Betanin

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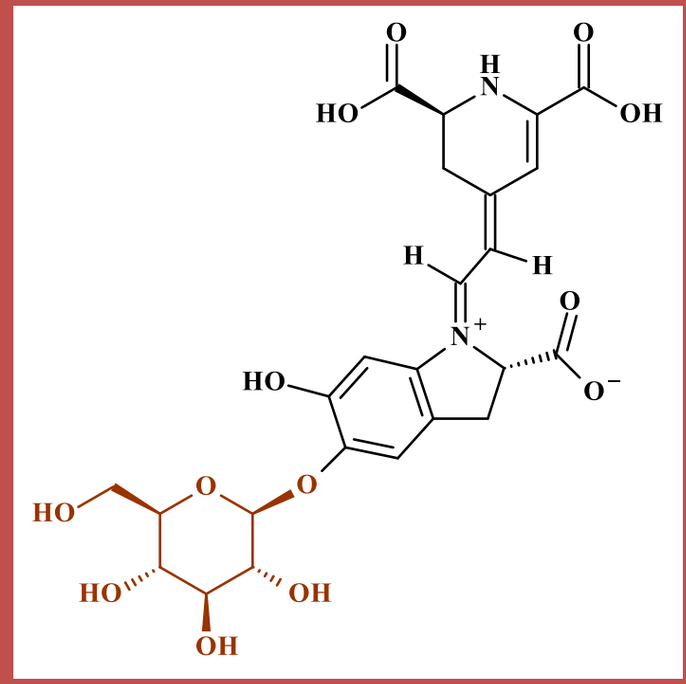
https://chem.hbcse.tifr.res.in

Molar mass : 550.47 g mol^{-1}
Melting point : Decomposes on heating beyond ~85°C



Betanin is a water soluble pigment belonging to betalains, a class of naturally available pigments. The major commercially exploited betalain containing crop is red beet-root (*Beta vulgaris*), in hindi it is called as '*Chukander*'. The betanin molecule contains two parts, a carbohydrate (indicated in red colour) and a non-carbohydrate (indicated in black colour) part which can be separated by hydrolysis.

Extraction of Betanin

Industrially, betanin has been isolated from beet root by solid–liquid extraction in slightly acidic aqueous solution. Betanin content in beetroot ranges between 100 mg / 100 g in fresh product and 16 to 38 mg / 100 g in dried vegetable product. Therefore, while selecting the suitable raw materials, plant species and harvesting conditions need to be considered.

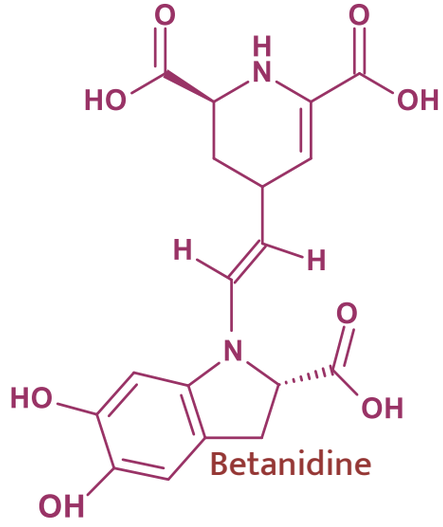
Typically, fresh red beet root is finely crushed to a puree form. This puree is mixed with appropriate volume of solvent (acidified distilled water) and pH of the solvent is adjusted (using acetate buffer). The mixture is stirred at room temperature and then filtered. Maximum pigment content is obtained with solid (puree) to solvent ratio of 1:5 and extraction time of 60 minutes.

Stability of betanin is a major issue during the extraction, as variation in temperature, pH or light intensity may cause significant degradation of betanin. Degradation studies of betanin show that at 75°C, the rate is about 50 times higher than at room temperature (22°C).

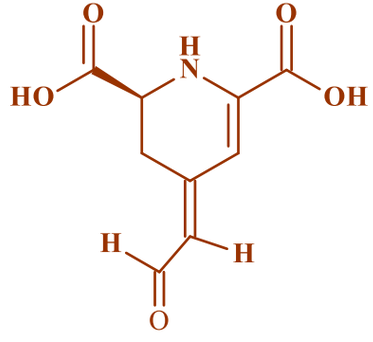
Another method that is being recently explored is in which betalains are attached to an organically modified resin (hydrophobic adsorbents) and extracted.

Effect of pH

At highly acidic pH (~ 3), the color of the pigment changes to reddish violet from red color at pH ~ 5 due to conversion of betanin to betanidine. As the pH becomes alkaline (~ 9 and above), betanin degrades by hydrolysis resulting in a yellow/brown color which is due to one of the degradation product, betalamic acid.



Betanidine



Betalamic acid

Antioxidant properties of Betanin

In food industry, synthetic antioxidants are added to foods containing fat, especially meats, for the purpose of delaying oxidative processes. Betanin is to be used in food and pharmaceutical products as a natural red colorant. It is used in ice creams as flavoring agent.

Beetroot flavored ice-cream

Betanin as an antioxidant / free radical scavenger prevents oxidative processes, such as Parkinson's disease; reduce oxidative stress related diseases by regulating the glucose levels, insulin and other antioxidant enzyme activities. Studies have shown that betanin was also able to reverse liver damage in rodents.

Other uses of Betanin

Betanin is used in wool dyeing. Direct dyeing using betanin doesn't give good results, that is why it is applied with a mordant like $CoSO_4$ for better color strength and light fastness.

References and further reading

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- Guesmi, A., Ladhari, N., Hamadi, N.B., Sakli, F. (2012). Isolation, identification and dyeing studies of betanin on modified acrylic fabrics, *Industrial Crops and Products*,Volume 37, Issue 1, Pages 342-346. https://doi.org/10.1016/j.indcrop.2011.12.034.
- Nestora, S., Merlier, F., Prost, E., Haupt, K., Rossi, C., & Tse Sum Bui, B. (2016). Solid-phase extraction of betanin and isobetanin from beetroot extracts using a dipicolinic acid molecularly imprinted polymer. *Journal of Chromatography A*, *1465*, 47–54. https://doi.org/10.1016/j.chroma.2016.08.069

Image sources- See the supplementary document.

Can you find this??

- Except from beet root, which are the other plants that contains betanin pigment?
- List five natural dyes.