1. Properties of saponins

1.1 Introduction to Saponin

Definition:-

The word saponin is derived from the latin word “sapo” which means soap and hence plants containing saponins and saponins as such produce frothing in aqueous solution. Saponins consist of non sugar part called aglycon and sugar part.

Physiochemical Property:-

Saponin are generally considered as haemostatic.
Saponins have a bitter and acrid taste.
Saponin causes irritation of mucous membrane.
Saponin is mostly non crystalline substances.
Saponin are soluble in water and alcohol but
Saponin are insoluble in non polar organic solvent.
Saponin contain aglycone called sapogenin.
Sapogenin are insoluble in water but soluble in organic solvent.
Sapogenin are high molecular weight substance which by acetylation give crystalline forms.
The harmful Sapogenins are called as sapotoxins.

Classification:-

Depending upon a nature of aglycone Saponin are categorized into two groups.

1 Steroidal Saponins.
2 Triterpenoid Saponins.

Steroidal Saponins:-

Steroidal Saponins are more important, as they are used as raw material for the synthesis of various medicinally useful steroid like vitamin D, Cardiac glycosides, Corticoids like betamethsone and Cortisone acetate, Sex hormone like Progesterone, testosterone, Oral contraceptives such as mestranol and norethisterone and spironolactone which are a diuretic steroid.

Important source of Steroidal Saponins are from Leguminosae, Solanaceae, Apocynaceae.

Pentacyclic triterpenoid Saponins:-

This group contain the sapogenin with Pentacyclic triterpenoid nucleus, which is linked with sugar or uronic acid.

Pentacyclic triterpenoid Saponins are available from various families of dicot plants like polygalaceae, Caryophyllaceae, Berberideaceae, Umbelliferae, Rubiaceae, Compositae, and Rutaceae.
Source of some steroidal saponins & Triterpenoids saponins

**Steroidal saponins**

<table>
<thead>
<tr>
<th>Botanical source</th>
<th>Steroidal saponins</th>
<th>Sapogenin</th>
<th>Sugars attached</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smilax aristolochiaeefolia</td>
<td>Sarasaponin</td>
<td>Sarasapogenin</td>
<td>2 glucose + 1 rhamnose</td>
</tr>
<tr>
<td>Digitalis purpurea</td>
<td>Digitonin</td>
<td>Digitogenin</td>
<td>2 glucose + 2 galactose + 1 xylose</td>
</tr>
<tr>
<td>Digitalis purpurea</td>
<td>Gitonin</td>
<td>Gitogenin</td>
<td>1 glucose + 2 galactose + 1 xylose</td>
</tr>
<tr>
<td>Dioscorea deltoida</td>
<td>Dioscin</td>
<td>Diosgenin</td>
<td>1 glucose + 2 rhamnose</td>
</tr>
<tr>
<td>Jurubia species</td>
<td>Jurubin</td>
<td>Jurubidine</td>
<td>1 glucose</td>
</tr>
<tr>
<td>Digitalis purpurea</td>
<td>F-gitonin</td>
<td>Gitogenin</td>
<td>1 glucose + 2 galactose + 1 xylose</td>
</tr>
<tr>
<td>Dioscorea deltoida</td>
<td>gracilllin</td>
<td>diosgenin</td>
<td>2 glucose + 1 rhamnose</td>
</tr>
<tr>
<td>Agave sisalana</td>
<td>hecogin</td>
<td>hecogenin</td>
<td>1 glucose + 1 rhamnose</td>
</tr>
</tbody>
</table>
Triterpenoid saponins

<table>
<thead>
<tr>
<th>saponin</th>
<th>source</th>
<th>genin</th>
<th>Sugar portion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aescin</td>
<td>Aesculus hippocastanum</td>
<td>aescigenin</td>
<td>2 glucose + glucuronic acid + tigalic acid</td>
</tr>
<tr>
<td>Aralin</td>
<td>Aralia japonica</td>
<td>Aralidin</td>
<td>glucuronic acid +2 arabinose</td>
</tr>
<tr>
<td>Cyclamin</td>
<td>Cyclamin europaeum</td>
<td>Cyclamigenin</td>
<td>2 glucose +xylose +arabinose</td>
</tr>
<tr>
<td>Glycyrrhizin</td>
<td>Glycyrrhiza officinalis</td>
<td>Glycyrrhetinic acid</td>
<td>2 glucuronic acid</td>
</tr>
<tr>
<td>Hederin</td>
<td>Hedera helix</td>
<td>Hederagenin</td>
<td>Glucose + arabinose</td>
</tr>
<tr>
<td>Primulasaponin</td>
<td>Primula elatior</td>
<td>Primulagenin</td>
<td>glucuronic acid + glucose + galactose + rhamnose</td>
</tr>
<tr>
<td>Araloside A</td>
<td>Aralia manschurica</td>
<td>Oleanolic acid</td>
<td>galactouronic acid + glucose + L-arabinose</td>
</tr>
<tr>
<td>Asiaticoside</td>
<td>Centella asiatica</td>
<td>Asiatic acid</td>
<td>2 glucose + rhamnose</td>
</tr>
<tr>
<td>Quinovin-</td>
<td>Cinchona calisaya</td>
<td>Quinovic acid</td>
<td>6 deoxyglucose (quinovose)</td>
</tr>
<tr>
<td>glycoside A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quillaia-saponin</td>
<td>Quillaia saponaria</td>
<td>Hydroxy-gypsogenin</td>
<td>glucuronic acid</td>
</tr>
<tr>
<td>Saikosaponin</td>
<td>Bupleurum falcatum</td>
<td>Saikogenin</td>
<td>glucuronic acid +fucose</td>
</tr>
<tr>
<td>Platycodin D</td>
<td>Platycodon grandiflorum</td>
<td>Platycodigenin*</td>
<td>glucuronic acid +arabinose + rhamnose +xylose + apiose</td>
</tr>
<tr>
<td>Tenuifolin</td>
<td>Polygala tenuifolia</td>
<td>Presnegin*</td>
<td>Glucose + rhamnose +xylose + fructose +galactose</td>
</tr>
<tr>
<td>akeboside</td>
<td>Akebia quinata</td>
<td>Oleanolic acid</td>
<td>Arabinose +glucose + arabinose</td>
</tr>
<tr>
<td>Ginsenoside</td>
<td>Panax ginseng</td>
<td>Oleanolic acid</td>
<td>2 glucuronic acid</td>
</tr>
</tbody>
</table>

sugars attached at two different places on the aglycone.
Sugar found in saponins

There some sugar found in saponins

Glucose, Rhamnose, Galactose, Xylose, Glucuronic acid, Tiglic acid, Arabinose, L-arabinose, 6-deoxyglucose, Fucose, Apiose, Fructose, Arabinose.

Uses of saponins

Steroidal saponins may have as such limited uses. Steroidal saponins are used as starting materials for the synthesis and production of steroid hormones. These hormones are very important agent in medicine. Triterpenoid saponins are used as expectorant. 18β-glycyrrhetic acid has anti-inflammatory properties. They also have the actions like diuretic and anthelminitic. They are also used as foaming agents in the aerated waters and in fire extinguishers.
1.2 COLOR REACTION OF SAPONINS

(A) COLOR REACTION OF TRITERPENOIDS SAPONIN

SALKOWSKI TEST: To powdered compound (10 mg) in chloform few drops of concentrated H2SO4 are added. Yellow color changing to red developed.

LIEBERMANN-BURCHARD TEST: To few mg of the substance dissolved in acetic anhydride, conc. H2SO4 is added. Agreement color chang in immediately or through red and blue shaded formed.

ROSENTHALER TEST: Addition of H2SO4 to an alchoholic sol. of triterpene containing vanillin-hydrochloric acid produces a lilac color.

NOLLER TEST: Triterpenic compound (20 mg) and noller reagent (0.5 ml) (0.1% stannic chloride in thionyl chloride) are mixed in T.T. The sol. passess through various color but red is always there. Oxyacids containing at least one hydroxyl group give a dark coloration.

TETRANITROMETHANE TEST: To the substance (10 mg) dissolved in CHCl3 few drops of tetraniromethane sol. in CHCl3 are added. Appearance of yellow color is indicative of double bond. Exocyclic methylene group containing an isolated double bond is also detected with this test.

SnCl4 TEST: A mixture of SnCl4-AcOH-CCl4 (6: 50: 50) when sprayed on a filter paper containing a spot of triterpene and heated at 100C produces a brown color.

WHITEBY TEST: On heating few drops of conc. in CHCl3 sol. of the compound various color are formed. This test is not given by steroidal sapogenins.

SANNIE TEST: Few mg of the ganin on a filter paper is sprayed with an alcoholic sol. of cinnamic aldehyde, dried and re-sprayed with a mixture of Ac20 and . Formation of a yellow color on heating indicates the presence of steroidal genin. The tritrapenic genins do not respond to this test.

ANTIMONY TRICHLORIDE REACTION: A place of filter paper dipped in a sol. of genin and a sol. of SbCl3 in Chloroform when treated with a mixture of and acetic anhydride develops orange color.

TRICHLOROACETIC ACID TEST: The compounds (0.5-1 mg) is heated with 0.2-0.3 g of CCl3COOH. A color, usually red, develops at 60’ for steroid and most Tetracyclic triterpenoids, and a blue or redcolor at 110’ for pentacyclic triterpenoids.

KEDLE REACTION: Kedle reaction is used to detect butenonide in triterpenoids molecules kedle reagent is prepared by mixing 3% ethanolic 3,5-dinitrobenzoic acid with 5 ml or 2M NaOH. The plate is sprayed with 5 - 8 ml mixture of and evaluated.
(B) COLOR REACTION OF STEROIDS SAPONIN

SALKOWSKI TEST: To powdered compound (10mg) in chloform few drops of concentrated H$_2$SO$_4$ are added. Yellow color changing to red developed

LIEBERMANN-BURCHARD TEST:— To few mg of the substance dissolved in acetic anhydride, conc. H$_2$SO$_4$ is added. A green color change in immediately or through red and blue shaded formed.

ROSENTHALER TEST:— Addition of to an alcoholic sol. of triterpene containing vanillin-hydrochloric acid produces a lilac color.

TSCHUGAEFF REACTION:— A glacial acetic acid solution of a sterol is treated with ZnCl$_2$ and acetyl chloride and boiled to get color.

LIFSCHUTZ REACTION:— Small quantities of the sterol and perbenzoic acid are heated in glacial AcOH solution and H$_2$SO$_4$ is added to get color.

ZIMMERMANN REACTION:— This test is positive for 3-keto sterols as given in the chemical reaction of triterpenoids.
1.3 General isolation procedure for saponins

(A) Isolation procedure for steroidal – saponins

Usually sterols are isolated by silica-gel column chromatography of dried alcoholic extract of a dried material using petroleum ether, chloroform, acetone and methanol as eluants. For the isolation of sterols from sponges the material is extracted with acetone and chloroform-methanol (1:1) for several days. The extracts were concentrated under reduced pressure to obtain an aqueous suspension that was extracted with Et$_2$O, dried over Na$_2$SO$_4$ and evaporated to obtain an oily residue that is chromatographed over Si-gel column and eluted with solvent of increasing polarity from petroleum ether through CHCl$_3$ and increasing amounts of MeOH in CHCl$_3$. The compounds so secured were purified by further chromatography over Si-gel, HPLC or RP-HPLC.

(B) Isolation procedure for triterpenoid saponins

The pulverized and dried sample of a plant material is extracted by maceration /percolation with methanol at room temperature. The org. solvent is evaporated in vacuum under 40$^\circ$C to afford a brown tar. Before chromatography separation the extract is purified by various method such as sequential solvent extraction with solvent of increasing polarity, treatment with activated animal charcoal, fractionation into acid and neutral triterpenes by sodium salt formation method, repeated acetylation &deacetylation, etc. The residue is partitioned into n-hexene-, CHCl$_3$, EtOAc-, &water soluble fraction. Some time the extract is treated with n-hexene to remove fatty matter &neutral triterpene. The dried n-hexane fraction is chromatographed on Si-gel eluting with n-hexane followed by n-hexane containing increment amounts ofEtOAc to isolate free triterpene. Further purification is carried out by re-chromatography.
1.4 Spectral properties of saponins

(A) Spectral data of Triterpenoids saponins

Ultra violate spectra:

Unsaturated esters, lactones and acid can usually be recognized by their absorption maxima in particular region. The UV spectra of pentacyclic triterpenoids in H_2SO_4 exhibit a characteristic Abs max. at 310nm regardless of the constituents present. The hypochromic shift associated with the 18β-to 18α-transformation has been observed in A-boswellic acid. The absorption maxima at 247nm and shoulder at 241 and 252 nm are Characteristic of a heteroannular diene. The compounds having a furan Ring show UV max. at 215nm. An α&β-unsaturated carbonyl group absorbs at 275nm. UV absorption at λ_max 241nm is characteriest of a 4; 9-heteroannular diene chromophore in lanostane skeleton rather than in tirucalane or euphorbane system. A7, 9-heteroannular diene of the latter two type of compound would have shows three UV absorption maxima at 223, 247, and 258nm while Δ^1(12) and Δ^13(18) heteroannular diene group located in rings C/D absorbs at 243, 151 and 260nm

Infra-red spectra:-

The IR spectra of the triterpenes resemble with the spectra of steroids. But for identical position in C-3 oxo-steroids the C-2 & C-4 methylene groups absorb near 1420 cm^-1 while in the corresponding 3-oxo-triterpenes the C-2 methylene group absorbs near 1430 cm^-1, a C-11 methylene in 12-oxo steroids absorbs at 1434 cm^-1 whereas the same group in 12-oxo triterpenes absorb close to 1420 cm^-1

On the basis of IR spectroscopic studies tertiary equatorial (3613 cm^-1) and axial (3617 cm^-1) hydroxyl group can be distinguished. In case of 18α-H & 18β-H olean-12-ene derivatives, the 18β-H compounds with axial COOMe at C-20 absorb at 1165 and 1090 cm^-1 while the 18α-H epimers absorb at 1117 cm^-1. The 18β-H compound an axial CH_2OH at C-20 exhibited an IR band at 1210-1205 cm^-1 whereas the 18α-H epimers absorb at 1193-1189 cm^-1. The band at 1510 cm^-1 is attested to the presence of a 2, 3-desubstituted furan ring.

Compound containing α β-unsaturated carbonyl group showed IR absorption band in the region 1665-1600 cm^-1; saturated CO group 1700 cm^-1 and α, β-unsaturated butyrolactone at 1760 cm^-1, δ-lactose at 1720 and 1250 cm^-1, ester carbonyl; group 1725 &1080 cm^-1, aliphatic C-H near 2800 cm^-1, COOH group at 3420-2500 cm^-1, CO at 1150-1000 cm^-1, dimethyl (1360, 1380 cm^-1), trisubstituted double bond (1670,830 cm^-1)
H-NMR Spectra:-

In $^1$H NMR spectra of triterpenoids containing carbomethoxyl function, the chemical shift of the highest or most shielded C-methyl group is partially indicative of the position of the carbomethoxy group. In C-28 carbomethoxy function contacting ursane or oleanane series the highest C-methyl absorption signal appears upfield from 0.77 ppm. Alternatively, when the C-28 position is represented either by hydroxymethylene, a methyl group or a lactose, the highest C-methyl absorption signal appears downfield from 0.77 ppm. Friedelin, which does not possess a C-28 carbomethoxy group, is the only naturally occurring triterpenes which has its highest C-methyl absorption below 0.77 ppm. The three doublets at δ 0.80-0.85, each corresponding to three protons (J=6.5 Hz), are attributed to gem-dimethyl at C-26, C-27 and a methyl at C-21 in cyclortane type triterpenoids. Four tertiary methyl signal at d 0.76, 0.88 and 0.96 (6 H, s) are assigned to C-18, C-28, -29 and C-30 quaternary methyl in these compounds.

The geometric relationship between C-24/C-25 double bond of a side chain and that of carboxylic acid (e.g. masticadienoic acid) is identified from the chemical shift of H-24 (δ 6.89) and its comparison with that of methyl angelate (δ 5.97, COOH and H-24 Trans) and methyl tiglate (δ 6.72, COOH and H-24 cis). The presence of H-2 protons as double-double at δ 2.42 and 2.44 and the H-1 equatorial proton as a double-double at δ 1.90 suggests 3-oxo- triterpenes nucleus.

Mass Spectra:-

In the mass spectrum of 3β-hydroxy-9β-Iantosta-7, 24-dien-26, 23R-olide-26, 23R-olide (31) the three characteristic fragment ion peaks are due to tetracyclic triterpene skeleton at m/z 315, the C₈ side chain moiety involving the lactone ring in the terminal position by the cleavage of the C-17/C-20 bond at m/z 139 and the γ-lactone portion at m/z 97 together with the peaks arising from the retro-Diels-Alder cleavage of the ring B at m/z 314 and 299 and cleavage of ring C at m/z 237 and 187.
**UV Spectra**

UV spectroscopy is useful in determining double bonds of the $R_2C=CR_2$ (170-210nm). The position of an isolated double bond can be found out on a micro-scale by treating the compound with $H_2SO_4$ to give a cyclic osmic ester, which on reduction with LiAlH$_4$ yields 1,2-diol and this is then oxidized by lead tetra-acetate. Examination of the ketoproduct gives position of the ethylenic double bond.

**IR Spectra**

In IR spectroscopy the more important groups are OH, C = O, C = C – C = O, CO$_2$H, and CO$_2$R. A very important feature of steroid IR spectroscopy, however, is the dependence of the absorption maximum of the keto group on its position in the nucleus, and also, in some cases, according to whether the hydrogen atom at a ring junction is a or b. The absorption maxima for saturated ketones are as: 3-CO(5α and 5β), 1719-1712; 4-CO(5α), 1712; 4-CO(5β), 1713; 6-CO(5α), 1714-1712; 6-CO(5β) 1708-1706; 11-CO (5β), 1710-1704 cm$^{-1}$. When the chromophore is the a,b-unsaturated carbonyl group, both the C=O(str.) and C =C (str.) have the absorption bands in regions depending on the position of the chromophore in the molecule, e.g., $\Delta^4$-3-ketone; C = O, 1684-1680, and C = C 1609-1604; $\Delta^4$-3-ketone: C = O, 1681-1677, and C = C, 1619-1615 cm$^{-1}$.

**$^1$H NMR spectra**

Steroids appear to have a finger print region which is characteristic of the CH and CH2 protons in the nucleus. Also, the proton in the group = CH- has a definite d-value. In the 1H NMR spectra the olefinic protons of steroids appear at $\delta$ 5.1-5.3 (m, H-7), 5.2 (H-11), 5.3-5.7 (H-6), 5.0-5.1 (dd/m, H-22), 5.2 (H-23), 4.65 and 4.71 (exocyclic methylene). A characteristic double doublet at $\delta$ 5.06 (J = 2.6 HZ) and 5.28(dd, 3.5,6 HZ) is assigned for $\Delta^{11}$-double bond. The cis nature of this double bond is evident from the IR bond at 1660,1410, and 695 cm$^{-1}$ and the J values for the C-11 and C-12 proton. The methyl groups of sterols resonate near $\delta$ 0.5-0.7 (Me-18), 0.8-1.0 (Me-19), 0.88-1.0 (d, Me-21), 0.81 (d, Me-26/27), 0.83 (d, Me 26/27), 0.84 (t, J = 7.4,Me-29), 0.76 (6H, gem-di-Me), 1.6 (vinyl Me) and 2.0 (S, acetyl). The presence of the two tertiary and four secondary methyls suggests an ergostane skeleton. A$\Delta^{16}$ double bond would induce shifts at the neighbouring carbon of the side chain. In a steroid possessing a double bond between H-22 and H-23, the large value (15.4HZ) of the coupling constant between these protons indicated the E configuration for the $\Delta^{22}$ double bond.

**$^{13}$C NMR spectra**

$^{13}$C NMR spectroscopy revealed itself as a straightforward method for the determination of the configuration at C-22 in substituted steroids for the cholestane-type. Comparison with cholesterol showed shielding effects on C-22,C-20 and C-23 and deshielding of C-17, C-21 and C-24 as a result of introducing substituents such as OH, NH$_2$ and N$_3$ at position 22.
2. Isolation and characterization of some commercially important saponins

2.1 Isolation and characterization of Diosgenin

Sources of diosgenin

<table>
<thead>
<tr>
<th>B.S</th>
<th>G.S</th>
<th>Percentage of diosgenins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dioscorea deltoidea</td>
<td>India</td>
<td>2.5%</td>
</tr>
<tr>
<td>Dioscorea floribunda</td>
<td>India</td>
<td>2-5%</td>
</tr>
<tr>
<td>Dioscorea composite</td>
<td>India</td>
<td>2-5%</td>
</tr>
<tr>
<td>Dioscorea villosa</td>
<td>U.S.A</td>
<td>3-6%</td>
</tr>
<tr>
<td>Dioscorea prazeri</td>
<td>India</td>
<td>1-2%</td>
</tr>
<tr>
<td>Dioscorea bulbifera</td>
<td>India</td>
<td>1-2%</td>
</tr>
<tr>
<td>Dioscorea tocoro</td>
<td>Japan</td>
<td>2.6%</td>
</tr>
<tr>
<td>Trigonella foenum graecum</td>
<td>Egypt &amp; India</td>
<td>0.4-1%</td>
</tr>
</tbody>
</table>

Isolation and extraction of diosgenin:

Dried rhizome are powdered to mesh 20 size and first subjected to hydrolysis by refluxing with 5% HCl for 2 hours. The hydrolyzed mass is filtered, washed twice with water and then twice with 5% sodium bicarbonate solution. It is finally washed with water till the washing are neutral. The residue thus obtained is dried are further extracted with toluene for 8 hours. The toluene extract is concentrated during which diosgenin gets precipitated. Diosgenin is filtered, washed with little hexane (40-60˚) and air dried to yield about 95% pure product.

Properties: Diosgenin occurs as a white crystalline powder, soluble in the usual organic solvent and in acetic acid. Diosgenin is used as a pharmaceutical aid for the synthesis of various steroidal drugs. M.P 204-207˚
Spectral data of diosgenin

**UV spectra:** maximum at 205 nm absorbance =0.986

Spectra UV 265

GRAPH (U.V.Spectra p.no.105) KBr disk(2mg,200mg) (Flours)

**IR spectra:**

<table>
<thead>
<tr>
<th>Frequencies (cm⁻¹)</th>
<th>Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>3460</td>
<td>Stretching vibration of OH</td>
</tr>
<tr>
<td>2906-2848</td>
<td>Stretching vibration of CH steroid skeleton</td>
</tr>
<tr>
<td>1660</td>
<td>Vibration of C = C bond</td>
</tr>
<tr>
<td>1452</td>
<td>Deformation vibration of methyl</td>
</tr>
<tr>
<td>1377</td>
<td>And methylene</td>
</tr>
</tbody>
</table>

GRAPH (IR Specturm p.no.601)

**Mass spectra:** Fragment of m/z 139 &115 characteristic for Spiroketal ring [5,6] of diosgenin

<table>
<thead>
<tr>
<th>Species</th>
<th>M/z (% rel. int.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>E1</td>
</tr>
<tr>
<td>M⁺ + 29</td>
<td></td>
</tr>
<tr>
<td>M⁺ + 1</td>
<td></td>
</tr>
<tr>
<td>M⁺</td>
<td>414(17)</td>
</tr>
<tr>
<td>A</td>
<td>342(10)</td>
</tr>
<tr>
<td>B</td>
<td>300(25)</td>
</tr>
<tr>
<td>(b-H₂O)</td>
<td>282(55)</td>
</tr>
<tr>
<td>C</td>
<td>285(15)</td>
</tr>
<tr>
<td>(c-H₂O)</td>
<td>267(10)</td>
</tr>
<tr>
<td>D</td>
<td>217(15)</td>
</tr>
<tr>
<td>E</td>
<td>139(100)</td>
</tr>
<tr>
<td>F</td>
<td>115(15)</td>
</tr>
</tbody>
</table>
2.2 Isolation and characterization of solasodine

Source of solasodine

<table>
<thead>
<tr>
<th>B.S</th>
<th>G.S</th>
<th>Percentage of solasodine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solanum incanum (Solanaceae)</td>
<td>India</td>
<td>2%</td>
</tr>
<tr>
<td>Solanum khasianum (Solanaceae)</td>
<td>India</td>
<td>1-1.75%</td>
</tr>
<tr>
<td>Solanum xanthocarpum (Solanaceae)</td>
<td>India</td>
<td>1.45%</td>
</tr>
<tr>
<td>Solanum dulcamura (Solanaceae)</td>
<td>India</td>
<td>0.9%</td>
</tr>
</tbody>
</table>

Properties: Solasodine is a crystalline powder. Its alcoholic solution is alkaline to litmus. It is freely soluble in Benzene, pyridine and chloroform, moderately soluble in alcohol and acetone, slightly soluble in ether in soluble in water.

Isolation & Extraction

The dried berries are first powdered and subjected to defattying with petroleum ether to yield greenish-yellow oil which is rejected as it is dividing of the glycoalkaloid. The defatted material is extracted thrice with ethyl alcohol; the extracts are combined and concentrated to 1/10th of its volume concentrated HCL is then added to it until the final concentration reaches 5 to 6% the whole mass is refluxed or about 6 hours to attain complete hydrolysis of glycoalkaloid. The reaction mixture is then basified with ammonia and again refluxed for 1 hour. The cooled reaction mixture is filtered and the residue obtained is thoroughly washed with water till neutral pH and dried. The dried material is then dissolved in chloroform. Solasodine goes into chloroform. The solution is filtered and the solvent is evaporated to yield the residue containing Solasodine. It is further purified by crystallizing it form methanol or by sublimation in high vaccum.
**Spectral data of solasodine**

**UV spectra:** maximum at 206 nm

**IR spectra:**

<table>
<thead>
<tr>
<th>Frequencies (cm⁻¹)</th>
<th>Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>3455</td>
<td>Stretching vibration of OH</td>
</tr>
<tr>
<td>2843-2967</td>
<td>Stretching vibration of CH steroid skeleton</td>
</tr>
<tr>
<td>3362</td>
<td>Stretching vibration of NH</td>
</tr>
<tr>
<td>1690</td>
<td>Stretching Vibration of C = C bond</td>
</tr>
<tr>
<td>1675</td>
<td>Deformation vibration of NH</td>
</tr>
<tr>
<td>1451,1344</td>
<td>Deformation vibration of CH₃</td>
</tr>
</tbody>
</table>

**Mass spectra:** Fragment of m/z 139 & 115 characteristic for Spiroketal ring [5,6] of diosgenin

<table>
<thead>
<tr>
<th>Species</th>
<th>M/z (% rel. int.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>E1</td>
</tr>
<tr>
<td>M⁺ + 29</td>
<td></td>
</tr>
<tr>
<td>M⁺ + 1</td>
<td></td>
</tr>
<tr>
<td>M⁺+1-18(H₂O)</td>
<td>414(17)</td>
</tr>
<tr>
<td>M⁺</td>
<td>413(27)</td>
</tr>
<tr>
<td>M⁺-15(CH₃)</td>
<td>398(3)</td>
</tr>
<tr>
<td>M⁺-28(C₂H₄)</td>
<td>300(25)</td>
</tr>
<tr>
<td>C₉H₂₇NO⁺</td>
<td>282(55)</td>
</tr>
<tr>
<td>a*</td>
<td>138(70)</td>
</tr>
<tr>
<td>b*</td>
<td>114(100)</td>
</tr>
</tbody>
</table>
2.3 Isolation and characterization Ginsenoside

Source of Ginsenoside:

<table>
<thead>
<tr>
<th>B.S</th>
<th>G.S</th>
<th>Percentage of Ginsenoside</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panax ginseng (Araliceae)</td>
<td>Asia</td>
<td>&lt;2%</td>
</tr>
<tr>
<td>Panax quinquefolium (Araliceae)</td>
<td>U.S.A</td>
<td>&lt;1.5%</td>
</tr>
<tr>
<td>Panax notoginseng (Araliceae)</td>
<td>China</td>
<td>1.2%</td>
</tr>
<tr>
<td>Panax japonicum (Araliceae)</td>
<td>Japan</td>
<td>-</td>
</tr>
<tr>
<td>Panax pseudoginseng (Araliceae)</td>
<td>India</td>
<td>-</td>
</tr>
<tr>
<td>Panax trifolium (Araliceae)</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Extraction & Isolation

The powder are finely cut and extracted three times with methanol under reflux for 3 hour. Evaporation of solvent under reduced pressure provided the methanolic extract. The methanolic extract is partitioned in an EtOAc-H₂O (1:1) mixture, and the aqueous phase is further extracted with n–BuOH. Removal of solvent from the EtOAc–soluble, n-BuOH-soluble, & water-soluble fractions under reduced pressure yielded 4.5%, 29.4%, & 44.1% of residue respectively.

TLC

Crude saponins were spotted together with standard samples of Rb1 and Rg1 on a Merck Silica gel TLC plate 60 F254 and developed with an upper layer of n-BuOH-AcOEt-H₂O (5:1:4). The saponin spots were detectable when sprayed with 10% H₂SO₄ followed by heating at 105 degree C for 10 min. Saponin spots were compared with the standard by densiometry using a TLC scanner. Rb group content was calculated as total of ginsenosides Ra, Rb1, Rb2, Rc, Rd, having proto Panaxadiol as the saponin; Rg group content was calculated as the total of ginsenosides Re, Rf, Rg1, Rg2, Rh1 having proto Panaxatriol as saponin. (Doran P.M, et al)

HPLC

Senshu pak NP 10*300=3000 mm column Mobile phase of 22% CH3CN for ginsenosides with proto Panaxatriol and 33% CH3CN for ginsenoside with proto Panaxadiol. Flow rate of 5 ml/min for the former and 4ml/min for the latter and detection by photodiode array (UV 202nm). Development of the HPLC method has allowed the accurate determination of saponin content. However it is extremely time intensive. Since ginsenosides must be treated separately based on their sapogenin content and assay time for each sample is about 1h. (Doran, P.M, et al)
Saponin from Rhizomes of wild *Panax* spp. (Araliaceae)

**Compound:** Pseudo-ginsenoside RC₁

**M.F.** C₃₀H₆₆O₁₉

**m.p.** white powder

\[ [\alpha]^{17}_D +20.8^\circ \ (c = 0.63, \text{MeOH}) \]

**Spectral data:** ¹³C-NMR

**Plant resources:** Rhizomes of wild *Panax* spp. (Araliaceae) collected at Chame (the eastern foot of Mt. Annapurna; elevation above sea level 2700 m)
Saponin from Rhizomes of wild *Panax* spp. (Araliaceae)

**Compound:** 24(5)-Pseudo-ginsenoside F₁₁

**M.F.** C₄₂H₇₂O₁₃

**m.p.** white powder

\([\alpha]^{17}_D - 24.5^\circ\) (c = 0.53, MeOH)

**Spectral data:** ¹³C-NMR

**Plant resources:** Rhizomes of wild *Panax* spp. (Araliaceae) collected at Chame (the eastern foot of Mt. Annapurna; elevation above sea level 2700 m)
Rhizomes of wild *Panax* spp. (Araliaceae) collected at Ghorapani (the western foot of Mt. Annapurna; elevation above sea level 2743 m)
2.4 Isolation and characterization of Glycyrrhizinic acid

Source of Glycyrrhizinic acid

<table>
<thead>
<tr>
<th>B.S</th>
<th>G.S</th>
<th>Percentage of Glycyrrhizinic acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glycyrrhiza glabra(Leguminosae)</td>
<td>Spain, U.S.A, England</td>
<td>2.5-7%</td>
</tr>
<tr>
<td>Glycyrrhizauralensis(Leguminosae)</td>
<td>China</td>
<td>2-7%</td>
</tr>
</tbody>
</table>

Isolation & extraction

Take 20gm powder passed through 20# & extract with 80 to 100 ml ethanol containing 0.5 to 1.0 ml HCl heat for 10 min filter the extract through the filter paper. Add dropwise 50% ammonia ppt of ammonia salts are formed. Stir fastly to make small ppt form big lumps ppt sets at bottom. Filter the ppt with waterman filter paper. Which previously weighted to filtrate. Add ammonia to check any ppt formation wash the obtained ppt with alcohol soluble impurities. Dry this ppt.

Properties

It is a very sweet, water-soluble substance.
It is 50 times sweeter than sucrose.
Glycyrrhizin is mixture of potassium and calcium salts of glycyrrzinic acid.
It shows especially in alkaline solution frothing but it has very weak haemolytic properties.
The yellow color of drug is due to chalcone glycoside isoliquiritin.
3. Isolation and characterization of some newer saponins from plant

3.1 Saponins from the Fungus *Ganoderma lucidum*\(^9\)

**Extraction and Isolation.**

Dried and chipped fruiting bodies of *G. lucidum* (373 g) were extracted with MeOH (3 L) combined solutions were concentrated in vacuo to give an extract (30.0 g), which was subjected to chromatography on silica gel (1 kg). The column was eluted successively with n-hexanes-EtOAc [1:0 (2.5 L), 19:1 (6.5 L), 9:1 (2.5 L), 4:1 (3.0 L), 7:3 (10.0 L), 3:7 (9.0 L), 0:1 (7.0 L), v/v] as eluant with monitoring by TLC, and the eluates were arranged into six fractions. A portion (5.0 g) of the most polar fraction (6.9 g) eluted by n-hexanes-EtOAc [7:3, 3:7, and 0:1] was further chromatographed on silica gel (200 g) with a stepwise gradient of n-hexanes-EtOAc [9:1 (4.5 L), 4:1 (5.8 L), 7:3 (3.0 L), 1:1 (3.4 L), 2:3 (0.6 L), 3:7 (5.2 L), 1:4 (0.8 L), 0:1 (1.0 L), v/v], which yielded fractions A (R\(_f\) ca. 0.7 on TLC; 707 mg), B (R\(_f\) ca. 0.5; 916 mg), and C (R\(_f\) ca. 0.2; 1.83 g) from the eluates of n-hexanes-EtOAc (7:3), (1:1 and 2:3), and (3:7, 1:4, and 0:1), respectively. Upon HPLC (I), a portion (427 mg) of fraction A yielded 11a (20.0 mg; retention time (t\(_R\)) 39.6 min). A portion (250 mg) of fraction B, on HPLC (II), afforded nine compounds, 1b (11.0 mg; t\(_R\) 39.6 min), 2b (4.9 mg; t\(_R\) 26.4 min), 3b (14.2 mg; t\(_R\) 39.4 min), 5b (1.6 mg; t\(_R\) 35.4 min), 6b (6.8 mg; t\(_R\) 29.9 min), 7b (5.1 mg; t\(_R\) 36.7 min), 8b (0.8 mg; t\(_R\) 21.2 min), 9a (4.9 mg; t\(_R\) 22.8 min), and 10b (1.4 mg; t\(_R\) 30.7 min). HPLC (II) of a portion of fraction C (556 mg) gave seven compounds, 2a (11.0 mg t\(_R\) 16.3 min), 3a (4.7 mg; t\(_R\) 27.2 min), 4a (9.0 mg; t\(_R\) 15.8 min), 5a (44.1 mg; t\(_R\) 23.3 min), 6a (27.7 mg; t\(_R\) 20.6 min), 7a (2.7 mg; t\(_R\) 24.8 min), and 10a (8.0 mg; t\(_R\) 25.2 min). Some physical characteristics and the spectral data of three new compounds, 1a, 1b, and 2b, are shown below. The \(^1\)H NMR data of five known triterpene acids, 5a, 6a, 7a, 9a, and 10a, are also described below since these were not previously reported.
Spectral data

Lucidenic Acid P (1a):
Colorless needles from acetone-MeOH, mp 135-137 °C; [α]$_D^{25}$ +14.7° (c 0.38, CHCl$_3$); UV (MeOH) $\lambda_{max}$ 255 nm; IR $\nu_{max}$ 3446, 1755, 1729, 1681 cm$^{-1}$; $^{13}$C and $^1$H NMR, see Table 1; EIMS m/z 518 [M]$^+$ (9), 503 (7), 490 (25), 472 (3), 458 (8), 440 (4), 430 (4), 355 (5), 329 (6), 306 (100), 277 (7), 255 (3), 199 (3), 171 (3), 153 (10), 135 (3); HREIMS m/z 518.2827 (calcd for C$_{29}$H$_{42}$O$_8$, 518.2880). Treatment of 1a with ethereal CH$_2$N$_2$ afforded 1b.

Methyl lucidenate P (1b):
Colorless needles from acetone-MeOH, mp 83-85 °C; [α]$_D^{25}$ +77.6° (c 0.41, CHCl$_3$); UV (MeOH) $\lambda_{max}$ 252 nm; IR $\nu_{max}$ 3459, 1733, 1680 cm$^{-1}$; $^1$H NMR δ 0.85 (3H, s, H$_{-29}$), 0.99 (3H, s, H$_{-18}$), 0.99 (3H, d, J = 6.3 Hz, H-21), 1.03 (3H, s, H-28), 1.27 (3H, s, H-19), 1.49 (3H, s, H-30), 2.22 (3H, s, 12β-OAc), 3.20 (1H, dd, J = 5.6, 10.7 Hz H-3α), 3.68 (3H, s, COOMe), 4.80 (1H, dd, J = 8.5, 8.7 Hz, H-7β), 5.61 (1H, s, H-12α); EIMS m/z 532 [M]$^+$ (12), 517 (4), 504 (23), 472 (3), 454 (6), 444 (14), 417 (2), 332 (7), 329 (7), 306 (100), 288 (4), 277 (10), 255 (5), 241 (4), 227 (7); HREIMS m/z 532.3036 (calcd for C$_{30}$H$_{44}$O$_8$, 532.3036).

Methyl lucidenate Q (2b):
Colorless needles from acetone-MeOH, mp 130-131 °C; [α]$_D^{25}$ +58.5° (c 0.13, CHCl$_3$); UV (MeOH) $\lambda_{max}$ 252 nm; IR $\nu_{max}$ 3445, 1736, 1707, 1661 cm$^{-1}$; $^{13}$C and $^1$H NMR, see Table 1; EIMS m/z 474 [M]$^+$ (100), 456 (42), 441 (16), 425 (17), 413 (12), 336 (92), 330 (17), 318 (46), 313 (22), 299 (14), 287 (14), 276 (19), 259 (28), 245 (13), 203 (28), 161 (29), 137 (24); HREIMS m/z 474.2979 (calcd for C$_{29}$H$_{42}$O$_8$, 474.2981).

Lucidenic acid D$_2$ (5a):
$^1$H NMR δ 0.86 (3H, s, H$_{-18}$), 1.02 (3H, d, J = 6.6 Hz, H-21), 1.12 (3H, s, H-29), 1.14 (3H, s, H-28), 1.33 (3H, s, H-19), 1.81 (3H, s, H-30), 2.22 (3H, s, 12β-OAc), 5.68 (1H, s, H-12α); EIMS m/z 514 [M]$^+$ (C$_{29}$H$_{38}$O$_8$).

Lucidenic acid E$_2$ (6a):
$^1$H NMR δ 0.82 (3H, s, H-18), 0.88 (3H, s, H-29), 0.98 (3H, d, J = 6.6 Hz, H-21) 1.02 (3H, s, H-28), 1.33 (3H, s, H-19), 1.73 (3H, s, H-30), 2.21 (3H, s, 12β-OAc), 3.23 (1H, dd, J = 4.8, 10.8 Hz, H-3α), 5.62 (1H, s, H-12α); EIMS m/z [M]$^+$ (C$_{29}$H$_{40}$O$_8$).

Lucidenic acid F (7a):
$^1$H NMR δ 0.86 (3H, s, H-18), 0.96 (3H, d, J = 6.6 Hz, H-21), 1.12 (3H, s, H-29), 1.14 (3H, s, H-28), 1.28 (3H, s, H-19), 1.65 (3H, s, H-30); EIMS m/z 456[M]$^+$ (C$_{27}$H$_{36}$O$_6$).
Ganoderic acid E (9a):
$^1$H NMR δ 0.88 (3H, s, H-18), 0.98 (3H, d, J = 6.4 Hz, H-21), 1.12 (3H, s, H-29), 1.14 (3H, s, H-28), 1.23 (3H, d, J = 7.0 Hz, H-27), 1.28 (3H, s, H-19), 1.64 (3H, s, H-30); EIMS m/z 512 [M]$^+$ (C$_{30}$H$_{40}$O$_7$).

Ganoderic acid F (10a):
$^1$H NMR δ 0.85 (3H, s, H-18), 0.99 (3H, d, J = 6.4 Hz, H-21), 1.12 (3H,s,H-29), 1.14 (3H,s,H-28), 1.22 (3H, d, J = 7.2 Hz, H-27), 1.34 (3H,s,H-19), 1.80 (3H,s,H-30), 2.25 (3H,s,12OAc), 5.68 (1H,s,H-12α); EIMS m/z 570 [M]$^+$ (C$_{32}$H$_{42}$O$_9$).
3.2 saponins from the Aerial Parts of Ibicella lutea

Extraction and Isolation:

The air-dried aerial parts of I. lutea from the Province of San Luis (2.5 kg, without fruits) were extracted with Me₂CO at room temperature for 2 days. After evaporation of the silvent, the residue (55 g) was dissolved in a mixture of MeOH-H₂O (9:1), filtered, and extracted with n-hehane in order to remove pigments and fatty materials. Water was added to the aqueous alcohol fraction until the mixture became MeOH-H₂O (7:3) and was then extracted with CHCl₃. The CHCl₃ extract was concentrated under vacuum, and the resulting dark brown syrup (30 g) was fractionated by vacuum-liquid chromatography (VLC) over silica gel 60 H (Merck, Darmstadt), using mixtures of n-hexane-EtOAc of increasing polarity as eluent. The fraction eluted with 50% EtOAc was then chromatographed on reversed phase silica gel with MeOH-H₂O (7:3), followed by HPLC purification, and recrystallization from CH₃CN, to afford compounds 1 (2.3 g, 0.092%) and 2 (50 mg, 0.002%). The acetone extract (37 g) of the air-dried aerial parts of I. lutea (2 kg, without fruits) from the Province of Mendoza was extracted and partitioned as described above to afford 17 g of a dark brown CHCl₃ extract, which was fractionated as above to give three fractions. Normal-phase column chromatographic separation of the first fraction eluted with hexane-EtOAc (9:1) afforded a sterol mixture, which GC-MS analysis showed to be mainly composed of stigmasterol, campesterol, and sitosterol. The second fraction, eluted with hexane-EtOAc (1:1), was chromatographed on reversed-phase silica gel (eluents: MeOH-H₂O, 7:3), followed by HPLC purification with MeOH-H₂O (7:3) and recrystallization from CH₃CN, to give compound 3 (160 mg, 0.008%). Finally, fraction 3 was eluted with pure EtOAc and afforded, after purification on a Sephadex LH-20 column eluted with MeOH, 50 mg (0.0025%) of apigenin.
Spectral data

1-Acetyl-24-epi-polacandrin (1):
colorless prisms (CH_3CN); mp 164 – 165 °C; [α]_D^{25} -13.9° (c 0.225, CHAL_3); IR (nest) ν_{max} 3488, 3303, 2970, 1738, 1468, 1374, 1184, 1088, 1044, 948, 873 cm⁻¹; ^1H and ^13C NMR, see tables 1 and 2; (+)-LRFABMS m/z 535 (17) [M + H]^+, 439 (15), 143 (100) [side chain, C_8H_15O_2];

(-)-LRFABMS m/z 535 (10) [M-H]⁻, 275 (10), 183 (100), 151 (20); LREIMS (70 eV) m/z 534 (1), 392 (4), 380 (30), 235 (5), 223 (7), 218 (19), 205 (22), 203 (25), 189 (50), 143 (100), [C_8H_15O_2], 125 (65) [C_8H_15O_2 – 18], 107 (96); (+)-HRFABMS m/z 535.3999 [M + H]^+ (calcd for C_{32}H_{55}O_6 535.3999, Δ 0.0 mmu).

1,3-Diacetyl-24-epi-polacandrin (2):
colorless prisms (CH_3CN); mp 212-213 °C; [α]_D^{27} -47.5° (c 0.060, CHCl_3); IR (neat) ν_{max} 3528.3374, 1736, 1466, 1375, 1247, 1184, 1089, 1045 cm⁻¹; ^1H and ^13C NMR, see Tables 1 and 2; LREIMS (70 eV) m/z 516 (1), 517 (2), 381 (75), 314 (15), 235 (6), 217 (12), 205 (10), 201 (50), 189 (65), 143 [side chain, C_8H_15O_2] (100), 125 [C_8H_15O_2. H_2O] (60), 107 (96), 85 (35); (-)-LRFABMS m/z 575 [M – H]⁻ (10), 533 (20), 325 (35), 183 (100), 151 (25); (+)-LRFABMS m/z 577 (10) [M + H]^+ (calcd for C_{34}H_{57}O_7 577.4104, Δ 0.1 mmu).

20S*,24S*-Epoxy-3β,12β,25-trihydroxydammarane (3):
colorless prisms (CH_3CN); mp 147 °C; [α]_D^{20} +16.5° (c 0.200, CHCl_3); IR (neat) ν_{max} 3395, 2970,1454, 1377, 1248, 1044, 1079 cm⁻¹; ^1H NMR (CDCl_3, 200 MHz) δ 3.89 (1H, dd, J = 10.5, 4.0 Hz, H-24), 3.54 (1H, ddd, J = 10.4, 10.4, 4.3 Hz, H-12), 3.17 (1H, dd, J = 9.8, 5.4 Hz, H-3), 2.25 (1H, ddd, J=10.4, 10.4, 4.3 Hz, H-17), 1.28 (3H, s, H-21), 1.22 (3H, s, H-18), 1.12 (3H, s, H-27), 0.97 (3H, s, H-26), 0.92 (3H,s,H-29), 0.83 (3H,s,H-28), 0.78 (3H,s,H-19); ^13C NMR, see Table 2; (+)-LRFABMS m/z 499 [M + Na]^+ (100), 385 (5), 279(18), 237 (18), 143 [side chain, C_8H_15O_2] (42).

Compound 5:
Colorless needles; mp 253-254 °C; [α]_D^{25} -67.2° (c 0.040 CHCl_3); IR (neat) ν_{max} 2967, 1737, 1709, 1462, 1374, 1239 cm⁻¹; ^1H NMR (CDCl_3, 200 MHz) δ 5.00 (1H, t, J=3.4 Hz, H-3), 3.30 (1H, dd, J=3.4, 13.5 Hz, H-2a), 2.90 (1H, brd, J=9.8 Hz, H-13), 2.84 (1H, dd, J=3.4, 13.5 Hz H-2β), 2.61 (2H,m,H-23), 2.44 (1H,dd,J=3.5, 13.0 Hz, H-11α), 2.25 (1H,dd,J=3.5, 13.0 Hz, H-11β), 2.18 (1H,m,H-22a), 2.07 (3H,s,OCOCH_3), 1.95 (3H,m,H-22b), 1.32 (3H,s,H-21), 1.23 (3H,s,H-18), 1.23 (3H,s,H-19) 1.20 (3H,s,H-28), 0.92 (3H,s,H-29), 0.83 (3H,s,H-30); ^13C NMR, see Table 2; LREIMS (70 eV) m/z 487 (1), 412 (100), 394 (50), 316 (65), 203 (55), 160 (50), 99 (13), 81 (42); (+)-LRFABMS m/z 509 (100) [M + Na]^+, 487 (10) [M + Na]^+, 318 (20), 317 (84), 289 (100), 214 (10), 181 (30).
Compound 6:
White powder; mp 218-219 °C; [α]_{D}^{22} -7.02° (c 0.035 CHCl₃); IR (neat) v_max 2966, 1735, 1465, 1373, 1250 cm⁻¹; ¹H NMR (CDCl₃, 200 MHz) δ 4.85 (1H, dd, J=10.0, 5.0 Hz, H-1), 4.82 (1H, ddd, J=10.0, 10.0, 5.0 Hz, H-12), 4.70 (1H, t, J=30 Hz, H-3), 3.66 (1H, t, J=6.5 Hz, H-24), 2.13 (3H, s, OCOCH₃), 1.99 (3H, s, OCOCH₃), 1.92 (3H, s, OCOCH₃), 1.18 (3H, s, H-26), 1.16 (3H, s, H-21), 1.12 (3H, s, H-27), 1.07 (3H, s, H-18), 1.05 (3H, s, H-30), 0.98 (3H, s, H-19), 0.92 (3H, s, H-29), 0.85 (3H, s, H-28); ¹³C NMR, see Table 2; LREIMS (70 eV) m/z 618 (5), 500 (16), 440 (35), 381 (100).
294 (45), 227 (65), 143 (57), 107 (85), 79 (40); (+)-LRFABMS m/z 641 (32) [M + Na]⁺, 581 (5), 421 (12), 173 (10), 143 (100).

Compound 7:
Colorless gum; [α]_{D}^{25} -30.98° (c 0.297, CHCl₃); IR (neat) v_max 2962, 1737, 1465, 1371, 1249, 1043, 1079 cm⁻¹; ¹H NMR (CDCl₃, 200 MHz) δ 4.83 (1H, ddd, J=10.3, 10.3, 5.5 Hz, H-3), 3.89 (1H, t, J=6.9 Hz, H-24), 1.43 (3H, s, H-27), 1.42 (3H, s, H-26), 1.16 (3H, s, H-19), 1.03 (3H, s, H-28), 2.12 (3H, s, OCOCH₃), 1.98 (3H, s, OCOCH₃), 1.96 (3H, s, OCOCH₃), 1.92 (3H, s, OCOCH₃); ¹³C NMR, see Table 2; (+)-LRFABMS m/z 683 (5) [M + Na]⁺, 421 (27), 185 (63), 143 (65), 125 (100).

Compound 8:
Colorless needles; mp 214-216 °C [α]_{D}^{25} +77.5° (c 0.200, CHCl₃); IR (neat) v_max 2971, 1770, 1707, 1461, 1386, 1274, 966, 935 cm⁻¹; ¹H NMR (CDCl₃, 200 MHz) δ 2.95 (1H, brd, J=10.0 Hz, H-13), 2.63 (1H, m, H-17), 2.66-2.54 (2H, m, H-22), 2.60 (2H, m, H-23), 2.47 (2H, m, H-2), 2.33-2.17 (2H, m, H-11), 1.9 (1H, m, H-9), 1.6 (2H, m, H-6), 1.47 (2H, m, H-7), 1.38 (1H, m, H-5), 1.18-1.31 (2H, m, H-15), 1.27 (3H, s, H-21), 1.27 (3H, s, H-18), 1.11 (3H, s, H-28), 1.08 (3H, s, H-29), 1.05 (3H, m, H-19), 0.79 (3H, s, H-30); ¹³C NMR, see Table 2; (+)-LRFABMS m/z 451 (100) [M + Na]⁺, 382 (5), 328 (4) [M + C₅H₈O₂]⁺, 237 (12), 163 (23), 149 (50), 121 (62).

Compound 9:
White prisms; mp 232-233 °C [α]_{D}^{20} +10.5° (c 0.493, CHCl₃); IR (neat) v_max 3373, 2969, 1731, 1457, 1373, 1246, 1078, 1030 cm⁻¹; ¹H NMR (CDCl₃, 200 MHz) δ 3.53 (1H, ddd, J=10.2, 10.2, 5.6 Hz, H-12), 4.48 (1H, dd, J=8.5, 5.5 Hz, H-3), 3.88 (1H, dd, J=10.8, 5.6 Hz, H-24), 2.04 (3H, s, OCOCH₃), 1.28 (3H, s, H-21), 1.26 (3H, s, H-28), 1.10 (3H, s, H-27), 1.00 (3H, s, H-18), 0.91 (3H, s, H-26), 0.91 (3H, s, H-29), 0.85 (3H, s, H-30), 0.85 (3H, s, H-19); ¹³C NMR, see Table 2; (+)-LRFABMS m/z 541 (14) [M + Na]⁺, 355 (7), 281 (35), 221 (53), 207 (40), 147 (97), 133 (100).
Compound 10:
White crystals; mp 185-187 °C  [α]$_{D}^{20}$+1.00° (c 0.497, CHCl$_3$); IR (neat) $v_{max}$ 2967, 1732, 1463, 1369, 1244, 1075 cm$^{-1}$; $^1$H NMR (CDCl$_3$, 200 MHz) δ 4.83 (1H, ddd, J=10.6, 10.6, 5.7 Hz, H-12), 4.48 (1H, dd, J=10.4, 5.4 Hz, H-3), 3.88 (1H, t, J=3.64 Hz, H-24), 2.04 (3H, s, OCOCH$_3$), 2.00 (3H, s, OCOCH$_3$), 1.19 (3H, s, H-21), 1.18 (3H, s, H-28), 1.09 (3H, s, H-27), 0.99 (3H, s, H-18), 0.93 (3H, s, H-26), 0.87 (3H, s, H-29), 0.85 (3H, s, H-30), (3H, s, H-19); $^{13}$C NMR, see Table 2; (+)-LRFABMS m/z 583 (93) [M + Na]$^+$, 523 (14), 279 (18), 237 (20), 189 (12), 153 (19), 143 (100).

Compound 11:
Colorless gum; [α]$_{D}^{20}$+6.7° (c 0.535, CHCl$_3$); IR (neat) $v_{max}$ 2967, 1732, 1464, 1368, 1244, 1092, 1075 cm$^{-1}$; $^1$H NMR (CDCl$_3$, 200 MHz) δ 4.83 (1H, ddd, J=10.0, 10.0, 5.0 Hz, H-12), 4.49 (1H, dd J=9.6, 4.3 Hz, H-3), 3.93 (1H, t, J=6.9 Hz, H-24), 2.04 (3H, s, OCOCH$_3$), 2.01 (3H, s, OCOCH$_3$), 1.97 (3H, s, OCOCH$_3$), 1.44 (3H, s, H-26), 1.42 (3H, s, H-27), 1.20 (3H, s, H-21), 0.99 (3H, s, H-18), 0.93 (3H, s, H-28), 0.87 (3H, s, H-29), 0.85(3H, s, H-30), 0.85 (3H, s, H-19); $^{13}$C NMR, see Table 2; (+)-LRFABMS m/z 625 (17) [M + Na]$^+$,483 (6), 423 (10), 189 (20), 185 (66), 143 (66), 125 (100).
3.3 Saponins from Conyza blinii

Extraction and Isolation:

The extraction procedure was the same as described previously. Fractions 68-69 (part I), fraction 73 (part II), fractions 83-85 (part III), fraction 103-108 (part IV), and fractions 117-119 (part V) obtained by Sigel column chromatography were subjected to open ODS column chromatography by eluting with 10%, 40%, 80%, and 100% MeOH. The 80% MeOH eluate of part I was subjected to HPLC purification with 60% MeOH to give 1 (500 mg). The 80% MeOH eluate of part III was chromatographed over a Lober RP-C18 (Merck) column, and the 60% MeOH fraction gave 2 (90 mg) after HPLC purification (PEGASIL ODS-II column, 58% MeOH as the mobile phase). The 80% MeOH eluate of part IV was passed over a Lobar RP-C18 (Merck) column twice, and then HPLC (PEGASIL ODS-II column) was conducted with 52% MeOH as the eluent to afford 3 (80 mg). The 80% MeOH eluate of part V was purified with a Lobar RP-C18 (Merck) column twice with 52% MeOH as the eluent to obtain a white mixture, and the mixture was further subjected to HPLC purification (PEGASIL ODS-II column) to give 4 (131 mg) with 26% CH3CN as the mobile phase. The 80% MeOH eluate of part II was further separated using a Lobar RP-C18 (Merck) column twice with MeOH-H2O mixtures eluted in a gradient manner, and the fractions obtained were subjected to HPLC (PEGASIL ODS-II, 28% MeCN in H2O) to give 5 (120 mg), 7 (6 mg), 8 (35 mg), and a mixture of 6 and 9. This mixture was subjected to HPLC (YMC ODS column, 28.2% MeCN in H2O) to afford 6 (36 mg) and 9 (24 mg).
Spectral data

Conyzasaponin I (1):
Amorphous white solid; mp 240-242 °C; [α]$_D^{23}$ -26.7° (c 1.14, methanol); IR $\nu_{max}$ (KBr) 3411, 2914, 1734, 1644, 1052 cm$^{-1}$; $^1$H NMR (pyridine-d$_5$, 500 MHz) aglycon δ 5.45 (1H, br s, H-12), 4.77 (1H, H-2), 4.33 (1H, H-3), 3.71, 4.33 (1H each, d, J=10.8 Hz, H-23), 3.27 (1H, dd, J=14.0, 3.8 Hz, H-18), 1.54, 1.33, 1.23, 1.12, 0.98, 0.90 (3H each, s, H$_3$-25, 24, 27, 26, 30, 29);
other NMR spectral data, see Tables 1-3; MALDI-TOFMS (positive-ion mode) m/z 1361 [M + Na]$^+$, 1377 [M + K]$^+$; high-resolution MALDI FTMS (positive-ion mode) m/z 1361.6343 (calcd for C$_{63}$H$_{102}$NaO$_{30}$ [M + Na]$^+$, 1361.6354).

Conyzasaponin J (2):
Amorphous white solid; 236-238 °C; [α]$_{20}^{23}$ -41.4° (c 0.86, methanol); IR $\nu_{max}$ (KBr) 3405, 2931, 1735, 1637, 1063 cm$^{-1}$; $^1$H NMR (pyridine-d$_5$, 500 MHz) aglycon δ 5.63 (1H, br s, H-12), 5.24 (1H, H-16), 4.80 (1H, br s, H-2), 4.35 (1H, H-3), 3.69, 4.34 (1H each, d, J=9.9 Hz, H-23), 3.58 (1H, dd, J=14.2, 3.9 Hz, H-18), 1.77, 1.58, 1.34, 1.16, 1.15, 0.99 (3H each, s, H$_3$-27, 25, 24, 26, 30, 29); other NMR spectral data, see Tables 1-3; MALDI-TOFMS (positive-ion mode) m/z 1377 [M + Na]$^+$,1393 [M + K]$^+$; high-resolution MALDI FTMS (positive-ion mode) m/z 1377.6288 (calcd for C$_{63}$H$_{102}$NaO$_{31}$ [M + Na]$^+$, 1377.6303).

Conyzasaponin K (3):
Amorphous white solid; 237-239 °C; [α]$_{20}^{25}$ -56.5° (c 0.76, methanol); IR $\nu_{max}$ (KBr) 3415, 2933, 1728, 1645, 1045 cm$^{-1}$; $^1$H NMR (pyridine-d$_5$, 500 MHz) aglycon δ 5.64 (1H, br s, H-12), 5.25 (1H, H-16), 4.80 (1H, br s, H-2), 4.35 (1H, H-3), 3.69, 4.34 (1H each, d, J=9.4 Hz, H-23), 3.58 (1H, dd, J=14.2, 3.9 Hz, H-18), 1.77, 1.60, 1.35, 1.18, 1.17, 1.01 (3H each, s, H$_3$-27, 25, 24, 30, 26, 29); other NMR spectral data, see Tables 1-3; MALDI-TOFMS (positive-ion mode) m/z 1509 [M + Na]$^+$, 1525 [M+ K]$^+$; high-resolution MALDI FTMS (positive-ion mode) m/z 1509.6716 (calcd for C$_{68}$H$_{110}$NaO$_{35}$ [M + Na]$^+$,1509.6725).

Conyzasaponin L (4):
Amorphous white solid; 236-238 °C; [α]$_{20}^{25}$ -33.6° (c 1.08, methanol); IR $\nu_{max}$ (KBr) 3390, 2933, 1732, 1653, 1055 cm$^{-1}$; $^1$H NMR (pyridine-d$_5$, 500 MHz) aglycon δ 5.63 1H, br s, H-12), 5.23 (1H, H-16), 4.79 (1H, H-2), 4.34 (1H, H-3), 3.69, 4.33 (1H each, d, J=10.1 Hz, H-23), 3.58 (1H, H-18), 1.77, 1.59, 1.35, 1.16, 1.15, 1.00 (3H each, s, H$_3$-27, 25, 24, 26, 30, 29); other NMR spectral data, see Tables 1-3; MALDI-TOFMS (positive-ion mode) m/z 1539 [M + Na]$^+$, 1555 [M+ K]$^+$; high-resolution MALDI FTMS (positive-ion mode) m/z 1539.6820 (calcd for C$_{69}$H$_{112}$NaO$_{36}$ [M + Na]$^+$,1539.6831).
Conyzasaponin M (5):
white needles from MeOH; mp 236-238 °C; [α]_{D}^{20} -42.5° (c 0.36, methanol); IR ν_{max} (KBr) 3419, 2931, 1726, 1645, 1043 cm^{-1}; ¹H NMR (pyridine-d₅, 500 MHz) aglycon δ 5.46 1H, br s, H-12), 4.78 (1H, H-2), 4.32 (1H, H-3), 3.70, 4.33 (1H each, H-23), 3.30(1H, dd, J=13.7, 3.6 Hz, H-18), 1.55, 1.33, 1.24, 1.14, 1.01, 0.91 (3H each, s, H₃-25, 24,27, 26, 30, 29); other NMR spectral data, see Tables 1,2, and 4; MALDI-TOFMS (positive-ion mode) m/z 1479 [M + Na]⁺, 1495 [M+ K]⁺; high-resolution MALDI FTMS (positive-ion mode) m/z 1479.6619 (calcd for C₆₇H₁₀₈NaO₃₄ [M + Na]⁺,1479.6620).

Conyzasaponin N (6):
white needles from MeOH; mp 231-233 °C; [α]_{D}^{20} -42.3° (c 0.36, methanol); IR ν_{max} (KBr) 3340, 2935, 1734, 1653, 1053 cm^{-1}; ¹H NMR (pyridine-d₅, 500 MHz) aglycon δ 5.46 1H, br s, H-12), 4.81 (1H, H-2), 4.33 (1H, H-3), 3.69, 4.36 (1H each, d, J=10.3 Hz, H-23), 3.32(1H, dd, J=14.0, 4.1 Hz, H-18), 1.56, 1.35, 1.23, 1.14, 1.02, 0.91 (3H each, s, H₃-25, 24,27, 26, 30, 29); other NMR spectral data, see Tables 1,2, and 4; MALDI-TOFMS (positive-ion mode) m/z 1347 [M + Na]⁺, 1495 [M + K]⁺; high-resolution MALDI FTMS (positive-ion mode) m/z 1347.6197 (calcd for C₆₂H₁₀₀NaO₃₀ [M + Na]⁺,1347.6197).

Conyzasaponin O (7):
white needles from MeOH; mp 245-247 °C; [α]_{D}^{20} -38.6° (c 0.17, methanol); IR ν_{max} (KBr) 3404, 2935, 1734, 1653, 1053 cm^{-1}; ¹H NMR (pyridine-d₅, 500 MHz) aglycon δ 5.46 1H, br s, H-12), 4.79 (1H, H-2), 4.34 (1H, H-3), 3.70, 4.35 (1H each, H-23), 3.32(1H, overlapped, H-18), 1.57, 1.35, 1.24, 1.15, 1.02, 0.91 (3H each, s, H₃-25, 24,27, 26, 30, 29); other NMR spectral data, see Tables 1,2, and 4; MALDI-TOFMS (positive-ion mode) m/z 1509 [M + Na]⁺, 1525 [M + K]⁺; high-resolution MALDI FTMS (positive-ion mode) m/z 1509.6722 (calcd for C₆₈H₁₁₀NaO₃₅ [M + Na]⁺,1509.6725).

Conyzasaponin P (8):
Amorphous white solid; mp 243-245 °C; [α]_{D}^{20} -30.4° (c 0.51, methanol); IR ν_{max} (KBr) 3413, 2931, 1734, 1645, 1049 cm^{-1}; ¹H NMR (pyridine-d₅, 500 MHz) aglycon δ 5.46 1H, br s, H-12), 4.79 (1H, H-2), 4.34 (1H, H-3), 3.70, 4.35 (1H each, H-23), 3.31 (1H, dd, J=14.0, 4.4 Hz, H-18), 1.56, 1.34, 1.24, 1.15, 1.02, 0.91 (3H each, s, H-25, 24, 27, 26, 30, 29); other NMR spectral data, see Tables 1,2, and 4; MALDI-TOFMS (positive-ion mode) m/z 1347 [M + Na]⁺, 1363 [M+ K]⁺; high-resolution MALDI FTMS (positive-ion mode) m/z 1347.6186 (calcd for C₆₂H₁₀₀NaO₃₀ [M + Na]⁺,1347.6197).
Conyzasaponin Q (9):
white needles from MeOH; mp 242-244 °C; [α]$^\text{D}_{20}$ -34.2° (c 1.26, methanol); IR $\nu_{\text{max}}$ (KBr) 3415, 2933, 1738, 1641, 1054 cm$^{-1}$; $^1$H NMR (pyridine-d$_5$, 500 MHz) aglycon δ 5.46 (1H, br s, H-12), 4.79 (1H, br s, H-2), 4.36 (1H, H-3), 3.70, 4.36 (1H each, H-23), 3.32(1H, dd, J=13.8, 4.2 Hz, H-18), 1.56, 1.34, 1.24, 1.14, 1.01, 0.91 (3H each, s, H$_3$-25, 24, 27, 26, 30, 29); other NMR spectral data, see Tables 1, 2, and 4; MALDI-TOFMS (positive-ion mode) m/z 1479 [M + Na]$^+$,

1495 [M + K]$^+$; high-resolution MALDI FTMS (positive-ion mode) m/z 1479.6618 (calcd for C$_{67}$H$_{108}$NaO$_{34}$ [M + Na]$^+$, 1479.6620).
3.4 Saponin from Gynostemma pentaphyllum

Extraction and Isolation:

Dried leaves of G. pentaphyllum (10 Kg) were extracted with EtOH (95%). The extract was concentrated, defatted with cyclohexane, and partitioned sequentially with CHCl₃ and n-BuOH. The n-BuOH layer was dried in vacuo to yield 81 g of crude total saponins. It was then repeatedly separated by silica gel column chromatography using CHCl₃-CH₂OH as solvent to yield a series of fractions. Each of the fractions was then subjected to ODS silica gel column chromatography with MeOH-H₂O (30:70-70:30) to afford 1 (0.2g), 2 (25 mg), 3 (12mg), 4 (77 mg), 5 (10 mg), gynosaponin TN-1 (3.6 g), ginsenoside Rb3(0.7 g), ginsenoside Rd (0.9 g), gypenoside XLII (21 mg), gypenoside XLII (86 mg), gypenoside XLVI ( 5.1 g), gypenoside LVI ( 63 mg), gypenoside LVII ( 5.1 g), gypenoside LX ( 23mg ), and gypenoside LXXVII (6.1 g).
Spectral data

Gynoside A(1):-

- Colorless plates, mp 203-205 °C, [α]20D -0.47 (c 0.9, Meoh); IR(KBr) $\nu_{\text{max}}$ 3420, 2969, 2943, 1639, 1456, 1381, 1164, 1080, 1042, 880, 645 cm$^{-1}$; 1H and 13C NMR, see Tables 1 and 2; FABMS m/z 771[M+H]$^+$ and 793[M+Na]$^+$; HRESIMS m/z found 771.4889 (called for C_{41}H_{11}O_{13}, 770.4895).

Gynoside B(2):-

Amorphous powder, mp 194-196°C, [α]20D + 0.10 (c 0.05, MeOH); IR (KBr) $\nu_{\text{max}}$ 3413, 2968, 2944, 1642, 1455, 1380, 1163, 1078, 1043, 880, 646 cm$^{-1}$; 1H and 13C NMR, see Tables 1 and 2; FABMS m/z 801[M+H]$^+$; HRESIMS m/z found 823.4814 (called for C_{8}H_{12}NaO_{13}, 823.4820).

Gynoside C(3):-

Amorphous powder, mp 195-197°C, [α]20D –8.0 (c 0.1 MeOH); IR(KBr) $\nu_{\text{max}}$ 3354, 2967, 2933, 2877, 1665, 1601, 1467, 1388, 1313, 1233, 1165, 1080, 1042, 903; 1H and 13C NMR, see Tables 1 and 2; FABMS m/z 770 [M]$^+$; HRESIMS m/z found 793.4709 (called for C_{41}H_{70}NaO_{13}, 793.4714).

Gynoside D(4):-

Amorphous powder, mp 195-197°C, [α]20D +0.61 (c 0.1, MeOH); IR (KBr) $\nu_{\text{max}}$ 3401, 2969, 2944, 1643, 1455, 1382, 1164, 1081, 1039, 923, 898, 646 cm$^{-1}$; 1H and 13C NMR, see Tables 1 and 2; FABMS m/z 787 [M + H]$^+$; HRESIMS m/z 809.4658 (called for C_{41}H_{70}NaO_{13}, 809.4663).

Gynoside E(5):-

Amorphous powder, mp 207-209°C, [α]20D + 2.0 (c 0.15, MeOH); IR(KBr) $\nu_{\text{max}}$ 3429, 2949, 2876, 1639, 1467, 1385, 1161, 1081, 1038, 899, 646, 596 cm$^{-1}$; 1H and 13C NMR, see Tables 1 and 2; FABMS m/z 787 [M + H]$^+$; HRESIMS m/z 791.4552 [M+Na]$^+$ (called for C_{41}H_{65}NaO_{13}, 791.4558).
Compound 1a:-

Amorphous powder, mp 135-137 C, [α]20D +2.9 (c 2.7, MeOH); IR (KBr) νmax 3395,2970,2876,1466,1380,1314,1163,1125,1080,1044,1017,879 cm⁻¹; ¹H NMR (pyridine-d5,500 MHz) δ 6.06 (1H, s, OH-12), 4.18 (1H, dd, J=5.4,10.9 Hz, H-24), 3.77 (1H, dt, J=4.6,10.1 Hz, H-12), 3.45 (1H, dd, J=4.7,10.5 Hz, H-3), 2.31 (1H, m, H-17), 2.15 (1H, H-11a), 2.01 (1H, H-22a), 1.96 (1H, H-15a), 1.96 (2H, H-13,-16a), 1.85 (2H, H-2-2b), 1.75 (1H, H-22b), 1.72 (1H, H-6a), 1.56 (1H, H-6a), 1.56 (1H, H-9), 1.55 (1H, H-15a), 1.51 (1H, H-6b), 1.50 (1H, H-7a), 1.46,1.25,1.08,1.06, 0.95, 0.94 (each 3H, s, H3-27, -28, -18, -29, -19, -30), 1.43 (1H, H-11b), 1.33 (6H, s, H3-21, -27), 1.31 (1H, H-7b), 1.30 (1H, H-16b), 1.06 (1H, H-15b), 0.99 (1H, H-1b), 0.86 (1H, br d, J=8.8 Hz, H-5); ¹³C NMR (pyridine-d5,125 MHz) δ 88.6 (CH,C-24), 87.2 (C,C-20), 78.2 (CH,C-3), 71.0 (CH,C-12), 70.2 (C,C-25), 56.7 (CH,C-5), 52.5 (C,C-14), 50.9 (CH,C-9), 49.7 (CH2,C-1), 37.6 (C,C-10), 35.4 (CH2,C-7), 32.9 (CH2,C-11), 32.8 (C,C-16), 28.8 (CH3,C-28), 28.4 (CH2,C-2), 27.1 (CH3,C-26), 26.7(CH3,C-27), 26.0 (CH2,C-26), 19.0 (CH2,C-6), 18.3 (CH3,C-30), 16.8 (CH3,C-19), 16.4 (CH3,C-29), 15.9 (CH3,C-18); ESIMS m/z 499 [M +Na]+, 477 [M+H]+.

Compound 4a:-

Amorphous powder, mp 154-156 C, [α]20D +36.9 (c 0.75, MeOH); IR (KBr) νmax 3401, 2970, 1466, 1381, 1277, 1167, 1126, 1082, 1033, 923, 896 cm⁻¹; ¹H NMR (pyridine-d5,500 MHz) δ 6.06 (1H, s, OH-12), 5.06 (1H, m, H-23), 4.25 (1H, d, J=7.96 Hz, H-24), 3.81 (1H, dt, J=4.5, 10.1 Hz, H-12), 3.44 (1H, m, H-3), 2.45 (1H, m, H-22a), 2.37 (1H, m, H-11a), 1.89 (1H, br d, J=9.9 Hz, H-13), 1.89 (1H, H-16a), 1.85 (2H, H-2-2b), 1.71 (1H, br d, J=2.9 Hz, H-1a), 1.63, 1.61, 1.43, 1.23, 1.05, 0.90 (each 3H, s, H3-27,-26, -21, -28, -29, -19), 1.58(1H, H-6a), 1.55 (1H, H-9), 1.53 (1H, H-15a), 1.47 (1H, H-6b), 1.46 (1H, H-7a), 1.39 (1H, m, H-11b), 1.32 (1H, H-16b), 1.25 (1H, H-7b), 1.02 (1H, H-15b), 0.97 (1H, H-1b), 0.92 (6H,s,H3-18,30), 0.84 (1H, br d, J=8.8 Hz, H-5); ¹³C NMR (pyridine-d5,125 MHz) δ 91.7 (CH,C-24), 85.3 (C,C-20), 78.2 (CH,C-3), 71.0 (CH,C-12), 70.7 (CH,C-23), 70.3 (C,C-20), 78.2 (CH,C-5), 52.4 (C,C-14), 50.8 (CH,C-9), 50.2 (CH,C-17), 49.9 (CH,C-13), 42.3 (CH2,C-22), 40.2 (C,C-8), 39.7 (CH2,C-1), 37.6 (C,C-10), 35.4 (CH2,C-7), 32.8 (CH2,C-11), 32.6 (CH2,C-15), 29.9 (CH3,C-21), 28.8 (CH3,C-28), 28.7(CH2,C-2), 28.7 (CH3,C-27), 18.9 (CH3,C-6), 18.3 (CH3,C-30), 16.8 (CH3,C-19), 16.4 (CH3,C-29), 15.7 (CH3,C-18); ESIMS m/z 515 [M + Na]+, 493 [M + H]+.
3.5 Saponins from Ganoderma applanatum\textsuperscript{13}

**Extraction and Isolation:-**

The ground fruiting bodies (2.1 Kg) of *G. applanatum* were extracted five times, with MeOH under reflux, to give an extract (85 g). The MeOH extract was suspended in water and successively partitioned with n-hexane, dichloromethane, EtOAc, and n-BuOH, to yield 15, 25, 30 and 15 g fractions, respectively. The dichloromethane fraction (25 g) was separated by silica gel column chromatography with CHCl\textsubscript{3} containing increasing amounts of MeOH (1, 2, 3, 5, 10, 50 and 100%), as the eluent, to give 16 fractions (MC01- MC16). Fraction MC09 was subjected to silica gel column chromatography, with increasing amounts of hexane Me\textsubscript{2}CO (5, 10, 15, 20, 30, and 50%) as the eluent, to yield 13 fractions (MC09-01-MC09-13). Fraction MC09-08 was further purified by crystallization from MeOH to yield 3 (12 mg). Fractions MC09-07, MC10, and MC11 were further purified on a silica gel column, with hexane-EtOAc (10:1, 8:5, 5:8, 1:10) as the eluent, to yield 4 (10 mg), 1 (120 mg), and 2 (150 mg), respectively).
Spectral data

3B, 7B, 20,23-Tetrahydroxy-11, 15-dioxolanosta-8-en-26-oic acid (1): -

colorless amorphous solid; [α]26D + 117.5 (C 0.211, CHCl3), UV (MeOH) λmax (log ε) 252 nm (4.34); IR vmax 3430(OH),1773 (five-membered ring C=O), 1711 (COOH), 1647 (α,β-unsaturated C=O), 1458(CH3), 1377(CH3),1181, 1034(OH),926 CM; EIMS m/z (rel int,%) 516 [M – H2O]+ (2.5), 498 [M – 2H2O]+ (0.8), 470 [M – (2H2O+CO)] + (5.8),358 [M – side chain (SC)-H]+ (1.7), 313[M – SC – (CO + H2O)]+ (0.8),175 [ C8H15O4,SC]+(8.3),157 [SC – H2O]+ (8.3),99(45.5), 69(100),55 (100); (+)-FABMS m/z 539.2982 (calcd for C30H44O7 Na, 539.2985).

7B, 20,23 Trihydroxy-3, 11, 15-trixolanosta-8-en-26-oic acid (2):
Coloeless amorphous solid; [α]26D +225.5 ( c 0.216,CHCl3), UV (MeOH) λmax ( log ε) 250 nm (4.07); IR Vmax 3569 and 3491 (OH), 1767 (five-membered ring C=O),1734 (six-membered ring C=O), 1699 (COOH), 1661 (α, β-unsaturated C=O), 1458 (CH3), 1377(CH3), 1171 and 1069 (OH), 924 cm; EIMS m/z 537 (rel int,%) 514[m – H2O](43.8), 468 [M – (2H2O + CO)-100],376 (20.8), 329 [M – (SC +CO)] (6.9), 175 [C8H15O4SC]+(8.5), 157 [SC – H2O] (8.3),99(13.8), 69 (13.5); (+)-FABMS m/z 537 [M + Na – H2O]; (+)- HRFABMS m/z 537.2807 (calcd for C30H42O7Na, 537.2828).

7B, 23 Dihydroxy-3, 11, 15-trixolanosta-8,20E(22)-dien-26-oic acid (3):
Colorless amorphous solid;[α]27D + 95.4 (c 0.2, MeOH), UV (MeOH) λmax ( log ε) 254 nm (3.94); IR Vmax 3437 (OH), 1761 (five-membered ring C=O), 1719 (six-membered ring C=O), 1655 (α,β-unsaturated C=O), 1458(CH3),1377 (CH3) cm; EIMS m/z (rel int %) 496 [M- H2O](7.3), 468 [ M – H2O – CO]+ (9.8), 450 [M – 2H2O – CO] (1.6), 435 [M – 2H2O – CO – CH3]+ (1.6), 395 (7.3), 358 [M – SC + H]+ (16.3), 273 (13.0), 175 (39.0), 157 [ C8H15O3SC] (12.2), 149 (42.3), 121 (59.3), 93 (87.8), 69 (74.8), 55 (100); (+)-FABMS m/z 497 [M + H – H2O]+, 479 [M + H – 2H2O]; (+)- HRFABMS m/z 497.2913 (called for C30H44O6, 497.2903).

7B Hydroxy-3, 11, 15,23-tetraoxolanosta-8,20E(22)-dien-26-oic acid methyl ester (4):
Colorless amorphous solid; [α]27D + 106.8 (c 0.5, MeOH) λ max ( log ε) 245 nm (3.74); IR Vmax 3429 (OH), 1736 (five-membered ring C=O), 1730 (six-membered ring C=O), 1710 (COCCH3), 1657 (α,β-unsaturated C=O), 1685 (CH3), 1170 and 833 cm; (+) FABMS m/z 527 [ M + H];(+)-HRFABMS m/z 527.3008 (called for C31H43O7, 527.3009).
3.6 Saponin from Seeds of *Abrus precatorius* (Leguminosae)\textsuperscript{14}

**Compound:** Abrus-saponin I

**M.F.** C\textsubscript{42}H\textsubscript{66}O\textsubscript{15}

**m.p.** colorless amorphous powder

\[ \alpha \]_D\textsuperscript{28} +25.1° (c = 1.0, pyridine)

**Spectral data:** IR, \textsuperscript{1}H-NMR, \textsuperscript{13}C-NMR, 2D NMR, ISI–MS (positive & negative)

**Plant resources:** Seeds of *Abrus precatorius* L. (Leguminosae)
3.7 saponin from Seeds of *Abrus precatorius*. (Leguminosae)\(^{14}\)

**Compound:** Abrus-saponin II

**M.F.** C\(_{48}\)H\(_{76}\)O\(_{20}\)

**m.p.** colorless amorphous powder

\([\alpha]^{28}_D +13.3^\circ (c = 0.61, \text{ pyridine})\)

**Spectral data:** IR, \(^1\)H-NMR, \(^{13}\)C-NMR, 2D NMR, ISI–MS (positive & negative)

**Plant resources:** Seeds of *Abrus precatorius* L. (Leguminosae)
3.8 Saponin from Rhizomes of *Cimicifuga foetida* (Ranunculaceae)

**Compound:** Acetylacteol-3-**O**-arabinoside

**M.F.** C$_{37}$H$_{56}$O$_{11}$

**m.p.** white powder

$[\alpha]_{D}^{25} = -66.06^\circ \ (c = 0.30, \text{CHCl}_3:\text{MeOH} = 1:1)$

**Spectral data:** IR, $^1$H-NMR, $^{13}$C-NMR, 2D NMR, FAB–MS (positive), HR–FAB–MS (positive)

**Biological activity:** inhibition of bone resorption induced by PTH

**Plant resources:** Rhizomes of *Cimicifuga foetida* L. (Ranunculaceae)
3.9 Saponin from Rhizomes of *Cimicifuga foetida* (Ranunculaceae)\(^1^4\)

**Compound:** 3’-O-Acetyl-24-*epi*-7,8-didehydrocimigenol-3-*O-*-xyloside

**M.F.** C\(_{37}\)H\(_{56}\)O\(_{10}\)

**m.p.** white powder

\([\alpha]^{31}_D -13.2^\circ (c = 0.53, \text{CHCl}_3:\text{MeOH} = 2:3)\)

**Spectral data:** IR, \(^1\)H-NMR, \(^{13}\)C-NMR, 2D NMR, FAB–MS (positive)

**Biological activity:** inhibition of bone resorption induced by PTH

**Plant resources:** Rhizomes of *Cimicifuga heracleifolia* KOMAROV (Ranunculaceae)
3.10 Saponin from Rhizomes of *Cimicifuga foetida* (Ranunculaceae)\textsuperscript{14}

**Compound:** 25-Anhydrocimigenol-3-\(O\)-\(\beta\)-xyloside

**M.F.** C\textsubscript{35}H\textsubscript{55}O\textsubscript{8}

**m.p.** 245–246°C, colorless needles (from hexane–AcOEt)

\([\alpha]\textsubscript{D}^\textsubscript{25} +8.42° (c = 0.14, CHCl\textsubscript{3}:MeOH = 1:1)

**Spectral data:** IR, \(\text{\textsuperscript{1}}\text{H-NMR}, \text{\textsuperscript{13}}\text{C-NMR}, 2\text{D NMR}, \text{FAB–MS (positive)}, \text{HR–FAB–MS (positive)}

**Biological activity:** inhibition of bone resorption induced by PTH

**Plant resources:** Rhizomes of *Cimicifuga foetida* L. (Ranunculaceae)
3.11 Saponin from Roots of *Astragalus ernestii* (Leguminosae)\textsuperscript{14}

**Compound:** Asernestioside C

**M.F.** C\textsubscript{49}H\textsubscript{80}O\textsubscript{19}

**m.p.** 204–207°C, colorless fine crystals (from MeOH)

\([\alpha]_D^{\circ} = -13.22^{\circ} (c = 0.32, \text{MeOH})

**Spectral data:** IR, \textsuperscript{1}H-NMR, \textsuperscript{13}C-NMR, 2D NMR, FAB–MS (positive)

**Plant resources:** Roots of *Astragalus ernestii* COBM. (Leguminosae)
3.12 Saponin from Bulbs of Allium chinense (Liliaceae)\textsuperscript{14}

**Compound:** Chinenoside II

M.F. C\textsubscript{49}H\textsubscript{78}O\textsubscript{22}

**m.p.** colorless amorphous powder

$[\alpha]^{20}_D$–63.1° \((c = 0.43, \text{ pyridine})\)

**Spectral data:** IR, \textsuperscript{1}H-NMR, \textsuperscript{13}C-NMR, 2D NMR, FD–MS (positive)

**Plant resources:** Bulbs of Allium chinense G. DON (Liliaceae)
3.13 Saponin from Bulbs of *Allium chinense* (Liliaceae)\textsuperscript{14}

**Compound:** Chinenoside III

**M.F.** C\textsubscript{43}H\textsubscript{70}O\textsubscript{18}

**m.p.** colorless amorphous powder

\[[\alpha]_D^20 = -42.8^\circ (c = 0.59, \text{pyridine})\]

**Spectral data:** IR, \textsuperscript{1}H-NMR, \textsuperscript{13}C-NMR, 2D NMR, FD–MS (positive)

**Plant resources:** Bulbs of *Allium chinense* G. DON (Liliaceae)
3.14 Saponin from Bulbs of *Allium chinense* (Liliaceae)

**Compound:** Chinenoside IV

**M.F.** C_{50}H_{80}O_{23}

**m.p.** 172–175°C, colorless amorphous powder

[α]_{D}^{20} = –35.8° (c = 0.32, pyridine)

**Spectral data:** IR, \textsuperscript{1}H-NMR, \textsuperscript{13}C-NMR, 2D NMR, FAB–MS (positive & negative)

**Plant resources:** Bulbs of *Allium chinense* G. DON (Liliaceae)
3.15 Saponin from Bulbs of *Allium chinense* (Liliaceae)\textsuperscript{14}

**Compound:** Chinenoside V

M.F. C\textsubscript{44}H\textsubscript{72}O\textsubscript{19}

m.p. 216–218°C, colorless amorphous powder

[α]\textsubscript{D}\textsuperscript{20} –47.1° (c = 0.57, pyridine)

**Spectral data:** IR, \textsuperscript{1}H-NMR, \textsuperscript{13}C-NMR, 2D NMR, FAB–MS (positive & negative)

**Plant resources:** Bulbs of *Allium chinense* G. DON (Liliaceae)
3.16 Saponin from Bulbs of *Allium chinense* (Liliaceae)

**Compound:** Cimicidanol-3-\(O\)-\(\beta\)-xyloside

**M.F.** \(C_{35}H_{52}O_9\)

**m.p.** 214–215°C, colorless plates (from CHCl3–MeOH)

\([\alpha]^{25}_D - 42.32^\circ\) (\(c = 0.20, \text{CHCl}_3:\text{MeOH} = 1:1\))

**Spectral data:** IR, \(^1H\)-NMR, \(^{13}C\)-NMR, 2D NMR, FAB–MS (negative), HR–FAB–MS (negative)

**Biological activity:** inhibition of bone resorption induced by PTH

**Plant resources:** Rhizomes of *Cimicifuga foetida* L. (Ranunculaceae)
3.17 Saponin from Bulbs of *Allium chinense* (Liliaceae)\textsuperscript{14}

**Compound:** Cimicidol-3-\textit{O}-\textit{β}-xyloside

**M.F.** C\textsubscript{35}H\textsubscript{54}O\textsubscript{10}

**m.p.** white powder

\([\alpha]^{25}_{D} -30.73^\circ\ (c = 0.60, \text{CHCl}_3:\text{MeOH} = 1:1)\)

**Spectral data:** IR, \textit{1}H-NMR, \textit{13}C-NMR, 2D NMR, FAB–MS (positive), HR–FAB–MS (positive)

**Biological activity:** inhibition of bone resorption induced by PTH

**Plant resources:** Rhizomes of *Cimicifuga foetida* L. (Ranunculaceae)
3.18 Saponin from Rhizomes of *Cimicifuga foetida* (Ranunculaceae)\(^{14}\)

**Compound:** Cimicifol

**M.F.** C\(_{37}\)H\(_{54}\)O\(_{10}\)

**m.p.** white powder

\([\alpha]^{25}_D - 99.33^\circ \) (\(c = 0.30\), CHCl\(_3\):MeOH = 1:1)

**Spectral data:** IR, \(^1\)H-NMR, \(^{13}\)C-NMR, 2D NMR, FAB–MS (positive), HR–FAB–MS (positive)

**Plant resources:** Rhizomes of *Cimicifuga foetida* L. (Ranunculaceae)
3.19 Saponin from Rhizomes of *Cimicifuga foetida* (Ranunculaceae)\(^{14}\)

**Compound:** Cimicinol

**M.F.** \(C_{35}H_{52}O_{8}\)

**m.p.** yellow powder

\([\alpha]^{25}_D +14.02^\circ\) (\(c = 0.30, \text{CHCl}_3:\text{MeOH} = 1:1\))

**Spectral data:** UV, IR, \(^1H\)-NMR, \(^{13}C\)-NMR, 2D NMR, FAB–MS (positive), HR–FAB–MS (positive)

**Biological activity:** inhibition of bone resorption induced by PTH

**Plant resources:** Rhizomes of *Cimicifuga foetida* L. (Ranunculaceae)
3.20 Saponin from Rhizomes of *Cimicifuga heracleifolia* (Ranunculaceae)\textsuperscript{14}

**Compound:** 2’,4’-Di-\textit{O}-acetyl-24-\textit{epi}-7,8-didehydrocimigenol-3-\textit{O}-\textbeta-xiloside

**M.F.** C\textsubscript{39}H\textsubscript{58}O\textsubscript{11}

**m.p:** white powder

\[\alpha\]\textsubscript{D}\textsuperscript{31} −15.5° (\textit{c} = 0.53, CHCl\textsubscript{3})

3.21 Saponin from Rhizomes of *Cimicifuga heracleifolia* (Ranunculaceae) \(^{14}\)

**Compound:** 7,8-Didehydro-24-\(O\)-acetylhydroshengmanol-3-\(O\)-\(\beta\)-xyloside

**M.F.** C\(_{37}\)H\(_{58}\)O\(_{11}\)

**m.p.** white powder

\[[\alpha]^{31}_D\] \(-27.4^\circ\) (c = 0.62, CHCl\(_3\):MeOH = 2:3)

**Spectral data:** IR, \(^1\)H-NMR, \(^{13}\)C-NMR, 2D NMR, FAB–MS (positive)

**Biological activity:** inhibition of bone resorption induced by PTH

**Plant resources:** Rhizomes of *Cimicifuga heracleifolia* KOMAROV (Ranunculaceae)
3.22 Saponin from Rhizomes of *Cimicifuga heracleifolia* (Ranunculaceae)\(^{14}\)

**Compound:** 24-*epi*-7,8-Didehydrocimigenol-3-*O*-°-xyloside

**M.F.** C\(_{35}\)H\(_{54}\)O\(_9\)

**m.p.** white powder

\([\alpha]^{31}_{D} -9.6^\circ (c = 0.35, \text{CHCl}_3:\text{MeOH} = 2:3)\)

**Spectral data:** IR, \(^1\)H-NMR, \(^{13}\)C-NMR, 2D NMR, FAB-MS (positive)

**Biological activity:** inhibition of bone resorption induced by PTH

**Plant resources:** Rhizomes of *Cimicifuga heracleifolia* KOMAROV (Ranunculaceae)
2.23 Saponin from Rhizomes of *Anemone flaccida* (Ranunculaceae)\textsuperscript{14}

**Compound:** Flaccidin B

**M.F.** $C_{41}H_{66}O_{12}$

**m.p.** 279–281°C, colorless needles

$[\alpha]^{24}_{D} +26.2^\circ$ ($c = 1$, MeOH)

**Spectral data:** IR, $^1$H-NMR, $^{13}$C-NMR, FAB–MS (positive)

**Biological activity:** reverse transcriptase inhibition

**Plant resources:** Rhizomes of *Anemone flaccida* FR. SCHMIDT (Ranunculaceae)
3.24 Saponin from Rhizomes of *Cimicifuga foetida* (Ranunculaceae)

**Compound:** Foetidinol-3- O- β-xyloside

**M.F.** C_{32}H_{48}O_{9}

**m.p.** slightly yellow amorphous

[α]_{D}^{25} = 43.46° (c = 0.27, CHCl₃:MeOH = 1:1)

**Spectral data:** IR, ¹H-NMR, ¹³C-NMR, 2D NMR, FAB–MS (positive), HR–FAB–MS (positive)

**Biological activity:** inhibition of bone resorption induced by PTH

**Plant resources:** Rhizomes of *Cimicifuga foetida* L. (Ranunculaceae)
3.25 Saponin from Leaves of *Panax ginseng* (Araliaceae)\(^{14}\)

**Compound:** Ginsenoside La

**M.F.** C\(_{42}\)H\(_{70}\)O\(_{13}\)

**m.p.** 179–180\(^\circ\)C, colorless needles (from MeOH)

\([\alpha]\)\(_D^{\circ}\) – 18.4\(^\circ\) (pyridine)

**Spectral data:** IR, \(^1\)H-NMR, \(^{13}\)C-NMR, 2D NMR, FAB-MS (negative)

**Plant resources:** Leaves of *Panax ginseng* C. A. MEYER (Araliaceae)
3.26 Saponin from Rhizomes of *Cimicifuga foetida* (Ranunculaceae)\(^{14}\)

**Compound:** 15 (-Hydroxycimicidol-3-*O*-pyxyloside

**M.F.** C\(_{35}\)H\(_{54}\)O\(_{11}\)

**m.p.** white powder

\([\alpha]^{25}_D -45.70^\circ (c = 0.38, \text{CHCl}_3: \text{MeOH} = 1:1)\)

**Spectral data:** IR, \(^1\)H-NMR, \(^{13}\)C-NMR, 2D NMR, FAB–MS (positive), HR–FAB–MS (positive)

**Biological activity:** inhibition of bone resorption induced by PTH

**Plant resources:** Rhizomes of *Cimicifuga foetida* L. (Ranunculaceae)
3.27 Saponin from Rhizomes of *Cimicifuga foetida* (Ranunculaceae)\(^4\)

**Compound:** 15 (-Hydroxyfoetidinol-3-O-®-xyloside

**M.F.** C\(_{32}\)H\(_{48}\)O\(_{10}\)

**m.p.** white powder

\([\alpha]_{D}^{25} = -73.64^\circ\) (c = 0.36, CHCl\(_3\):MeOH = 1:1)

**Spectral data:** IR, \(^1\)H-NMR, \(^{13}\)C-NMR, 2D NMR, FAB–MS (positive), HR–FAB–MS (positive)

**Plant resources:** Rhizomes of *Cimicifuga foetida* L. (Ranunculaceae)
## 4. Summary

<table>
<thead>
<tr>
<th>S.R</th>
<th>Saponins</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Diosgenin</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>Solasodine</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>Ginsenoside</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>Glycyrrhizinic acid</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>Saponins from the Fungus Ganoderma lucidum</td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>Saponins from the Aerial Parts of Ibicella lutea</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>Saponins from Conyza blinii</td>
<td>11</td>
</tr>
<tr>
<td>8</td>
<td>Saponin from Gynostemma pentaphyllum</td>
<td>12</td>
</tr>
<tr>
<td>9</td>
<td>Saponins from Ganoderma applanatum</td>
<td>13</td>
</tr>
<tr>
<td>10</td>
<td>Saponin from Seeds of Abrus precatorius</td>
<td>14</td>
</tr>
<tr>
<td>11</td>
<td>saponin from Seeds of Abrus precatorius</td>
<td>14</td>
</tr>
<tr>
<td>12</td>
<td>Saponin from Rhizomes of Cimicifuga foetida</td>
<td>14</td>
</tr>
<tr>
<td>13</td>
<td>Saponin from Rhizomes of Cimicifuga foetida</td>
<td>14</td>
</tr>
<tr>
<td>14</td>
<td>Saponin from Rhizomes of Cimicifuga foetida</td>
<td>14</td>
</tr>
<tr>
<td>15</td>
<td>Saponin from Roots of Astragalus ernestii</td>
<td>14</td>
</tr>
<tr>
<td>16</td>
<td>Saponin from Bulbs of Allium chinense</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>Page</td>
</tr>
<tr>
<td>---</td>
<td>------------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>17</td>
<td>Saponin from Bulbs of <em>Allium chinense</em> (Liliaceae)</td>
<td>14</td>
</tr>
<tr>
<td>18</td>
<td>Saponin from Bulbs of <em>Allium chinense</em> (Liliaceae)</td>
<td>14</td>
</tr>
<tr>
<td>19</td>
<td>Saponin from Bulbs of <em>Allium chinense</em> (Liliaceae)</td>
<td>14</td>
</tr>
<tr>
<td>20</td>
<td>Saponin from Bulbs of <em>Allium chinense</em> (Liliaceae)</td>
<td>14</td>
</tr>
<tr>
<td>21</td>
<td>Saponin from Bulbs of <em>Allium chinense</em> (Liliaceae)</td>
<td>14</td>
</tr>
<tr>
<td>22</td>
<td>Saponin from Rhizomes of <em>Cimicifuga foetida</em> (Ranunculaceae)</td>
<td>14</td>
</tr>
<tr>
<td>23</td>
<td>Saponin from Rhizomes of <em>Cimicifuga foetida</em> (Ranunculaceae)</td>
<td>14</td>
</tr>
<tr>
<td>24</td>
<td>Saponin from Rhizomes of <em>Cimicifuga heracleifolia</em> (Ranunculaceae)</td>
<td>14</td>
</tr>
<tr>
<td>25</td>
<td>Saponin from Rhizomes of <em>Cimicifuga heracleifolia</em> (Ranunculaceae)</td>
<td>14</td>
</tr>
<tr>
<td>26</td>
<td>Saponin from Rhizomes of <em>Cimicifuga heracleifolia</em> (Ranunculaceae)</td>
<td>14</td>
</tr>
<tr>
<td>27</td>
<td>Saponin from Rhizomes of <em>Anemone flaccida</em> (Ranunculaceae)</td>
<td>14</td>
</tr>
<tr>
<td>28</td>
<td>Saponin from Rhizomes of <em>Cimicifuga foetida</em> (Ranunculaceae)</td>
<td>14</td>
</tr>
<tr>
<td>29</td>
<td>Saponin from Leaves of <em>Panax ginseng</em> (Araliaceae)</td>
<td>14</td>
</tr>
<tr>
<td>30</td>
<td>Saponin from Rhizomes of <em>Cimicifuga foetida</em> (Ranunculaceae)</td>
<td>14</td>
</tr>
</tbody>
</table>
5. Referance


4. Mohmand, Ali., Techniques in terpenoid identification, Birla Publication, Delhi, pp346

5. Atal, C.K., Kapur, B.M., Cultivation and utilization of medicinal plant., Regional research laboratory, Jammu-Tawi., pp88


Web site

14. www.google.com