift ($\Delta^{CDCl_3}_{C_5D_5N}$ −0·19 ppm). The interpretation of this solvent shift is similar to that given for other 17α-hydroxywithanolides [4].

These assignments were substantiated by the fragmentation under electron impact of **7a**. The usual cleavage of the C(20)–C(22) bond [leading to the very intense signal *m/e* 125, and to *m/e* 309 (M^+-18-125)] was accompanied by a significant fragmentation of the C(17)–C(20) bond known to occur in other 17-OH substituted compounds of this series [4]. The corresponding signals were at *m/e* 299 (M^+-153) and *m/e* 281 (M^+-153-18). A very interesting fragment in the MS of **7** was due to cleavage of ring D across the C(13)–C(17) and C(15)–C(16) bonds; this cleavage resulted in the loss of 196 m.u. (the whole side chain plus the 16 and 17 carbon atoms) and the appearance of a very abundant signal at *m/e* 238 (M^+-196-18). The same cleavage was observed in the 4-keto derivative **18**, leading to an intense peak at *m/e* 254 (M^+-196). It is noteworthy that in 17α-OH withanolides lacking the $\Delta^{8(14)}$ bond, the cleavage of ring D is across the C(13)–C(17) and C(14)–C(15) bonds [4].

27-Hydroxywithanolide D, (4β,20α,27-trihydroxy-1-oxo-5β,6β-epoxy-20*R*,22*R*-witha-2,24-dienolide), $C_{28}H_{38}O_7$, (**11a**) has been isolated as the 4β,27-diacetate (**11b**). The close relationship between **11b** and **9b** was evident from their NMR spectra, all signals being similar with the exception of those related to the lactone moiety: only one vinylic Me group (δ 2·06 or 2·10) and a two H signal for the CH_2OAc group (δ 4·90). Catalytic hydrogenation of **11b** (Pd–$CaCO_3$) afforded a dihydro-deoxy-derivative identical with 2,3-dihydro **9b**.

14α-Hydroxywithanolide D, (4β,14α,20α-trihydroxy-1-oxo-5β,6β-epoxy-20*R*,22*R*-witha-2,24-dienolide), $C_{28}H_{38}O_7$ (**12a**) and the isomeric *17α-hydroxywithanolide D*, (4β,17α,20α-trihydroxy-1-oxo-5β,6β-epoxy-20*S*,22*R*-witha-2,24-dienolide (**13a**) will be analysed together in order to emphasize the subtle differences between them.

Both compounds, which were isolated as the monoacetates **12b** and **13b**, showed very similar absorption spectra in the IR and UV. The presence of two tertiary OH groups in both **12b** and **13b** was disclosed by the reaction with trichloroacetylisocyanate [12] (two low field signals for the NH protons of the carbamate moiety at δ 8·56 and 8·59 in **12b**, and at δ 8·59 and 8·64 in **13b**). Since in both compounds, the 21-Me appeared as a singlet in a

rather deshielded position ($\sim\delta$ 1·25), one of the tertiary OH groups must be located at C-20. The assignment of the second tertiary OH group at C-14 in **12**, and at C-17 in **13**, was based on NMR as well as MS arguments. The only significant differences between the NMR spectra of **12**b and **13**b, and that of **9**b, were in the chemical shifts of the 18-Me and 22-H, which were 0·83 and 4·20 (**9**b), 1·00 and 4·21 (**12**b), 0·83 and 4·51 (**13**b) respectively.

In 14α-hydroxywithanolide D (**12**) the 14α-OH is far from the 22-H and cannot perturb its environment, however it influences the 18-Me and shifts its signal downfield by 0·17 ppm (by comparison with **9**b). In compound **2**b, in which the presence of the 14α-OH has been unequivocally proven [6], the corresponding downfield shift is of 0·10 ppm. The larger deshielding observed for **12**b may well be due to the conjugated effect of the 14α-OH and 20α-OH. Such an interpretation was supported by comparing the position of the 18-Me in **3**b (δ 0·70) with that observed for **12**b. The isolated influences of the 14α-OH and the 20α-OH should contribute to the deshielding of the 18-Me signal by 0·10 and 0·13 ppm, respectively, i.e. a total contribution of 0·23 ppm; the deshielding was actually larger, 0·30 ppm.

In 17α-hydroxywithanolide D, the 17α-OH exerted the known deshielding effect on the 22-H, leaving unaffected the environment of the 18-Me. These relations were similar to those observed in **3**b (18-Me, δ 0·70; 22-H, δ 4·37) and 4b (18-Me, δ 0·71; 22-H, δ 4·70).

The pyridine induced shifts (in ppm) support the above findings: −0·14 (18-Me), −0·12 (21-Me) and −0·16 (22-H) for **12**b; −0·13 (18-Me), −0·18(21-Me) and −0·33 (22-H) for **13**b. The 18-Me is similarly influenced by the 14α-OH or the 17α-OH, whereas the proximity of the 17α-OH to the 22-H and 21-Me affects strongly the former and moderately the latter signals. A similar problem exists in withanolide J which has already been analysed [1].

Finally the MS of **12**b and **13**b point towards similar conclusions to those drawn from the NMR analysis. Cleavage of the C(17)–C(20) bond was more favored in **13** due to the presence of the 17-OH. Indeed, the abundance of the *m/e* ion 169 (the whole side chain) in **13**b was 7·36%, whereas in **12**b it accounted only for 2·42% of the total ion current. The rest of the molecule gave in **13**b a peak at *m/e* 299 (M^+-169-60) with an intensity of 0·48%, whereas in **12**b there was no significant signals for such an ion. The preferential cleavage of the C(17)–C(20) bond in **13**b resulted in a diminution of the peaks arising by the cleavage of the C(20)–C(22) bond at *m/e* 385 (M^+-125-18, 0·18%) and *m/e* 325 (M^+-125-18-60, 0·21%). Conversely, in **12**b there were more fragments of significantly higher abundance resulting from this cleavage at *m/e* 385 (M^+-125-18, 0·65%); *m/e* 367 [M^+-125-(2 × 18), 0·61%]; *m/e* 325 (M^+-125-18-60, 1·03%) and *m/e* 307 [M^+-125-60-(2 × 18), 0·62%].

EXPERIMENTAL

M.p.s were taken on a Fisher–Johns apparatus. Optical rotations were recorded in $CHCl_3$; IR spectra were recorded in $CHCl_3$; UV spectra were recorded in EtOH; NMR spectra were determined on a Varian A-60 spectrometer for 5–10% solns in $CDCl_3$, containing TMS as internal standard. CD spectra were recorded by Mrs Batia Romano with a Cary 60 spectropolarimeter. TLC were carried on chromatoplates of silica gel G (Merck) and spots were developed with iodine vapour. MS were done on an Atlas CH4 instrument under the direction of Dr Z. Zaretskii. Analyses were performed in the microanalytical laboratory of our Institute, under the direction of Mr R. Heller.

Plant material. Withania somnifera Dun, chemotypes I and II, were collected around the village of Azor (Middle coastal plane of Israel) and Migdal (Northern shore of the lake Galilee), respectively. Plants from these types were also raised from seeds in a nursery and found to be identical with the natural specimens. The extraction procedure was similar with that previously described [1].

The ethereal extracts obtained from dried leaves of chemotype I (8 kg) and chemotype II (30 kg), respectively, were introduced at the top of dry chromatographic columns of silica gel 60 (Merck 70–230 mesh; 3 kg and 8 kg respectively). The columns were eluted with mixtures of $CHCl_3$–EtOAc, 1 l. fractions were collected. Yields for chemotype I in order of elution, were 150 mg **3**, 35 mg **8**, 95 mg **5**, 225 mg **7**, 20 g mixture A, 195 mg **2**, 19 g **1** and 3·5 g mixture B.

Mixtures A and B were acetylated with Ac_2O–pyridine, overnight at room temp. and the products were chromatographed on silica gel H (Merck). The only compounds which could be isolated by elution with C_6H_6–EtOAc were **4**b (38 mg; from mixture A) and **6**b (45 mg; from mixture B).

Yields, for chemotype II in order of elution, were 55 mg **10**, 16·5 g **9** and 10·5 g mixture C. Mixture C, a dark green product, was acetylated and then chromatographed on silica gel H (Merck; 600 g). Elution with C_6H_6 EtOAc afforded **11**b (200 mg), **12**b (115 mg) and **13**b (58 mg). No other compounds could be identified in the residual material.

Compounds **1**a, **2**a, **3**a, **4**b, **5**, **9**a and **10** were identified by direct comparison with authentic samples.

Withanolide N (**6**a), 17α,27-dihydroxy-1-oxo-20*R*,22*R*-witha-2,5,14,24-tetraenolide, was isolated as the 27-acetate **6**b, which could not be induced to crystallize. $[\alpha]_D$ + 31° (*c* 0·15); ν_{max} 1739, 1704 and 1695 cm^{-1}; λ_{max} nm (ϵ 18000). (Found: M^+ 494. $C_{30}H_{38}O_6$ requires: MW 494·60).

Withanolide O (**7**a), 4β,17α-dihydroxy-1-oxo-20*R*,22*R*-witha-2,5,8(14), 24-tetraenolide, m.p. 201–202° ($CHCl_3$–EtOAc); $[\alpha]_D$ + 112·5° (*c* 0·10); ν_{max}^{KBr} 1690 cm^{-1}; λ_{max} 214 s nm (ϵ 18000)

and strong end absorption; CD (*c* 0·35, EtOH) 336(−0·29); 302i(−0·09); 256(+3·86). (Found: M^+ 452. $C_{28}H_{36}O_5$ requires: MW 452·57).

27-Hydroxywithanolide D (**11a**), 4β,20α,27-trihydroxy-1-oxo-5β,6β-epoxy-20*R*,22*R*-witha-2,24-dienolide, was isolated as the 4,27-diacetate (**11b**) m.p. 202° (acetone–hexane); $[\alpha]_D$ +17° (*c* 0·10); ν_{max} 1736, 1706 and 1683 cm^{-1}; λ_{max} 214 nm (ε 17800) (Found: C, 67·31; H, 7·43. $C_{32}H_{42}O_9$ requires: C, 67·35; H, 7·42%).

14α-Hydroxywithanolide D (**12a**), 4β,14α,20α-trihydroxy-1-oxo-5β,6β-epoxy-20*R*,22*R*-witha-2,24-dienolide, isolated as the 4-acetate (**12b**), m.p. 211–213° (EtOAc); $[\alpha]_D$ −18° (*c* 0·10); ν_{max} 1738 and 1695 cm^{-1}; λ_{max} 217 nm (ε 19800) (Found: M^+ 528. $C_{30}H_{40}O_8$ requires: MW 528·62).

17α-Hydroxywithanolide D (**13a**), 4β,17α,20α-trihydroxy-1-oxo-5β,6β-epoxy,20*S*,22*R*-witha-2,24-dienolide, isolated as the 4-acetate (**13b**), m.p. 196–197° (EtOAc); $[\alpha]_D$ +2° (*c* 0·15); ν_{max} 1738, and 1695 cm^{-1}; λ_{max} 217 nm (ε 19600). (Found: M^+ 528. $C_{30}H_{40}O_8$ requires: MW 528·62).

Hydrogenation of **6b** *to give* **14.** Compound **6b** (40 mg) in abs EtOH (50 ml) was hydrogenated over 10% Pd–$CaCO_3$ at room temp. and atm. press. The reaction was discontinued after the absorption of two molar equivalents of H_2 and the product was crystallized from EtOAc (42 mg), m.p. 217°; $[\alpha]_D$ +43° (*c* 0·15); ν_{max} 1706 and 1695 cm^{-1}; λ_{max} 220 nm (ε 10000) and strong end absorption. CD (*c* 0·40; EtOH) 251 nm (+4·21). (Found: M^+ 438. $C_{28}H_{38}O_4$ requires: MW 438·58).

Acetylation of **7a** *to give* **7b.** Compound **7a** (30 mg) in pyridine (0·2 ml) was treated with Ac_2O (0·2 ml) overnight at room temp. The product was filtered through silica gel and crystallized (28 mg) from acetone–hexane, m.p. 198–199°, $[\alpha]_D$ +100° (*c* 0·10); ν_{max} 1735 and 1702 cm^{-1}; λ_{max} 210 nm (ε 18000) and strong absorption. (Found: M^+ 494. $C_{30}H_{38}O_6$ requires: MW 494·60).

MnO_2 oxidation of **7a** *to give* **18.** Freshly prepared MnO_2 (300 mg) was added to a soln of **7a** (20 mg) in acetone (20 ml). The mixture was shaken overnight at room temp. and filtered through silica gel. The product crystallized from EtOAc (18 mg), m.p. 210–211°; $[\alpha]_D$ +80° (*c* 0·10); ν_{max} 1709, 1667, 1625 and 1608 cm^{-1}; λ_{max} 225 (ε 20800) and 278 nm (ε 2100). (Found: M^+ 450. $C_{28}H_{34}O_5$ requires: MW 450·55).

Isomerization of **7b** *to give* **19.** Dry HCl was bubbled for 1 hr at 0° through a soln of **7b** (15 mg) in $CHCl_3$ (6 ml). The solvent was removed in vacuum, the residue dissolved in Et_2O, shaken with 2% aq. $NaHCO_3$, washed with H_2O, dried and chromatographed on silica gel; elution with $CHCl_3$ yielded **19** (12 mg) which could not be induced to crystallize; λ_{max} 215 nm (ε 18500). (Found: M^+ 494. $C_{30}H_{38}O_6$ requires: MW 494·60).

Hydrogenation of **11b** *to give dihydro* **9b.** The hydrogenation was done on compound **11b** (100 mg) as described for **6b**. The product was found to be identical with an authentic sample of 2,3-dihydro-**9b**.

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