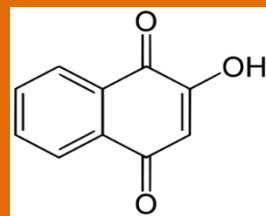




Molar mass : 174.15 g mol⁻¹
 Melting point : 191 °C - 195 °C with decomposition



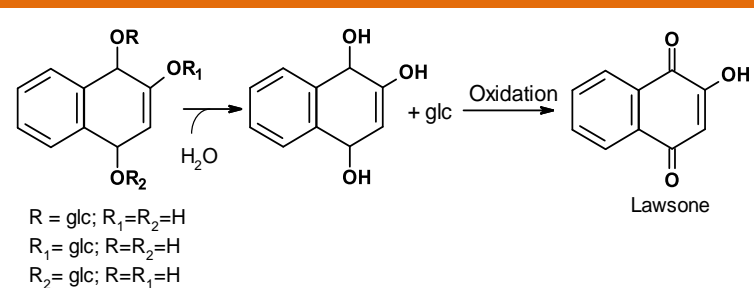
Lawsonia inermis



Eichhornia crassipes

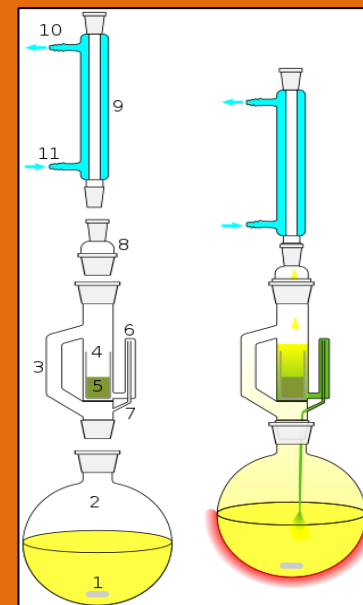
Lawson

Lawson, or hennatonic acid, is an orange coloured substance produced from hennosides present in leaves of the henna plant (*Lawsonia inermis*) and flowers of water hyacinth (*Eichhornia crassipes*). Hennosides are three isomeric glucosides, i.e. glucose derivatives. On hydrolysis under mild acidic conditions, hennosides convert into the trihydroxynaphthalene derivative (aglycone) which on oxidation gives lawsone.



Homi Bhabha Centre for Science Education
 HBCSE, TIFR
<https://chem.hbcse.tifr.res.in>

Extraction of Lawsone



Soxhlet extractor

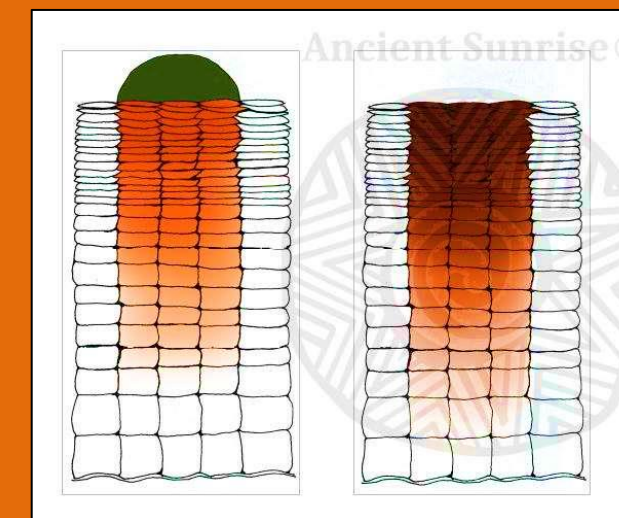
- 1: Stirrer bar
- 2: Round bottom flask
- 3: Distillation path
- 4: Thimble
- 5: Solid
- 6: Siphon top
- 7: Siphon exit
- 8: Expansion adapter
- 9: Condenser
- 10: Cooling water out
- 11: Cooling water in

Lawson can be extracted from henna leaves using the soxhlet extraction method by the following steps-

- Suspension of dried henna leaves and n-hexane is filtered and placed in porous bag or “thimble” which is placed in the chamber of the soxhlet apparatus.
- Ethanol is heated in the flask below and its vapors condense in the condenser.
- Condensed ethanol then drips into the thimble containing henna powder and extracts the hennosides during contact.
- The extracted hennosides are collected in the round bottom flask and the whole cycle is repeated.
- The extract undergoes solvent extraction which gives brown colored crude product. This crude product is further purified to get lawsone.

Lawson on hair and skin

When henna leaves are crushed and mixed with water to make a paste to apply on hair or skin, hennosides present in the leaves get slowly hydrolyzed into the corresponding aglycone molecule. The aglycone binds to the keratin present in the hair and skin and forms a dark stain. The aglycone form is stable under acidic condition. So if you maintain acidic pH during henna paste making then it will give you dark stains. Possibly this is the reason why people found mixing lemon juice to henna paste giving better colour on skin.



Diffusion of lawsone in outer layer of skin

With time the henna stain fades, due to slow aerial oxidation of aglycone adduct to lawsone form, which doesn't bind with the keratin

Metal complexes of lawsone

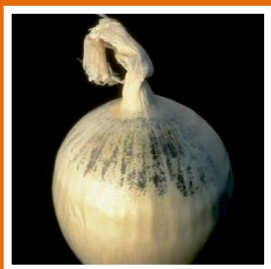
Binding ability of quinones to metals in different oxidation states and through multiple sites in the molecule allows them to play an important role in biological systems.

Lawsone, like other hydroxynaphthoquinones makes, variety of mononuclear, di and polynuclear complexes with transition metal ions such as Cu (II), Zn (II), Cd (II), Ni (II) and lanthanides.

These metal complexes of lawsone have been found to have antifungal, antiviral and antimalarial properties.

Antimicrobial properties of lawsone

Historically, henna was used to treat fungal infections like ringworm, skin rashes and normal wounds. Many studies have concluded that the antifungal activity of henna on human skin and on plants is predominantly due to lawsone. This antifungal activity is showed against many fungal species such as *Aspergillus niger*, *Rhizopus stolonifer* and *Penicillium*.



A. Niger on onion

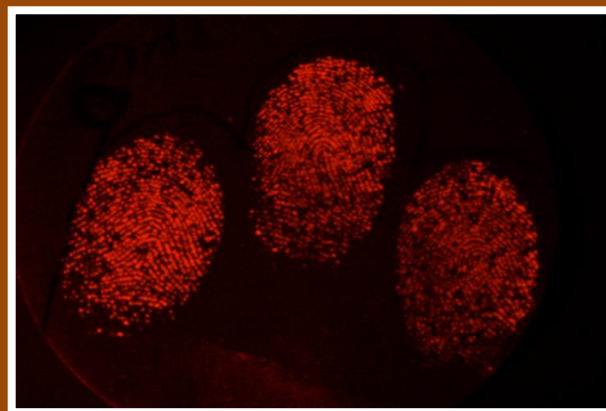


R. stolonifer on strawberry

Lawsone in forensic science

Naphthoquinones are well known for their reactions with amino acids. 1,2-Naphthoquinone-4-sulfonate has been used for the determination of amino acids through the formation of highly coloured compounds. 1,2-Naphthoquinone yields brown/purple pigments with cysteine and proteins.

Lawsone, therefore, is of significant interest as potential fingerprint detection reagent, which can replace ninhydrin (the current reagent for latent fingerprint development).

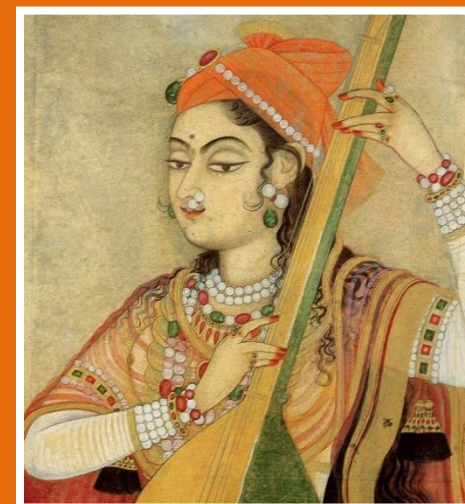


Lawsone treated latent fingerprints

Photoluminescence studies of lawsone suggested that with excitation at 590 nm, maximum intensity of luminescence occurs at around 640 nm. This is operationally advantageous as photoluminescence emission at longer wavelengths has the potential to improve detectability by avoiding native background luminescence.

Cultural value in History

This dye has been used since most ancient times by Egyptians and Indians for coloring hair and dyeing nails and skin. In ancient Egypt having unhennaed nails was even considered impolite. In ancient India, musicians hennaed their fingers before playing instrument like Tanpura; it protected their fingers from rashes (caused by the strings of musical instrument) and keep their skin smooth.



Painting of a lady with hennaed fingertips playing the Tanpura, Rajasthan, Kishangarh, 1735, Metropolitan Museum of Art, New York

The tradition of applying henna on hands and use it to make body art in marriage ceremonies is seen worldwide.

Uses

Apart from previously mentioned applications, lawsone can be used as an acid base indicator. It shows the color change from pale yellow to red (pH range 2.6-3.4).

Lawsone is an extremely useful starting material for organic synthesis. It is used in preparation of variety of biologically active compounds potentially useful for the treatment of several diseases.

Eg. Cardiovascular disease.

Reference and further reading

Catherine Cartwright-Jones. (2018). *Ancient sunrise-Henna for hair*, Chapter 4- Science and Microscopy (Part 2: The Phytochemistry of Henna, Lawsonia inermis L. [Lythraceae]). Retrieved in June 2020, from http://tapdancinglizard.com/AS_henna_for_hair/chapters/chap4/henna_phytochemistry.pdf

Jelly, R., Lewis, S. W., Lennard, C., Lim, K. F., & Almog, J. (2008). Lawsone: a novel reagent for the detection of latent fingerprints on paper surfaces. *Chemical Communications*, (30), 3513. <https://doi.org/10.1039/b808424f>

Can you find this??

1. What is the Lawsone content in henna?
2. What method you use at home to darken the henna color after applying henna on your body and how does it affect the lawsone in henna?
3. What is the IUPAC name of lawsone?

For more questions, refer Indian National Chemistry Olympiad questions 2019 paper: Problem 3- <https://olympiads.hbcse.tifr.res.in/>