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A NEW ROUTE TO α-METHYLENE LACTONES[1]

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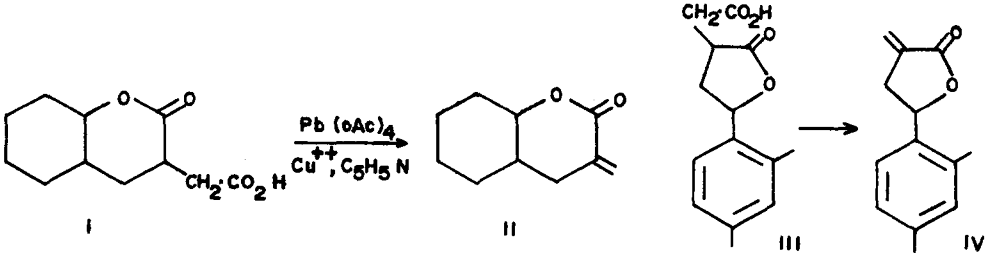
A large number of α-methylene γ-lactones have been isolated from natural sources and costunolide[2] isolated in our laboratory belongs to this group. Many recent publications[3] describe a variety of routes for the synthesis of α-methylene γ-lactones since this structural unit appears to play an important role in the interesting biological activity exhibited by a number of natural products[4]. In the present communication, a new route for the preparation of α-methylene-γ and δ-lactones is described.

Oxidative decarboxylation of primary acids with lead tetraacetate in the presence of cupric acetate is known to furnish alkenes[5]. Hence, the lactone acid (I)[6], $C_{11}H_{16}O_4$, was subjected to oxidative decarboxylation[8] when the anticipated α-methylene δ-lactone (II) was obtained in 30% yield; ir (neat): 1725, 1625 and 805 cm^{-1}; nmr (CCl_4) (δ): olefinic protons at 5.43 (1H) and 6.30 (1H). Oxidative decarboxylation[8] of the lactone acid III, m.p. 92°, furnished in 50% yield the α-methylene γ-lactone (IV); nmr (CCl_4) (δ): olefinic protons at 5.53 (1H, t, J = 3Hz) and 6.13 (1H, t, J = 3 Hz).



I II III IV

The lactone acid (III) was prepared starting from m-xylene. Michael addition of diethylmalonate to the ester (VI)(prepared from the acid V[9]) in the presence of catalytic amounts of NaOEt furnished VII, which was heated under reflux for 16 hours with a mixture of formic acid- conc. HCl to give the ketodiacid (VIII), m.p. 136°. Reduction of VIII with $NaBH_4$ in boiling ethanol in the presence of NaOH, followed by acidification furnished the lactone acid (III). The overall yield in the transformation (V) $\longrightarrow$ (III) is 55%.

The α-methylene γ-lactones XII, XIII and XIV were prepared by carrying out the oxidative decarboxylation[8] of the lactone acids IX, X and XI respectively.

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3. K. Yamada, M. Kato and Y. Hirata, Tetrahedron Letters, 2745 (1973) and references cited therein.
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5. J.D. Bacha and J.K. Kochi, Tetrahedron, 24, 2215 (1968).
6. Acid I was obtained by reducing coumarin-3-acetic acid[7] in aqueous NaOH solution in the presence of Raney Ni at 150° with hydrogen at 70 atmospheres.
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8. A mixture of lactone acid (0.06 mol), benzene (400 ml), lead tetraacetate (0.1 mol), cupric acetate (0.013 mol) and pyridine (0.02 mol) was stirred at room temp. under N_2 for 1/2 hr and heated under reflux for 2 hrs.
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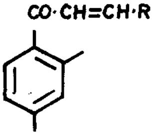
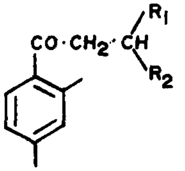


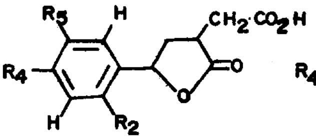
V $R=CO_2H$

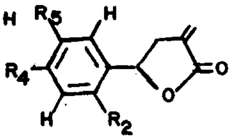
VI $R=CO_2Et$



VII $R_1=CO_2Et$, $R_2=CH(CO_2Et)_2$

VIII $R_1=CO_2H, R_2=CH_2\cdot CO_2H$





IX $R_2=R_4=R_5=H$ XII

X $R_2=R_5=H; R_4=CH_3$ XIII

XI $R_2=R_5=CH_3; R_4=H$ XIV