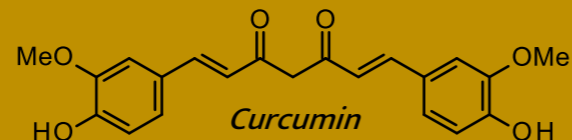


CURCUMIN

Molar Mass : 368.4 g mol⁻¹

Melting point : 183 °C (decomposes above 180 °C on prolonged heating)



Curcumin is a yellow coloured compound extracted from the rhizome of plants belonging to the ginger family, *zingiberaceae*. Turmeric (*Curcuma longa*), which belongs to the ginger family is the most widely used species as a source of curcumin. Other species from which curcumin can be extracted are Mango ginger (Am Haldi), wild turmeric (Jangli Haldi), the Indian barberry (Dar hald) etc. Turmeric has been used in Indian system of medicines since ancient times.

Curcumin shows least solubility in water at room temperature (< 0.1 mg mL⁻¹). At higher temperature, the solubility is enhanced.

Laboratory synthesis of curcumin is carried out by using acetyl acetone and vanillin in the presence of boron trioxide, n-butyl amine and trialkylborate. Synthetic curcumin is also available in the market.

Discovery of curcumin

Curcumin was first discovered by German chemists Vogel and Pelletier when they extracted a yellow colouring-matter from rhizomes of *Curcuma longa* and named it curcumin.

Studies showed that incomplete oxidation of curcumin produces vanillin, which became the starting point of structure determination of curcumin.

In 1910, Milobedzka and co-workers from University of Bern, Switzerland identified the structure of curcumin. In 1913, the same group also reported the synthesis of curcumin.

Later, K.R. Srinivasan from King Institute, Chennai, India, did a chromatographic study of colouring components of turmeric and found that three analogues of curcumin differing in substituents attached; curcumin I (OCH₃, OCH₃), curcumin II (OCH₃, H) and curcumin III (H, H) were present in it. They are together termed as curcuminoids. Curcuminoid content of turmeric is around 3-5%

Extraction of curcumin

Curcumin is extracted from turmeric rhizomes by various methods depending upon its use afterward and level of purity desired. Extraction can be done using water or an organic solvent by the following laboratory methods.



Using organic solvent

Powdered turmeric is taken in dichloromethane solvent and stirred. The mixture is refluxed and then filtered. The filtrate is concentrated in hot-water bath. The reddish yellow oily residue obtained is then triturated with hexane and the resulting solid (curcumin) is collected by filtration. A mixture of the three analogues of curcumin is obtained.

Using water as a solvent

Fresh clean turmeric is crushed into fine particles, mixed with water and heated. The dye extract (water extract of turmeric rich in curcumin) is used for dyeing.

Hot Compressed Water Extraction (HCWE) is a new technique in which hot compressed water or superheated water is used for extraction because of its unique properties like low dielectric constant, high polarity and high diffusion rate.

Dyeing with dye extract of turmeric

Turmeric dye extract prepared by the method given previously is mostly used for dyeing. Cotton fabric is dyed in dye extract and the solution is heated. Sodium sulphate is added to promote fixation of the dye on fabric.

Optimum conditions for dyeing for best colour strength using turmeric dye extract are - dyeing time: 100 min, temperature: 90 °C and sodium sulphate conc.: 50 gL⁻¹. Maximum colour strength is obtained at 90 °C, but the colouration is not uniform.

For uniformity of colour, optimum temperature is 70°C. Colour strength decreases at salt concentration > 50 gL⁻¹ because of increased dye aggregation.



Fabric dyed with turmeric



Shades obtained depends on the composition of yarn.

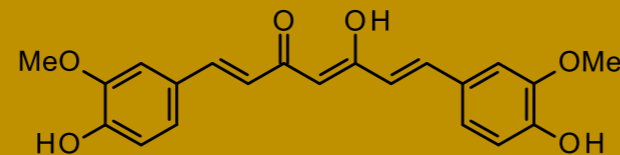
Cotton yarns have the lightest, synthetic yarns have medium shade and wool yarns develop the darkest shade.



Fabric dyed with turmeric

Properties of curcumin

Turmeric turns red in alkaline condition because of which it can be used as an acid-base indicator. Colour changes because curcumin changes to red coloured enolic form (shown below) in alkaline condition.



Yellow in acidic solution and red in alkaline solution

Turmeric (due to curcumin) shows greenish yellow fluorescence when sprinkled in alcoholic solution and illuminated with UV light.



Did you know???

India produces nearly 80% of world's turmeric and it is the largest producer and exporter in the world. Turmeric is also known as "Indian saffron" due to its bright yellow colour and it is often used as a cheap substitute for saffron in dyeing/ food colouring.

Applications of curcumin

Curcumin is an antioxidant, having several functional groups, β -diketo group, carbon-carbon double bonds, and phenyl rings containing hydroxyl and methoxy substituents, which help it in scavenging free radicals which are responsible for causing oxidative damage to biomembranes.

Curcumin is used as an active ingredient in cosmetic products due to its anti-inflammatory, antioxidant and antiaging properties. Curcumin shows antibacterial properties against *Staphylococcus aureus*, *Salmonella paratyphi*, *Trichophyton gypsum*, and *Mycobacterium tuberculosis*.



The whole turmeric root containing curcumin is used in ayurvedic, unani and siddha medicines for ages. Turmeric has been used for treatment of skin injury because of curcumin present in it. It is also used in food as a spice.

Did you know???

A city in Tamil Nadu state, Erode, is the world's largest producer and the most crucial trading center for turmeric. It is also known as "Yellow City," "Turmeric City," or "Textile City." Sangli, a city of Maharashtra ranks second in terms of production and trading.

Global curcumin market

The global curcumin market is expected to increase because of growing demand from application sectors such as pharmaceutical, food, cosmetic and others. This growth in demand is due to curcumin's anti-cancer, anti-oxidant and anti-inflammatory properties. Application in various sector by percentage are approximately as follows: pharmaceutical- ~56%, food- ~37%, cosmetics- ~4% and others- ~3%. In skin care industry, curcumin containing products include soap, face wash, scrub, lotion and cream, serums and shampoo and conditioners.



References and Further Reading-

1. Yulianto, M. E., Paramita, V., Hartati, I., & Handayani, D. (2018). *Hot compressed water extraction of curcumin from Curcuma domestica Val.* AIP Conference Proceedings 1977, 020009 (2018); <https://doi.org/10.1063/1.5042865> Published Online: 26 June 2018
2. Jagannathan, R., Abraham, P. M., & Poddar, P. (2012). Temperature-Dependent Spectroscopic Evidences of Curcumin in Aqueous Medium: A Mechanistic Study of Its Solubility and Stability. *The Journal of Physical Chemistry B*, 116(50), 14533-14540. doi:10.1021/jp3050516

Image sources- See the supplementary document.

Now, can you find?

1. What are other applications of curcumin?
2. What is the IUPAC name of curcumin?

