SECTION-A:

Section A describes the results of the chemical investigation of the flowers of an Indian plant *Eugenia jambolana* Lam., from which Nair and Sankara Subramanian\(^a\) had earlier reported the isolation of two 'new' triterpenoids: 'Eugenia terpenoid A' and 'Eugenia terpenoid B' besides acetyl oleanolic acid (1a) by successive extraction of the ethanol extract of the flowers with ether, acetone and methanol respectively.

\[ R = \text{Ac}\text{, } R' = \text{H} \]
\[ R = \text{Ac}\text{, } R' = \text{Me} \]
\[ R = \text{H}\text{, } R' = \text{Me} \]

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Dried flowers of *E. jambolana*  
\[ \text{Ethanol} \downarrow \]  
Ethanol extract  
\[ \text{Ether} \downarrow \]  
Ether soluble, Fraction A  
Ether insoluble residue  
\[ \text{Alkali} \downarrow \]  
Acidic  
Neutral  
\[ \text{Chromat.} \downarrow \]  
CH$_2$N$_2$  
\[ \beta\text{-Sitosterol (ii)} \downarrow \]  
Ester Mixture  
\[ \text{Chromatographed} \downarrow \]  
Benzene eluate  
(Less polar)  
\[ \downarrow \]  
1. Acetylated  
2. Fractionally crystallised  
Methyl oleanolate acetate (ib)  
(Less soluble)  
\[ \downarrow \]  
Methyl crategolate (iiia)  
\[ \text{Chromat.} \downarrow \]  
\[ \text{Ether eluate} \downarrow \]  
(More polar)  
\[ \downarrow \]  
1. CH$_2$N$_2$  
2. Chromat.  
Methyl oleanolate acetate (lb)  
(Less soluble)  
\[ \downarrow \]  
Methyl ursolate acetate (iv)  
(More soluble)  
\[ \text{Fraction C} \downarrow \]  
\[ \text{Methanol soluble} \downarrow \]  
\[ \text{Methanol insoluble} \downarrow \]  
\[ \text{Acetone} \downarrow \]  
Acetone soluble  
Acetone insoluble  
\[ \text{Fraction B} \downarrow \]  
1. CH$_2$N$_2$  
2. Chromat.  
\[ (\text{ib, iv, iiia, ii}) \downarrow \]  
\[ \text{Chart-A} \]
By following the reported procedure, the present investigator separated the ethanol extract of the flowers into three fractions (Chart-A): (i) an ether soluble fraction, Fraction A, (ii) an acetone soluble fraction, Fraction B and (iii) a methanol soluble fraction, Fraction C. Each of these three fractions, however, was found to be a complex mixture of the same three triterpenoid acids and a phytosterol, although in different proportions. The sterol from each fraction was identified (mixed m.p.) as $\beta$-sitosterol (ii).

The acidic component from each fraction on esterification with ethereal diazomethane followed by chromatography over neutral alumina could be resolved into a less polar fraction (eluted with benzene) and a more polar fraction (eluted with ether). The more polar fractions from each were found to be the same and identical with methyl crategolate (iiiA) as demonstrated by the direct comparison of their infra-red spectra with that of an authentic specimen.*

Thin layer chromatography of the above mentioned less polar ester fractions revealed that each was a mixture of two compounds. Indeed, each ester mixture could be resolved by acetylation followed by fractional crystallisation into the same two methyl ester acetates viz. methyl oleanolate acetate (ib) and methyl ursolate acetate (iv).

* Kindly compared by Prof. R. Tschesche, University of Bonn, West Germany.
Thus, the 'new' triterpenoids as reported earlier, were presumably mixtures of the above four components.

The chemistry of the pentacyclic triterpenoids and the modern concepts on their biogenesis have been briefly reviewed. Special attention has been paid to the acids belonging to the olean-12-ene sub-group, more particularly to the 2,3-dihydroxy-olean-12-en-28-oic acids. To save space, the naturally occurring acids belonging to the above mentioned
sub-group known up to the present time have been represented in the tabular form. The structure and stereochemistry of crategolic acid (iiib) have been discussed in details.

SECTION-B:

The rarely encountered naturally occurring pentacyclic triterpenoid simple 2,3-diol have been briefly reviewed.

Olean-12-ene-2α, 3β-diol (v), a compound belonging to the above rare sub-group of triterpenoids and not previously known either in nature or by synthesis, was unequivocally synthesised (Chart-B) from crategolic acid (iiib), the isolation of which has been described in Section A.

Crategolic acid diacetate (iiic) was converted to the acid chloride (vi), which furnished the vital intermediate 2α, 3β-diacetoxy-olean-12-en-28-al (vii) through two routes:

1) The above acid chloride (vi) on Rosenmund reduction in xylene\(^b\) using 5\% palladium-barium sulphate catalyst gave the diacetoxy aldehyde (vii) in good yield.

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(xi)

![Chemical structures and reactions](chart-B)

**Chart-B**
2) The same acid chloride (vi) on being heated at 100° in a sealed tube with benzyl thiol in a mixture of benzene and pyridine for 96 hours furnished the benzylthiol ester of crategolic acid diacetate (viii). The latter on reductive desulphurisation with partially deactivated Raney nickel was smoothly converted into the desired 2α, 3β-diacetoxyolean-12-en-28-al (vii).

The diacetoxy aldehyde (vii) prepared by either route mentioned above, on Huang-Minlon reduction gave the desired olean-12-ene-2α, 3β-diol (v) in high yield. The diol (v) was characterised by the preparation of its diacetate (ix). C,H-analyses, coupled with I.R. and N.M.R. data amply support the structures of the synthesised new compounds described above.

Exploratory experiments leading to unsuccessful results have also been discussed in the main body of the Thesis.

SECTION-C :

The syntheses of steroidal and triterpenic 2,3-diols have been reviewed.

Since the key compound viz. oleana-2,12-diene (x), required for the synthesis of the four stereoisomeric olean-12-ene-2,3-diols can be prepared in a reasonably pure state and in quantity from $\beta$-amyrin only with great difficulty by the classical method, a convenient method has been successfully devised for this purpose, starting from methyl oleanolate (ic), which, as discussed in Section A, was obtained in fairly pure state and in good quantity from the flowers of E. jambolane.

Methyl oleanolate (ic) on treatment with phosphorus oxychloride and pyridine according to the method of Tschesche *et al* was converted to methyl oleana-2,12-dien-28-oate (xi), which on reduction with lithium aluminium hydride furnished oleana-2,12-dien-28-ol (xii) in good yield. The diene alcohol (xii) on oxidation with Jones' chromic acid reagent gave in fairly good yield the aldehyde, oleana-2,12-dien-28-al (xiii), which was smoothly reduced to oleana-2,12-diene (x) by the Huang-Minion procedure (Chart-C). The diene alcohol (xii) and the diene aldehyde (xiii), both hitherto unknown compounds showed I.R. and N.M.R. spectra, fully consistent with their respective structures.

SECTION-A:

The chemistry of naturally occurring friedelane derivatives has been reviewed.

The stem-bark of *E. jambolana* was chemically examined and found to contain (Chart-D) triterpenoids, both acidic and neutral, in quantity. The acidic part was shown to consist of betulinic acid (xiv\(a\)), isolated as its methyl ester, whose infra-red spectrum was found to be identical with that of an authentic specimen of methyl betulinate (xiv\(b\)).*

* Kindly compared by Prof. C. Djerassi of Stanford University, U.S.A.
Dried and powdered stem-bark of *E. jambolana*

\[ \text{Benzene} \]

- Residual plant material (rejected)
- Benzene extract
  - Digested with ether and filtered
  - Ether solution
    - 10% aq. NaOH
      - White ppt. of sodium salt A from aq. alkaline layer
      - Neutral ether soluble material B
        - Concentrated HCl
          - Betulinic acid
            - Diazomethane
              - Methyl betulinate
                - Solid 1
                - Solid 2
                - Solid 3
                - Solid 4
                  (Eugenin) (Friedelin) (Epifriedelanol) (β-sitosterol)

Chart-D
The neutral material was resolved through chromatography into four components, three of which were identified (mixed m.p. and I.R.) as friedelin (xv), epifriedelanol (xvi) and $\beta$-sitosterol (ii) and the fourth proved to be a new compound and christened 'Eugenin' (xvii). Eugenin showed infra-red bands at 1718 and 1234 cm$^{-1}$ revealing that it was an ester. It could be converted to epifriedelanol (xvi) either by reductive cleavage with lithium aluminium hydride or by ester exchange on boiling with a methanolic solution of sodium methoxide. Thus Eugenin (xvii) is a new ester of
epifriedelanol (xvi). It may be mentioned that the ester moiety in Eugenin (xvii) was resistant to hydrolysis by conventional methods even utilising the most drastic conditions. Eugenin (xvii) showed a negative test with tetranitromethane and analytical data \((M^+ = 834 \text{ from mass spectrometry})\) suggested the molecular formula \(C_{27}H_{55}COOC_{30}H_{51}\). The acidic part was hence presumed to be an open-chain saturated fatty acid of the formula, \(C_{27}H_{55}COOH\). However, due to the poor yield of Eugenin, it has not been possible to identify the fatty acid part so far, although N.M.R. data suggest the presence of the grouping \(-\text{CH}_2-\text{CH}_2-\text{CO}-0\) in the same.

**SECTION-B:**

The biogenesis of phytosterols has been briefly reviewed.

The chemical investigation of the stem-bark of *Jatropha gossypifolia* Linn. has been described. Villalba\(^f\) had previously reported the isolation of an 'isophytosterol' \((C_{27}H_{45}OH)\), m.p. 124°, \((\alpha)_D \, -49^0\), from the same plant material. The present investigator, however, failed to isolate the reported\(^f\) 'isophytosterol', but isolated and characterised \(\beta\)-sitosterol (ii) instead.