

# Plants and microbes: Source of dermatology drugs

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Since time immemorial, natural products have been the backbone of traditional system of healing throughout the globe and have also been an integral part of history and culture. It has been well documented that natural products played critical roles in modern drug development, especially for antibacterial and antitumor agents. Until recently, plants were an important source of novel pharmacologically active compounds with many drugs being derived directly or indirectly from plants. Despite the current preoccupation with synthetic chemistry as a vehicle to discover and manufacture drugs, the contribution of plants to disease treatment and prevention is still enormous. In this article, we enumerate the structure of drugs and its derivative.<sup>1</sup>

## Systemic Antimicrobials

### Penicillin G

It is derived from a fungus *Penicillium chrysogenum*<sup>2</sup> [Figure 1a] having broad-spectrum antibacterial action which has a five-membered thiazolidine ring [Figure 1b].<sup>3</sup>

### Cephalosporins

It is derived from a mould *Cephalosporium acremonium*. It has a four-membered  $\beta$ -lactam ring attached to a six-membered dihydrothiazine ring and, therefore, belongs to  $\beta$ -lactams.<sup>2</sup>

### Vancomycin

A macrolide derived from actinomycetes *Streptomyces orientalis* which is a glycopeptide antibiotic used in the treatment of staphylococcal infections that are resistant to conventional antibiotics.<sup>2</sup>

### Rifamycin

It is derived from a soil mould *Amycolatopsis rifamycinica*/*Streptomyces mediterranei*.

### Clindamycin

It is derived from *Streptomyces lincolnensis*. The drug is a derivative of lincomycin that has increased antibacterial activity and is better absorbed than its parent drug.<sup>2</sup>

### Erythromycin

It is derived from *Saccharopolyspora erythraea*. It contains macrocyclic lactone rings. It has specific anti-inflammatory properties, contributes to their therapeutic benefit in inflammatory facial dermatoses such as acne and rosacea.<sup>2</sup>

### Tetracycline

It is derived from *Streptomyces species* It has four fused six-membered rings and is bacteriostatic with greater gram-positive than gram-negative activity.<sup>2</sup>

## Systemic Antifungals

### Griseofulvin

It is derived from a mould *Penicillium griseofulvum* which is indicated for the treatment of dermatophyte infections of the skin, scalp and nails.<sup>4</sup>

### Amphotericin B

It is derived from *Streptomyces nodosus* used in the treatment of systemic fungal infections and leishmaniasis.<sup>4</sup>

## Systemic Antiparasitic

### Ivermectin

It is derived from *Streptomyces avermitilis* [Figure 2a].<sup>5</sup> It is the 22, 23-dihydro derivative of avermectin [Figure 2b] B<sub>1</sub> and is classified as a macrocyclic in the avermectin family.<sup>6</sup>

## Topicals

### Bacitracin

It is derived from *Licheniformis group of Tracy 1 strain of Bacillus subtilis*. Bacitracin complexes with the carrier

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Figure 1a: *Penicillium chrysogenum*



Figure 2a: *Streptomyces avermitilis*

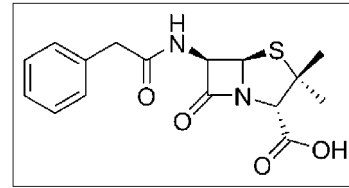


Figure 1b: Structure of penicillin

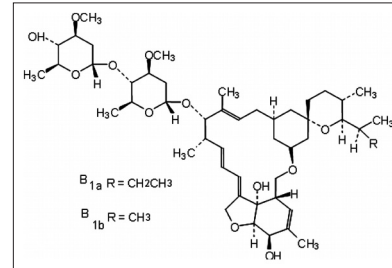


Figure 2b: Structure of ivermectin

protein C55-prenol pyrophosphatase which is involved in bacterial cell wall synthesis.<sup>7</sup>

#### Polymyxin B

Polymyxin B is a cationic branched cyclic decapeptide isolated from the aerobic gram-positive rod *Licheniformis* group of *Tracy 1* strain of *Bacillus subtilis*.<sup>7</sup>

#### Neomycin

Neomycin is a bactericidal aminoglycoside antibacterial agent produced by *Streptomyces fradiae*.<sup>7</sup>

#### Mupirocin

It inhibits bacterial isoleucyl-tRNA synthetase, thereby hindering bacterial RNA, protein and cell wall synthesis derived from *Pseudomonas fluorescens*.<sup>7</sup>

#### Retapamulin

Retapamulin is a semi-synthetic pleuromutilin derivative and the first topical antibacterial in the pleuromutilin class developed for human use. Pleuromutilin is a tricyclic diterpene produced by *Clitopilus scyphoides* (previously known as *Pleurotus mutilus*).<sup>7</sup>

#### Gentamicin

It is derived from *Micromonospora purpurea*. Enclosure of gentamicin-collagen sponge following primary excision in hidradenitis suppurativa, has reduced the rate of complications one week postoperatively without affecting the recurrence rates.<sup>7</sup>

#### Nystatin

It is derived from *Streptomyces noursei* used as an antifungal agent.<sup>8</sup>

**Permethrin**

Pyrethrins are organic compounds originally derived from a flower species of the genus *Compositae*, which is related to the chrysanthemum used in scabies and ticks.<sup>9</sup>

**Immunosuppressants****Mycophenolic acid**

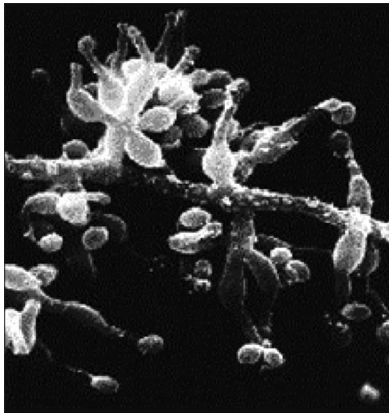
It is derived from *Penicillium brevicompactum* [Figure 3a].<sup>10</sup> It has antibacterial, antiviral, antifungal, antitumour and immunosuppressive properties. It is the morpholinoethyl ester of mycophenolic acid [Figure 3b].<sup>11</sup>

**Cyclosporine**

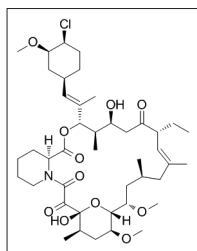
It is derived from soil fungus, *Tolypocladium inflatum gams*<sup>12</sup> [Figure 4a] which is a neutral cyclic peptide composed of 11 amino acids [Figure 4b].<sup>13</sup>



**Figure 3a:** *Penicillium brevicompactum*



**Figure 4a:** *Tolypocladium inflatum gams*



**Figure 5a:** Structure of pimecrolimus

**Tacrolimus**

It is derived from *Streptomyces tsukubaensis*. Tacrolimus is a macrolide that inhibits calcineurin by binding to the FK506 binding protein.<sup>14</sup>

**Pimecrolimus**

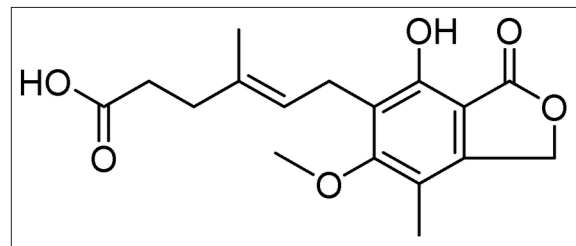
It is an immunomodulating agent of the calcineurin inhibitor<sup>15</sup> class which is a epi-chloro-derivative of the ascomycin [Figure 5a] used in the treatment of atopic dermatitis derived from *Streptomyces hygroscopicus* [Figure 5b].<sup>16</sup>

**Chemical Peels****Glycolic acid**

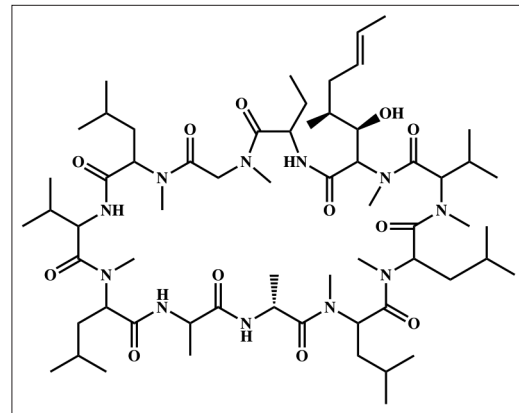
The smallest of the alpha-hydroxy acid is the two-carbon [Figure 6]<sup>17</sup> molecule, glycolic acid. It contains the formula HOCH<sub>2</sub>COOH derived from sugarcane.<sup>18</sup>

**Lactic acid**

Lactic acid can exist in several isomeric forms: L-lactic acid<sup>19,20</sup> (levorotatory), the D-lactic acid (dextrorotatory)



**Figure 3b:** Structure of mycophenolic acid



**Figure 4b:** Structure of cyclosporine



**Figure 5b:** *Streptomyces hygroscopicus*

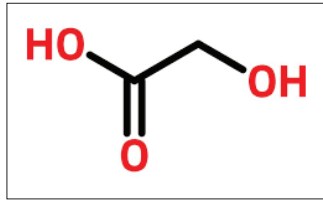


Figure 6: Structure of glycolic acid

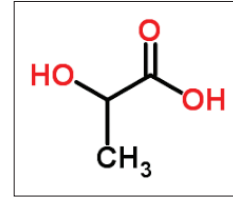


Figure 7: Structure of lactic acid

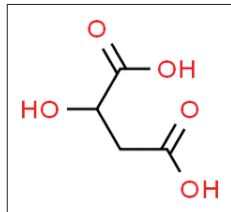


Figure 8: Structure of malic acid

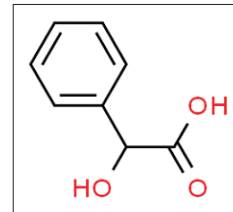


Figure 9: Structure of mandelic acid

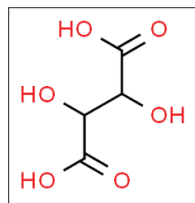


Figure 10: Structure of tartaric acid

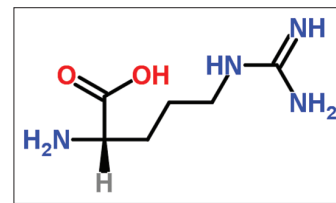


Figure 11: Structure of arginine



Figure 12a: *Aspergillus oryzae*

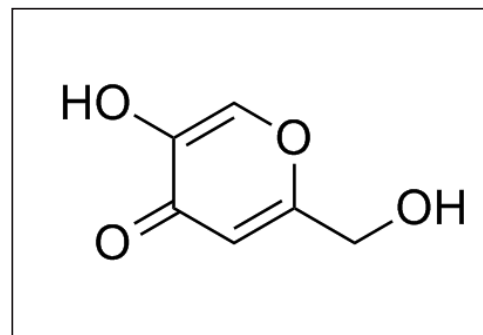


Figure 12b: Structure of kojic acid

[Figure 7] or the DL racemic mixture which is derived from sour milk, bilberries and yogurt.

#### Malic acid

Malic acid was first described by Scheele in 1785, who isolated this acid from unripe apples. It is found in other fruits such as grapes, watermelons and cherries and in vegetables such as carrots and broccoli. It is dicarboxylic acid [Figure 8].<sup>21</sup>

#### Mandelic acid

Mandelic acid is named after the German word 'mandel'<sup>22</sup> for almond, as it is derived from bitter almond extract. It is an eight-carbon alpha-hydroxy acid (molecular formula  $C_6H_5CH(OH)COOH$ ) [Figure 9],<sup>23</sup> and it is also available in two enantiomeric and pharmacologically distinct forms.



Figure 13a: *Colchicum autumnale*

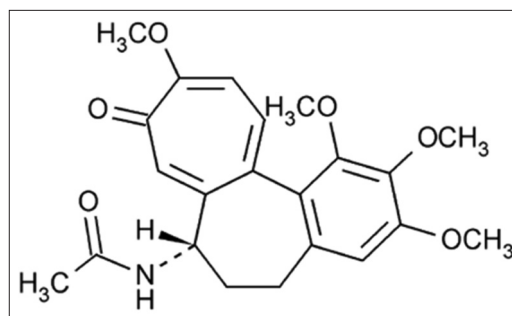


Figure 13b: Structure of colchicine

#### Tartaric acid

Tartaric acid is an abundant constituent<sup>24</sup> of many fruits such as grapes and bananas and exhibits a slightly astringent and refreshing sour taste. It is carboxylic acid with molecular formula C<sub>4</sub>H<sub>6</sub>O<sub>6</sub> [Figure 10].<sup>25</sup>

#### Ferulic acid

It is a phenolic compound and an effective scavenger of free radicals derived from cereals.

#### Phytic acid

Phytic acid is only found in plant-derived foods. All edible seeds, grains, legumes and nuts contain in varying quantities, and small amounts are also found in roots and tubers.<sup>26</sup>

#### Arginine

It is a large molecule and hence does not cause any irritation to the skin. It is derived from brown sugar. It is an alpha-amino acid containing a 3-carbon aliphatic straight chain ending in a guanidine group [Figure 11].<sup>27</sup>

#### Black peel

It is derived from fermentation of black rice.

#### Jasmonic acid

It is derived from jasmine.<sup>28</sup>

### Miscellaneous

#### Kojic acid

It is derived from the fungus *Aspergillus oryzae* [Figure 12a], used as a depigmenting agent. It is a pyranone that is 4H - pyran substituted by a hydroxyl group 5, a hydroxymethyl group at position 2 and oxo group at position 4 [Figure 12b].<sup>29</sup>

#### Podophyllin

It is derived from the roots of the mayapple (*Podophyllin peltatum*). It is cytotoxic agent used in the treatment of external genital warts and condyloma acuminatum.<sup>30</sup>

#### Sinicatechins

It is derived from green tea polyphenol extract from *Camellia sinensis* used in the treatment of external genital and perianal warts.<sup>31</sup>

#### Colchicine

It is derived from *Colchicum autumnale* [Figure 13a] used as an anti-inflammatory agent for treatment of Behcet disease.<sup>32</sup> It is an alkaloid having molecular formula C<sub>22</sub>H<sub>25</sub>N<sub>3</sub>O<sub>6</sub> [Figure 13b].

#### Declaration of patient consent

Patient's consent not required as there are no patients in this study.

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#### Conflicts of interest

There are no conflicts of interest.

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