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# BITTER PRINCIPLES OF CAESALPINIA BONDUCELLA

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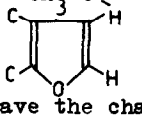
The seeds of Caesalpinia bonducella[1] contain three bitter principles: α-caesalpin, β-caesalpin and γ-caesalpin. These compounds have been the subjet of prolonged investigation, especially by M.Q.Khuda and M.E.Ali.[2,3,4] As yet, however, none structures are been proposed for these compounds.
α and β-caesalpin, isolated in small quantity, are cristalline, the most abundant constituent, γ-caesalpin, is amorphous.

From the seeds of Caesalpinia bonducella we isolated, among other products, an amorphous bitter substance,which, on alkaline hydrolysis,afforded acetic and myristic acids (recognised as methyl ester by gas chromatography) and a cristalline bitter compound (I) appeared to be identical with hydrolysed γ-caesalpin of M.Q.Khuda and M.E.Ali.Therefore,we think the amorphous bitter substance we have isolated to be γ-caesalpin.

The molecular formula of I is $C_{20}H_{30}O_6$ (molecular weight determined by mass spectrometry)* , m.p. 251° (acetone); $[\alpha]_D^{25,MeOH}$ +40.7;

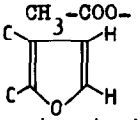
* All compounds reported gave satisfactory analyses. Mass spectra were measured with a Atlas Werke CH 4 instrument; NMR spectra with a Varian Associates (60 Mc) using tetramethylsilane as an internal reference; IR spectra in nujol with a spectrofotometer Perkin-Elmer Mod. 21 - NaCl prism.

$\lambda_{max}^{MeOH}$ 215.5 mμ (ε 8600); $\nu_{max}$ 3.500, 3.400, 3330 (OH) 1653, 1571, 1510 (furan)[5]; NMR (deuteriopyridine):

| | | | | |
|---|---|---|---|---|
| 0.98 δ (ppm) | (s) | | 3H | $CH_3$-C≤ |
| 1.33 | (s) | | 3H | $CH_3$-C≤ |
| 1.56 | (s) | | 6H | $CH_3$-C≤ |
| 6.73[6] | (d) | (J = 2 cps) | 1H |  |
| 7.46 | (d) | (J = 2 cps) | 1H | |

I consumed two moles of perphtalic acid and gave the characteristic colour reactions of furan ring (e.g. the Ehrlich reaction)

Acetylation of I yielded a diacetate (II), m.p. 148-50°; 3420, 3300 (OH) 1740, 1710, 1250 (ester) 1650, 1590, 1510 (furan) $cm^{-1}$; NMR($CDCl_3$):

| | | | | |
|---|---|---|---|---|
| 1.07 δ (ppm) | (s) | | 3H | $CH_3$-C≤ |
| 1.17 | (s) | | 6H | $CH_3$-C≤ |
| 1.49 | (s) | | 3H | $CH_3$-C-OH |
| 1.97 | (s) | | 3H | $CH_3COO$- |
| 2.05 | (s) | | 3H | $CH_3$-COO- |
| 6.36 | (d) | (J = 2 cps) | 1H |  |
| 7.21 | (d) | (J = 2 cps) | 1H | |

II is reconverted to the parent compound by treatment with alkali

Selenium dehydrogenation of I afforded a mixture of alkylnaphthalenes. Among them, we are able to identify 1,2,5-trimethyl naphthalene by a comparison , on gas chromatography, with a specimen of the same naphthalene afforded by dehydrogenation of marrubin*.

When compound I was hydrogenated catalitically and reduced with HJ and red P, its following dehydrogenation gave in good yields an hydrocarbon $C_{18}H_{18}$ (molecular weight determined by mass spectrometry) identified with 1,8-dimethyl-2-ethylphe-

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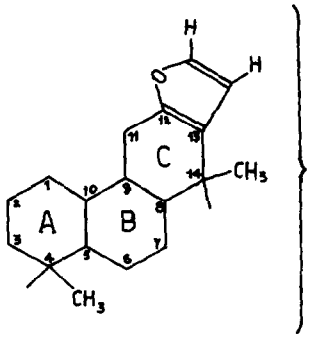
* We are greatly indebted to prof.E.Ghigi for a sample of marrubiin.

nantrene (picrate m.p. 150°, 2,4,6-trinitrobenzene adduct m.p. 168°).[7,8] Its structure was confirmed by a direct comparison, on gas chromatography, with an authentic sample of 1,8-dimethyl-2-ethylphenantrene.*

These results together with the molecular formula, chemical and spectral evidences described, can be rationalised in terms of the partial structure:




2 $CH_3$-C≤
2 OH acetylable
3 OH hindered

Treatment of I with anhydrous copper sulfate in dioxane at room temperature (or sublimation at 240° in high vacuum) gave III $C_{20}H_{28}O_5$ with loss of one mole of water, m.p. 134-7°, $\lambda_{max}^{MeOH}$ 236 mμ (ε 8040), 212 mμ (ε 8100).

Acetylation of III afforded a diacetate (IV) $C_{24}H_{32}O_7$, m.p. 217-9°, $\lambda_{max}^{MeOH}$ 236 mμ (ε 10.400), 210 mμ (ε 11.700); 3430 (OH) 1750, 1735 (ester) 1820, 1658, 1410, 890 ($CH_2$=C≤) 1645, 1588, 1512 (furan) $cm^{-1}$; NMR ($CDCl_3$):

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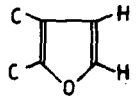
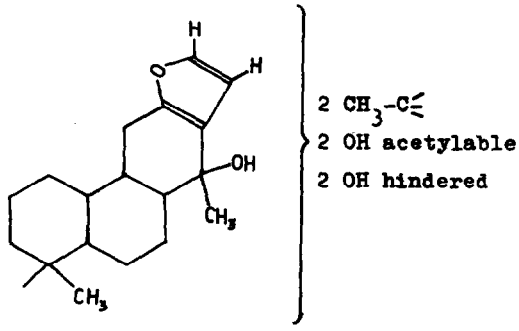
*We are greatly indebted to dr.T.J.King and dr.D.Nasipuri for the samples of 1,8-dimethyl-2-ethylphenatrene.

| | | | | |
|---|---|---|---|---|
| 1.12 δ (ppm) | (s) | | 6H | $CH_3-C\lesseqgtr$ |
| 1.19 | (s) | | 3H | $CH_3-C\lesseqgtr$ |
| 1.97 | (s) | | 3H | $CH_3-COO-$ |
| 2.08 | (s) | | 3H | $CH_3-COO-$ |
| 4.81 | (s) | | 1H | $CH_2=C<$ |
| 4.95 | (s) | | 1H | |
| 6.38 | (d) | (J = 2 cps) | 1H |  |
| 7.21 | (d) | (J = 2 cps) | 1H | |

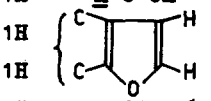
The IR and NMR spectra of IV indicate the presence of a $CH_2=C<$ function instead of the hydroxyl-bearing methyl group (1.49 δ) as in diacetate II. The UV absorption suggestes the double bond formed on dehydratation is conjugated to furan ring.

On the basis of these observations the partial structure of I can be put as:




Nitric oxidation of I gave α,α-dimethylglutaric acid ( identified as dimethylester by mass spectrometry and on a comparison with an authentic sample). From the result of this degradation reaction it is apparent that a gem -dimethyl group is present at $C_4$ and the positions 2 and 3 are free from hydroxylic function.

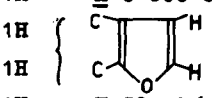
The γ-caesalpin hydrolysed (I) consumed one mole of sodium metaperiodate to give the aldehyde (V) $C_{20}H_{28}O_6$, m.p. 198-200° (dec.); $\lambda_{max}^{MeOH}$ 224 mμ (ε 4800), $\nu_{max}$ 3500, 3380, 3330 (OH) 2820, 2700, 1730 (CHO) 1650, 1580, 1505 (furan) $cm^{-1}$; NMR ( deuteriopyridine):

| | | | | |
|---|---|---|---|---|
| 0.98 δ (ppm) | (s) | | 3H | $CH_3$-C≤ |
| 1.16 | (s) | | 3H | $CH_3$-C≤ |
| 1.34 | (s) | | 3H | $CH_3$-C≤ |
| 1.62 | (s) | | 3H | $CH_3$-C≤ |
| 5.31 | (d) | (J = 9 cps) | 1H | H-C-OH |
| 6.70 | (d) | (J = 2 cps) | 1H |  |
| 7.44 | (d) | (J = 2 cps) | 1H | |
| 10.03 | (s) | | 1H | H-CO-C≤ |

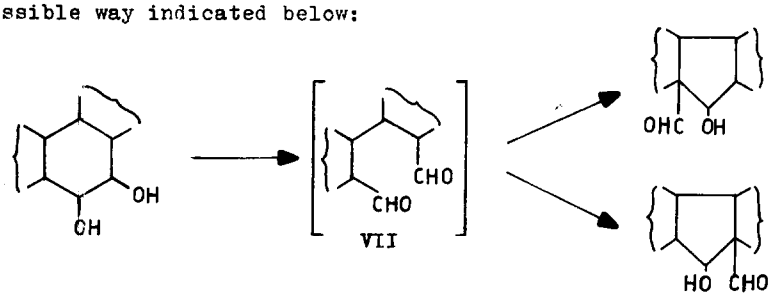
From this reaction it is evident that I has a cyclic vic-glycol group, one hydroxyl group,at least, being secondary ( II did not react with sodium metaperiodate).

The spectral data of V are in agreement with the presence of one carbonilic group, aldehydic, tertiary and strongly hindered (UV absorption is not affected by thiosemicarbazide).

Acetylation of V yielded a monoacetate (VI) $C_{22}H_{30}O_7$, m.p. 143.5°; $\lambda_{max}^{MeOH}$ 214 mμ (ε 7000); $\nu_{max}$ 3570, 3475 (OH) 2820, 2700, 1736 (CHO) 1768, 1199 (ester) 1650, 1600, 1510 (furan) $cm^{-1}$; NMR (deuteriopyridine):

| | | | | |
|---|---|---|---|---|
| 0.97 δ (ppm) | (s) | | 3H | $CH_3$-C≤ |
| 1.14 | (s) | | 3H | $CH_3$-C≤ |
| 1.35 | (s) | | 3H | $CH_3$-C≤ |
| 1.60 | (s) | | 3H | $CH_3$-C≤ |
| 2.09 | (s) | | 3H | $CH_3$-COO- |
| 6.40 | (d) | (J = 9 cps) | 1H | H-C-OOC-$CH_3$ |
| 6.66 | (d) | (J = 2 cps) | 1H |  |
| 7.43 | (d) | (J = 2 cps) | 1H | |
| 10.05 | (s) | | 1H | H-CO- C≤ |

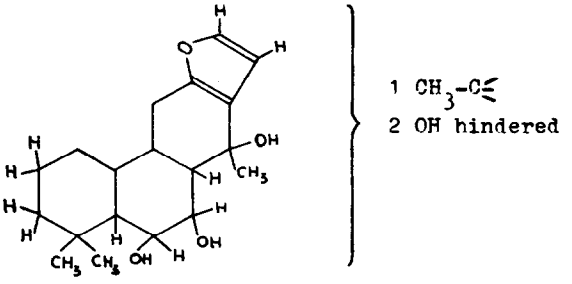
The foregoing results and the achievement of a tertiary aldehyde on oxidation with sodium metaperiodate lead to put the vic-glycol function into the positions 6 and 7 of ring B. V has been considered to be an internal aldol condensation product of the dialdehyde VII transformed in one of the two possible way indicated below:



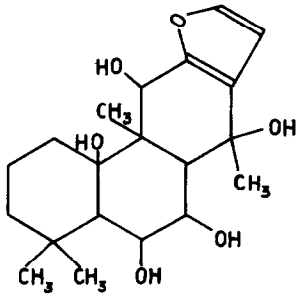

One hydrogen atom, at least, should be in α-position to the vic-glycol group.

In addition, the NMR spectra of V and VI showed a doublet, centered at 5.31 and 6.40 δ (ppm) respectively, due to the proton of the group arising from the aldolization: >C(CHO)-CH(OH)-CH<

These facts can be rationalised with the presence of two hydrogen atoms in the positions 5 and 8 of I. It is now possible to extend the partial structure of I as followed:



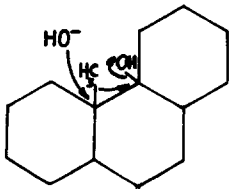
The behaviour of I towards acetylation and periodic oxidation and the lack of aromatization of ring C under vigorous conditions lead to following structure for I:




I

In the foregoing structure one of the hindered hydroxyl groups is secondary; accordingly NMR spectrum of I (deuteriopyridine showed a single broad peak at 3.75 δ(ppm).

From the biogenetic point of view I can be regarded as a diterpenoid which does not obey the isoprene rule. Before now examples of 14-methyl group were known in vinhaticoic [7] and vouacapenic acids.[9] The 9-methyl group may be derived, by the methyl migration indicated below, from the position 10 as in rosenonolactone:[10]



Further work on the constitutions and stereochemistry of the Caesalpinia bonducella bitter principles is in progress.

Acknowledgment.- We should like to express our gratitude to dr. G. Nencini and T. Salvatori of Laboratori Riuniti SNAM for mass spectra, to dr.G. G. Gallo and A. Vigevani of Lepetit S.p.A. for proton magnetic resonance and to dr. G. Ricca for infrared spectra.

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