mations with respect to the C(1)—C(2) and C(8)—C(9) bonds respectively. These conformations bring the N(1)–H proton and the N(2) lone pair into a favourable position to form an intramolecular hydrogen bond. However, in DMAN these conformations are such that at each N atom one methyl group is almost eclipsed with either C(1)—C(2) or C(8)—C(9) (torsion angles −18 and −19·4° respectively) while the other methyl groups have torsion angles of 120 and 119° respectively.

References

ALDER, R. W., BOWMAN, P. S., STEELE, W. R. S. & WINTERMANN, D. R. (1968). *Chem. Commun.* pp. 723–724.

ALDER, R. W., GOODE, N. C., MILLER, N., HIBBERT, F., HUNTE, K. P. P. & ROBBINS, H. J. (1978). *Chem. Commun.* pp. 89–90.

ALLEN, F. H., KENNARD, O. & TAYLOR, R. (1983). *Acc. Chem. Res.* **16**, 146–153.

AWWAL, A. & HIBBERT, F. (1977). *J. Chem. Soc. Perkin Trans.* 2, pp. 152–156.

BROWN, D. A., CLEGG, W., COLQUHOUN, H. M., DANIELS, J. A., STEPHENSON, I. R. & WADE, K. (1987). *Chem. Commun.* pp. 889–891.

CHOJNACKI, H., LASKOWSKI, Z. & MALARSKI, Z. (1983). *J. Mol. Struct.* **102**, 251–255.

CROMER, D. T. & LIBERMAN, D. (1970). *J. Chem. Phys.* **53**, 1891–1898.

CROMER, D. T. & MANN, J. B. (1968). *Acta Cryst.* A**24**, 321–324.

EINSPAHR, H., ROBERT, J. B., MARSH, R. E. & ROBERTS, J. D. (1973). *Acta Cryst.* B**29**, 1611–1617.

GLOWIAK, T., MALARSKI, Z., SOBCZYK, L. & GRECH, E. (1987). *J. Mol. Struct.* **157**, 329–337.

GRECH, E., MALARSKI, Z. & SOBCZYK, L. (1985). *J. Mol. Struct.* **129**, 35–43.

GROOT, R. L. DE & SIKKEMA, D. J. (1976). *Recl Trav. Chim. Pays-Bas*, **95**, 10–14.

HAMANN, S. D. & LINTON, M. (1976). *Austr. J. Chem.* **29**, 1641–1647.

HIBBERT, F. (1974). *J. Chem. Soc. Perkin Trans.* 2, 1862–1866.

MILLER, P. K., ABNEY, K. D., RAPPÉ, A. K., ANDERSON, O. P. & STRAUSS, S. H. (1988). *Inorg. Chem.* **27**, 2255–2261.

PAWLEY, G. S. & YEATS, E. A. (1969). *Acta Cryst.* B**25**, 2009–2013.

PYZALSKA, D., PYZALSKI, R. & BOROWIAK, T. (1983). *J. Cryst. Spectrosc. Res.* **13**, 211–220.

SHELDRICK, G. M. (1976). *SHELX*76. Program for crystal structure determination. Univ. of Cambridge, England.

SHELDRICK, G. M. (1986). *SHELXS*86. Program for the solution of crystal structures. Univ. of Göttingen, Germany.

SPEK. A. L. (1982). *The EUCLID Package.* In *Computational Crystallography*, edited by D. SAYRE, p. 528. Oxford: Clarendon Press.

TRUTER, M. R. & VICKERY, B. L. (1972). *J. Chem. Soc. Dalton Trans.* pp. 395–403.

Acta Cryst. (1991). C**47**, 810–812

Structure of Lantadene A, the Major Triterpenoid of *Lantana Camara*, Red Variety*

BY VASANTHA PATTABHI† AND N. SUKUMAR

Department of Crystallography and Biophysics, University of Madras, Madras-600 025, *India*

AND O. P. SHARMA

Biochemistry Laboratory, Indian Veterinary Research Institute, Regional Station, Palampur, Kanagara Valley, Himachala Pradesh-176 061, *India*

(*Received* 5 *June* 1990; *accepted* 2 *August* 1990)

Abstract. Lantadene A, [22β(*Z*)]-2-methylisocrotonoyloxy-3-oxoolean-12-en-28-oic acid, is the major triterpenoid constituent of *L. Camara*, red variety. Mixed toxin preparation from lantana leaves has been found to exist in two molecular forms, of which only one was found to be hepatotoxic to guinea pigs. The structure of form (I), which is not hepatotoxic to guinea pigs, is reported. $C_{35}H_{52}O_5$, $M_r = 552{\cdot}35$, orthorhombic, $P2_12_12_1$, $a = 12{\cdot}494\ (2)$, $b = 15{\cdot}790\ (2)$, $c = 16{\cdot}367\ (2)$ Å, $V = 3229{\cdot}0$ Å^3, $Z = 4$, $D_x = 1{\cdot}14$ g cm^{-3}, $D_m = 1{\cdot}15$ g cm^{-3}, λ(Cu $K\alpha$) = 1·5418 Å, $\mu = 5{\cdot}9$ cm^{-1}, $F(000) = 1208$, $T = 296\ (1)$ K, $R = 0{\cdot}061$ for 3152 unique observed reflections. The *A*/*B* and *B*/*C* rings are *trans* fused while the *D*/*E* rings are *cis* fused. The packing of the molecule is stabilized by O—H···O hydrogen bonds.

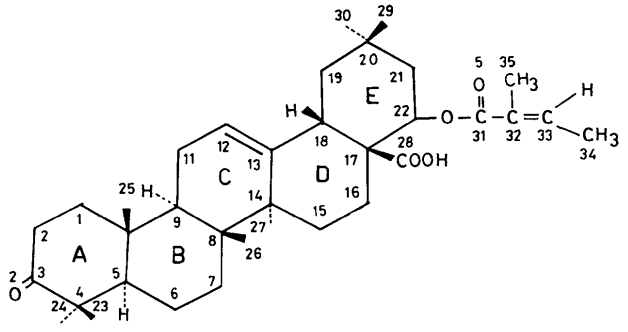
Introduction. Ingestion of lantana foliage causes cholestasis and hepatotoxicity in animals (Sharma, Makkar & Dawra, 1988). Consensus did not exist regarding the capacity of lantadene A, which is the major constituent of *L. Camara*, red variety (Sharma, Dawra & Makkar, 1987), to elicit hepato-

* DCB Contribution No. 757.

† To whom correspondence should be addressed.

0108-2701/91/040810-03$03.00

toxicity (Sharma, Makkar & Dawra, 1988). Crystal polymorphism and difference in molecular forms of drugs and xenobiotics are known to influence their interactions with biomolecules and receptors (Ravin, 1985). Recently, we reported a mixed toxin preparation from lantana leaves which existed in two molecular forms and only one of them was found to be hepatotoxic to guinea pigs (Sharma, Dawra & Makkar, 1988). The present study was undertaken to investigate the X-ray structure of lantadene A [form (I)] for its further use in understanding pharmacodynamics and the spatial aspects of its molecular interactions in the vicinity of biomolecules and biomembranes.



Experimental. Crystals of lantadene A were obtained from a mixture of 80% benzene, 10% acetone and 10% 2-propanol. Intensity data were collected on a colorless parallelepiped crystal, 0·35 × 0·35 × 0·30 mm, on an Enraf–Nonius CAD-4 diffractometer in the $\omega/2\theta$ scan mode in the range $2 \le 2\theta \le 140°$, $0 \le h \le 15$, $0 \le k \le 19$, $0 \le l \le 19$ with graphite-monochromated Cu $K\alpha$ radiation. Data were corrected for direct-beam polarization and Lorentz effects. Empirical absorption correction with maximum and minimum correction factors 0·999 and 0·982, respectively, was applied. Out of 3492 reflections measured, 3426 were unique and 3152 observed with $I \ge 2{\cdot}5\sigma(I)$. Cell constants were obtained from 20 reflections in the range $14 < \theta < 38°$. Three standard reflections monitored every 2 h did not show any variation in intensity. Aperture width = $(4 + 2\tan\theta)$ mm, maximum time spent on any reflection was 60 s and the background count was half the scan time.

Structure solution was by direct methods, 22 out of 52 H atoms were located from $\Delta\rho$ maps and the rest (barring the hydroxyl H atom) were geometrically fixed and refined isotropically only for two cycles. The non-H atoms were refined anisotropically on F_o to a final $R = 0{\cdot}061$ and $wR = 0{\cdot}090$, with individual weighting scheme based on counting statistics, where $w = 4F_o^2/\sigma^2(F_o^2)$, $\sigma(F_o^2) = [\sigma^2(I) + (0{\cdot}05I)^2]^{1/2}$/Lp. $(\Delta/\sigma)_{max} = 0{\cdot}04$, $S = 2{\cdot}77$ for 361 parameters. Final map had $(\Delta\rho)_{max}/(\Delta\rho)_{min} = 0{\cdot}34/-0{\cdot}3$ e Å^{-3}. Atomic scattering factors were from *International Tables for X-ray Crystallography* (1974, Vol. IV, pp. 99, 149). All calculations were carried out on a VAX 11/730 computing system using the *SDP* package (Frenz, 1978). The final atomic coordinates are listed in Table 1.*

Table 1. *Positional parameters and B_{eq} values of non-H atoms with e.s.d.'s in parentheses*

Anisotropically refined atoms are given in the form of the isotropic equivalent displacement parameter defined as: $(4/3)[a^2B(1,1) + b^2B(2,2) + c^2B(3,3) + ab(\cos\gamma)B(1,2) + ac(\cos\beta)B(1,3) + bc(\cos\alpha)B(2,3)]$.

	x	y	z	B_{eq}(Å^2)
O1	0·2224 (2)	0·0196 (1)	0·7969 (1)	3·44 (4)
O2	0·2918 (3)	0·7830 (1)	1·0433 (2)	5·20 (6)
O3	0·3079 (2)	0·1564 (2)	0·6778 (2)	4·28 (5)
O4	0·1781 (2)	0·2136 (2)	0·7524 (2)	4·43 (5)
O5	0·2823 (3)	−0·0968 (2)	0·7350 (2)	7·15 (8)
C1	0·2528 (3)	0·5590 (2)	1·0601 (2)	4·79 (7)
C2	0·2731 (5)	0·6466 (2)	1·0930 (2)	6·5 (1)
C3	0·3189 (3)	0·7090 (2)	1·0374 (2)	3·89 (6)
C4	0·4009 (3)	0·6833 (2)	0·9738 (2)	3·50 (6)
C5	0·3956 (3)	0·5854 (2)	0·9570 (2)	2·75 (5)
C6	0·4426 (3)	0·5610 (2)	0·8742 (2)	3·35 (6)
C7	0·4594 (3)	0·4666 (2)	0·8686 (2)	3·17 (6)
C8	0·3556 (2)	0·4151 (2)	0·8802 (2)	2·45 (5)
C9	0·2945 (3)	0·4465 (2)	0·9568 (2)	2·92 (6)
C10	0·2842 (3)	0·5453 (2)	0·9703 (2)	3·00 (6)
C11	0·1850 (3)	0·4019 (2)	0·9608 (3)	4·91 (8)
C12	0·1947 (3)	0·3088 (2)	0·9435 (3)	4·26 (7)
C13	0·2809 (3)	0·2690 (2)	0·9145 (2)	2·82 (5)
C14	0·3837 (2)	0·3173 (2)	0·8944 (2)	2·51 (5)
C15	0·4367 (3)	0·2799 (2)	0·8167 (2)	3·12 (6)
C16	0·4400 (3)	0·1822 (2)	0·8162 (2)	2·82 (5)
C17	0·3262 (2)	0·1446 (2)	0·8212 (2)	2·50 (5)
C18	0·2731 (3)	0·1729 (2)	0·9025 (2)	2·75 (5)
C19	0·3192 (3)	0·1250 (2)	0·9766 (2)	3·39 (6)
C20	0·3185 (3)	0·0278 (2)	0·9701 (2)	3·22 (6)
C21	0·3737 (3)	0·0027 (2)	0·8900 (2)	3·10 (6)
C22	0·3317 (3)	0·0470 (2)	0·8137 (2)	2·89 (6)
C23	0·3898 (4)	0·7392 (2)	0·8987 (2)	5·66 (9)
C24	0·5108 (4)	0·7045 (3)	1·0148 (4)	7·0 (1)
C25	0·1978 (3)	0·5877 (2)	0·9180 (3)	4·57 (8)
C26	0·2874 (3)	0·4244 (2)	0·8018 (2)	3·95 (7)
C27	0·4644 (3)	0·3054 (2)	0·9649 (2)	3·66 (7)
C28	0·2610 (3)	0·1756 (2)	0·7482 (2)	3·28 (6)
C29	0·2044 (3)	−0·0087 (2)	0·9772 (3)	4·10 (7)
C30	0·3846 (3)	−0·0097 (2)	1·0414 (2)	4·66 (7)
C31	0·2086 (3)	−0·0551 (2)	0·7599 (2)	4·46 (7)
C32	0·0908 (4)	−0·0745 (3)	0·7528 (3)	6·38 (9)
C33	0·0593 (5)	−0·1523 (3)	0·7311 (4)	9·2 (1)
C34	0·1181 (9)	−0·2272 (4)	0·7202 (6)	14·2 (3)
C35	0·0144 (4)	−0·0010 (4)	0·7666 (4)	8·5 (1)

Discussion. Bond lengths and angles (Table 2) agree with the values observed in similar structures such as maytenfolic acid, maytenfoliol (Nozaki, Suzuki, Lee & McPhail, 1982), cantoniensistriol triacetate (Mak, Chang & Chang, 1982) and in [3β(*E*)]-acetoxyolean-12-en-28β-oic acid *etc.* (Roques, Declercq & Germain, 1978). The lengthening of the C8—C14 [1·604 (4) Å], C9—C10 [1·581 (4) Å] and C4—C5 [1·572 (4) Å] bonds is in accord with expectations and is due to steric crowding around C8, C9, C14

* Lists of structure factors, anisotropic thermal parameters, H-atom parameters, torsion angles and least-squares-planes data have been deposited with the British Library Document Supply Centre as Supplementary Publication No. SUP 53452 (28 pp.). Copies may be obtained through The Technical Editor, International Union of Crystallography, 5 Abbey Square, Chester CH1 2HU, England.

Table 2. *Bond distances* (Å) *and angles* (°) *with e.s.d.'s in parentheses*

O1—C22	1·459 (4)	C11—C12	1·502 (5)
O1—C31	1·337 (4)	C12—C13	1·334 (5)
O2—C3	1·221 (4)	C13—C14	1·529 (4)
O3—C28	1·327 (4)	C13—C18	1·534 (4)
O4—C28	1·199 (4)	C14—C15	1·551 (5)
O5—C31	1·202 (5)	C14—C27	1·543 (5)
C1—C2	1·506 (5)	C15—C16	1·543 (4)
C1—C10	1·536 (5)	C16—C17	1·543 (4)
C2—C3	1·459 (5)	C17—C18	1·552 (4)
C3—C4	1·515 (5)	C17—C22	1·547 (4)
C4—C5	1·572 (4)	C17—C28	1·528 (5)
C5—C6	1·526 (5)	C18—C19	1·541 (5)
C5—C10	1·545 (5)	C19—C20	1·538 (4)
C6—C7	1·509 (4)	C20—C21	1·532 (5)
C7—C8	1·542 (4)	C20—C29	1·543 (6)
C8—C9	1·548 (4)	C20—C30	1·547 (5)
C8—C14	1·601 (4)	C21—C22	1·525 (5)
C8—C26	1·546 (5)	C31—C32	1·508 (6)
C9—C10	1·581 (4)	C32—C33	1·338 (7)
C9—C11	1·540 (5)	C32—C35	1·519 (8)
C10—C25	1·532 (5)	C33—C34	1·40 (1)
C22—O1—C31	117·9 (3)	C13—C14—C15	110·1 (2)
C2—C1—C10	115·4 (3)	C13—C14—C27	109·1 (3)
C1—C2—C3	117·6 (3)	C15—C14—C27	106·7 (3)
O2—C3—C2	119·3 (3)	C14—C15—C16	113·4 (3)
O2—C3—C4	119·9 (3)	C15—C16—C17	111·1 (2)
C2—C3—C4	120·9 (3)	C16—C17—C18	109·2 (2)
C3—C4—C5	110·8 (3)	C16—C17—C22	109·8 (2)
C4—C5—C6	112·8 (3)	C16—C17—C28	109·0 (2)
C4—C5—C10	114·6 (3)	C18—C17—C22	112·0 (2)
C6—C5—C10	111·6 (3)	C18—C17—C28	110·5 (2)
C5—C6—C7	110·9 (3)	C22—C17—C28	106·3 (2)
C6—C7—C8	113·3 (3)	C13—C18—C17	111·6 (2)
C7—C8—C9	110·3 (2)	C13—C18—C19	111·1 (3)
C7—C8—C14	109·9 (2)	C17—C18—C19	111·9 (2)
C7—C8—C26	108·1 (3)	C18—C19—C20	115·7 (3)
C9—C8—C14	107·4 (2)	C19—C20—C21	108·4 (3)
C9—C8—C26	111·7 (3)	C19—C20—C29	111·9 (3)
C14—C8—C26	109·5 (2)	C19—C20—C30	109·1 (3)
C8—C9—C10	118·0 (3)	C21—C20—C29	112·5 (3)
C8—C9—C11	109·1 (3)	C21—C20—C30	107·8 (3)
C10—C9—C11	111·9 (3)	C29—C20—C30	107·0 (3)
C1—C10—C5	107·9 (3)	C20—C21—C22	115·3 (3)
C1—C10—C9	107·1 (3)	O1—C22—C17	105·6 (2)
C1—C10—C25	107·0 (3)	O1—C22—C21	109·9 (2)
C5—C10—C9	108·1 (3)	C17—C22—C21	114·0 (3)
C5—C10—C25	112·1 (3)	O3—C28—O4	123·1 (3)
C9—C10—C25	114·2 (3)	O3—C28—C17	111·7 (3)
C9—C11—C12	111·5 (3)	O4—C28—C17	125·2 (3)
C11—C12—C13	126·4 (3)	O1—C31—O5	122·6 (4)
C12—C13—C14	121·3 (3)	O1—C31—C32	109·8 (3)
C12—C13—C18	117·4 (3)	O5—C31—C32	127·6 (3)
C14—C13—C18	121·3 (3)	C31—C32—C33	119·6 (4)
C8—C14—C13	109·1 (2)	C31—C32—C35	116·5 (4)
C8—C14—C15	110·0 (2)	C33—C32—C35	123·7 (5)
C8—C14—C27	111·7 (2)	C32—C33—C34	130·8 (7)

and C23, while C11—C12 [1·502 (5) Å] and C6—C7 [1·509 (4) Å] appear to be shortened. Fig. 1 shows a view of the molecule.

Three of the five six-membered rings (*B*, *D* and *E*) are in the chair conformation, while rings *A* and *C* are in sofa and half-chair conformations, respectively (Duax, Weeks & Rohrer, 1976) (Fig. 1). The presence of a double bond in ring *C* accounts for its twist conformation. Furthermore, it has been reported that the keto functionality will generally result in ring *A* adopting a twisted boat conformation (Corbett, Simpson, Goh, Nicholson, Wilkins & Robinson, 1982). The *A*/*B* and *B*/*C* rings are *trans* fused while the *D*/*E* rings are *cis* fused as in the case of methylmicromerol bromoacetate (Stout & Stevens, 1963) and cantoniensistriol triacetate (Mak, Chang & Chang, 1982).

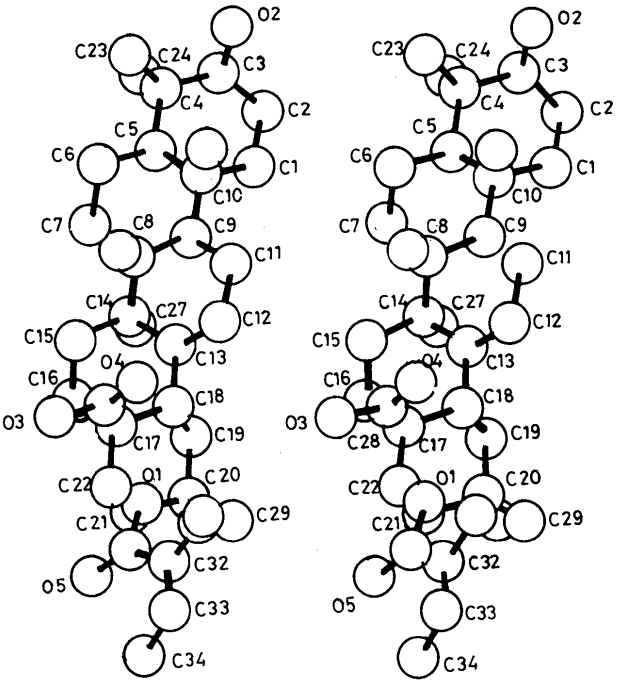


Fig. 1. Stereoview of the molecule.

Substitution at the 22 position is β-axial. The absolute configuration of the structure has not been established but is given as in the related structure. The packing of the molecule is stabilized by O3—H···O2 [2·704 (4) Å] type hydrogen bonds. The C28—O3···O2 angle is 115·0 (3)°.

References

Corbett, R. E., Simpson, J., Goh, E. M., Nicholson, B. K., Wilkins, A. L. & Robinson, W. T. (1982). *J. Chem. Soc. Perkin Trans.* 2, pp. 1339–1343.

Duax, W. L., Weeks, C. M. & Rohrer, D. C. (1976). *Topics in Stereochemistry*, edited by N. L. Allinger & E. L. Eliel, ch. 9, pp. 271–383. New York: John Wiley.

Frenz, B. A. (1978). *The Enraf–Nonius CAD4 SDP – A Real-Time System for Concurrent X-ray Data Collection and Crystal Structure Solution.* In *Computing in Crystallography*, edited by H. Schenk, R. Olthof-Hazekamp, H. van Koningsveld & G. C. Bassi. Delft Univ. Press.

Mak, T. C. W., Chang, T.-C. & Chang, H.-M. (1982). *J. Chem. Soc. Chem. Commun.* pp. 785–786.

Nozaki, H., Suzuki, H., Lee, K. H. & McPhail, A. T. (1982). *J. Chem. Soc. Chem. Commun.* pp. 1048–1051.

Ravin, L. J. (1985). *Preformulations.* In *Remington's Pharmaceutical Sciences*, 17th ed., edited by A. R. Gennaro. Easton, PA: Mack.

Roques, P. R., Declercq, J.-P. & Germain, G. (1978). *Acta Cryst.* B**34**, 2367–2370.

Sharma, O. P., Dawra, P. K. & Makkar, H. P. S. (1987). *Toxicol. Lett.* **37**, 165–172.

Sharma, O. P., Dawra, R. K. & Makkar, H. P. S. (1988). *Toxicol. Lett.* **42**, 29–37.

Sharma, O. P., Makkar, H. P. S. & Dawra, R. K. (1988). *Toxicon*, **26**, 975–987.

Stout, G. H. & Stevens, K. L. (1963). *J. Org. Chem.* **28**, 1259–1262.