

# **MORDANTING THE TEXTILES FOR NATURAL DYEING**

# Mordant

The term mordant is used for chemicals which usually have a metal with a valency of at least two or more, they can also be other types of compound as well.

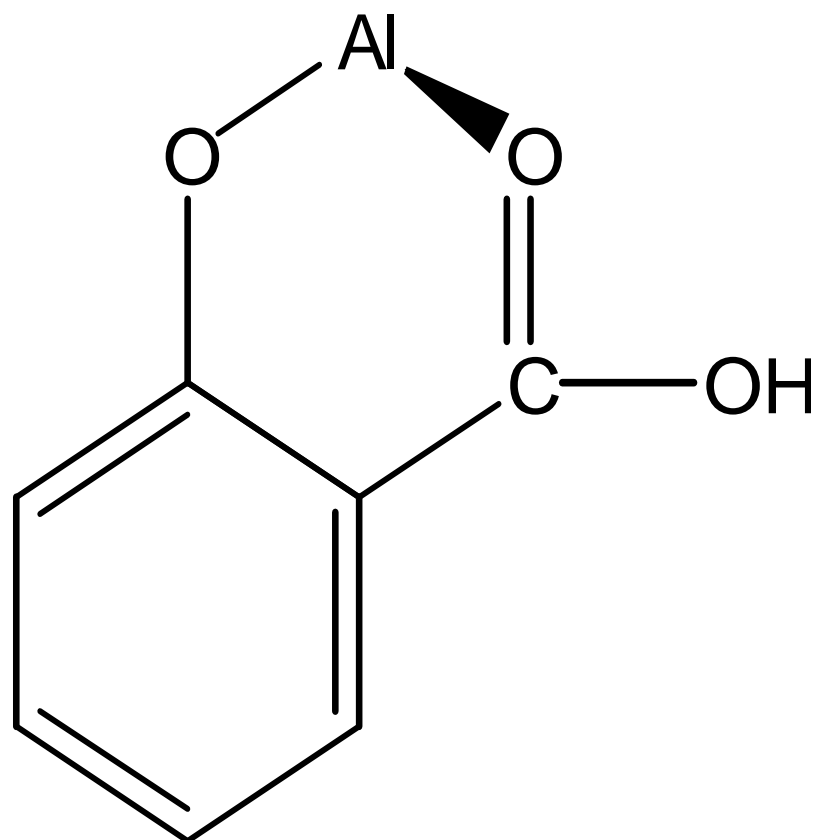
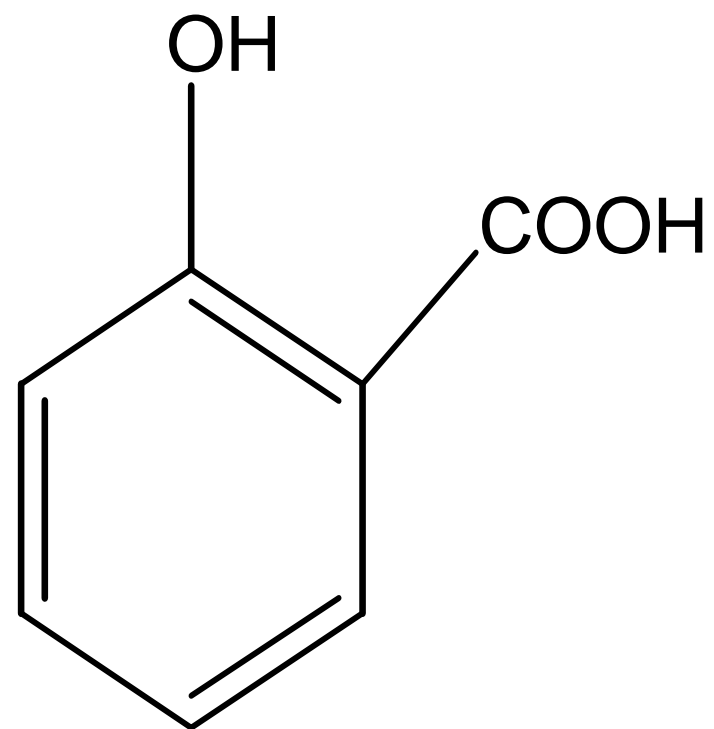
- Natural dyes also referred as mordant dyes; do not readily adhere to cotton so mordants are used. Mordants are needed to set the color when using natural dyes.
- Different mordants will give different hue color with the same dye. A mordant is thus a chemical agent which allows a reaction to occur between the dye and the fabric. In textiles, mordants are used to fix the color in dyeing or fabric printing, especially for fabrics of plant origin (cotton).

# Mordants

- Mordant is added to the dye source to influence it, it does not serve as a color source on its own. The fabric is impregnated with the mordant, then during the dyeing process the dye reacts with the mordant, forming a chemical bond and attaching it firmly to the fabric.
- The choice of mordant depends upon the fabric. An alkali mordant, such as soda ash, works well with cotton, and acid mordant such as vinegar works well with wool.

## Metal Mordants

- Metal mordants can be defined as a polyvalent metal ion which forms coordination complexes with certain dyes.
- Two types of bonds are involved in the fundamental reaction between a mordant dye and a mordant. One is a covalent bond with usually hydroxyl oxygen and the metal atom.
- The other is a coordinate bond with the metal with the double bonded other oxygen also referred as “chelation”. It is possible, however that the formation of dye-mordant complexes involving several molecules of dye can also form. Varying the amount of mordant with the dye is a way to exert some control over the change in hue color.
- The two commonest metals used in natural dyeing are aluminium and ferric ions both having valencies of three.



# Treatment of fabric before dyeing

- After removing the impurity of fabric then it is treated with 4 % (owf) solution of tannic acid in water. The fabric should be dipped in tannic acid solution for at least 4-5 hours. It is squeezed and dried. After mordanting, the fabric is used for dyeing. Dyeing would depend upon the type of mordanting used. There are other types of pretreatment used these days which are ecofriendly. They are mainly two types:
  - 1. **Enzymes** like amylase, trypsin, cellulase and
  - 2. **Polyethylene glycol (PEG)**.
- Both these types are used as depth improver for dye fixation.
- In case where the dye molecule has acidic functionalities—betalamic acid type, usually basic pretreatment with sodium hydroxide, ethylene diamine or morpholine helps as depth improver for dye fixation.

## Methods of Mordanting:

- The percentage of chemicals and the weight of the material to be dyed are very important. The details of chemicals to be used for various mordants with their quantity, fixed temperature is to be maintained, duration of time and the procedure to be followed after mordanting and before dyeing have to be followed strictly. There are three ways of mordanting. Mordants and dyes may be applied in three ways. They are as follows:
- **Pre-mordanting**, where the mordant is applied first, followed by dyeing.
- **Post-mordanting**, where the dyeing is done first and then mordanting is carried out.
- **Simultaneous mordanting**, where mordant and dye are mixed together and applied.

## Different types of Mordants

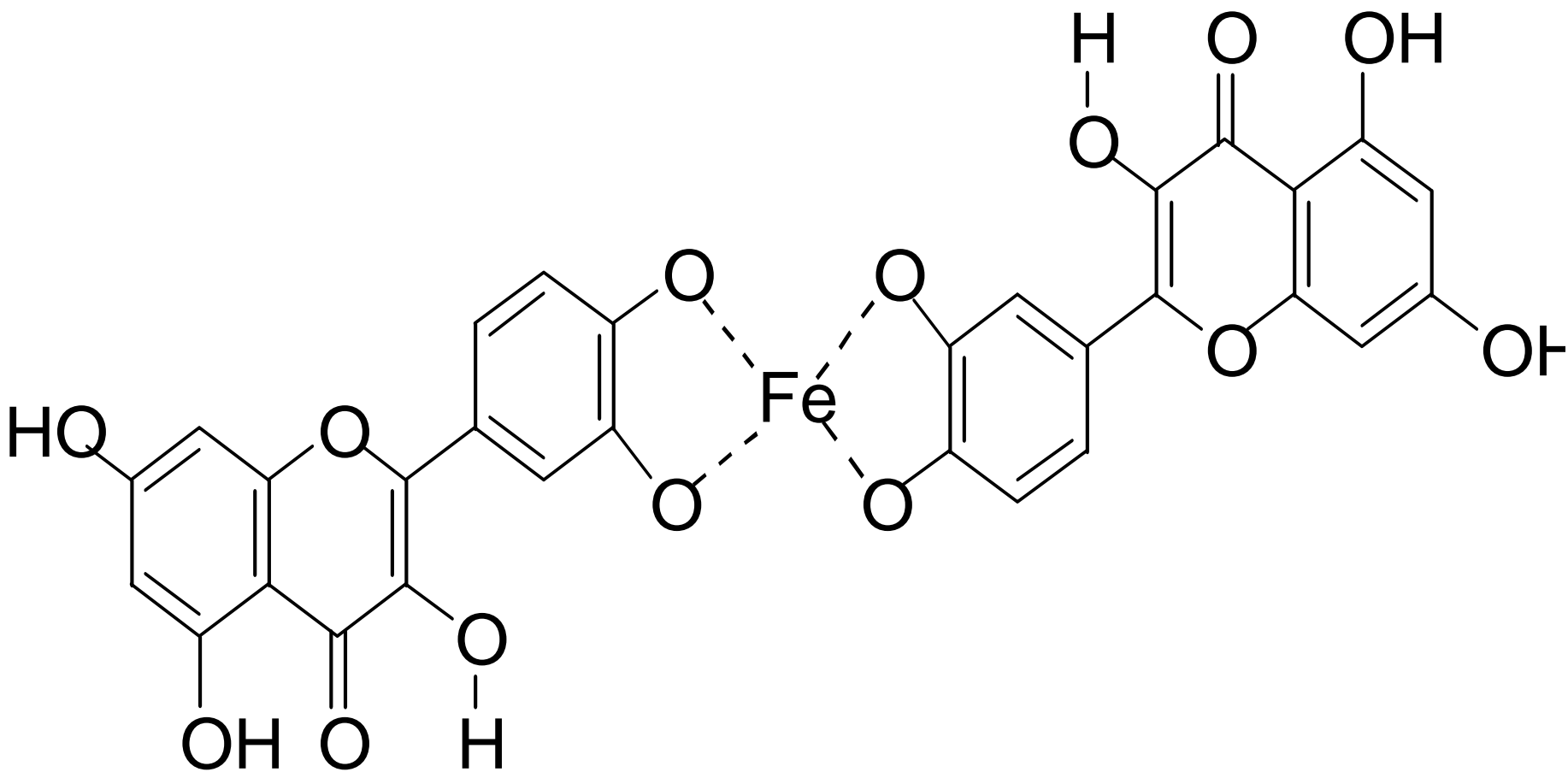
- Mordants are commercially available, commonly in the form of salts from metals such as chrome, copper, tin, iron and aluminium.
- These mordants are listed in descending order of relative toxicity. Other types of mordants which are not metal mordants are tannins, cream of tartar, baking soda and vinegar.
- The later two serve to change the alkalinity and acidity, respectively, of the dye, another property that influences the final color.
- Besides metallic salts, tannins and other inorganic compounds, sometimes oils such as oil of turkey and its type are also used as mordants

## Enhancement by mordant

- It is often remarked that the addition of a mordant to an appropriate dye solution results in a very sudden, dramatic change in color. This is due to the incorporation of the metal atom into the delocalized electron system of the dye. Metals have relatively low energy levels, so their incorporation into a delocalized system results in lowering of the overall energy. The absorbance of the hue and thus its color is related to this phenomenon.

## Use of Mordant

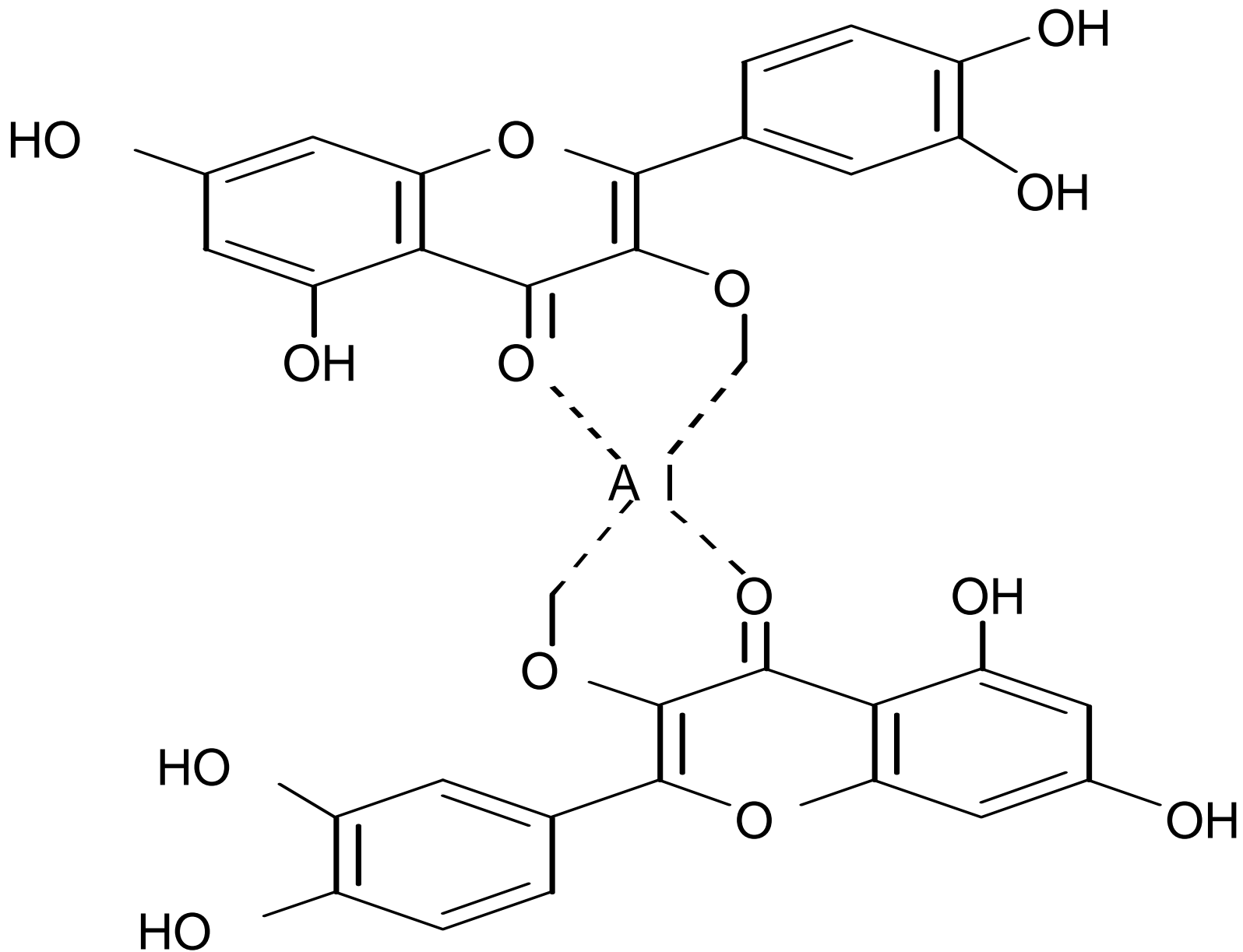
- Most dyers mordant the cloth and then apply the dyes as two separate steps. The advantage is that the mordant has a chance to “bite” into the fiber, so that when the color is applied, maximum amount of bonding takes place. Many dyers turned to natural dyes because they are safe and non-toxic, so it is imperative to ascertain whether the mordants that are used to fix the dyes are safe or not. Most of the mordants that are used for natural dyeing are not seriously toxic.
- The better results obtained in case of pre-mordanting with stannous chloride and ferrous sulphate are attributed to the empty d-orbitals of ferrous and stannic ions. The mode of binding of dye seems different with iron and aluminium ions.



## Binding with ferrous ion

The pre-mordanting with ferrous sulphate showed least color discharge after washing because of the pretreatment of fabric with tannic acid which shows 100% iron binding efficiency in terms of tannic acid equivalents.

The iron binding by phenolics increases with increasing number of –OH groups. A flavonoid ring B and a 3', 4'-dihydroxy group is required for Fe-binding (I) and in case of aluminium ion binding, the 3-hydroxychromane groups are required as shown in the structure (II) below.



## Mordanting for Cotton

- Cotton has very low affinity for natural dyes. The tannins play an important role in cotton dyeing and are largely used for preparing cotton so as to enable it to retain coloring matter permanently.
- Most common mordant for cotton is thus tannin or tannic acid. It occurs in many tannin containing substances, especially in gall nuts which has about 60-70% tannic acid.
- The aqueous solution of tannic acid gradually decomposes on standing by fermentation. Addition of boric acid inhibits the decomposition. It is also considered as primary mordant before mordanting the cotton fabric with metallic salts.

## Common mordants used in Natural dyeing

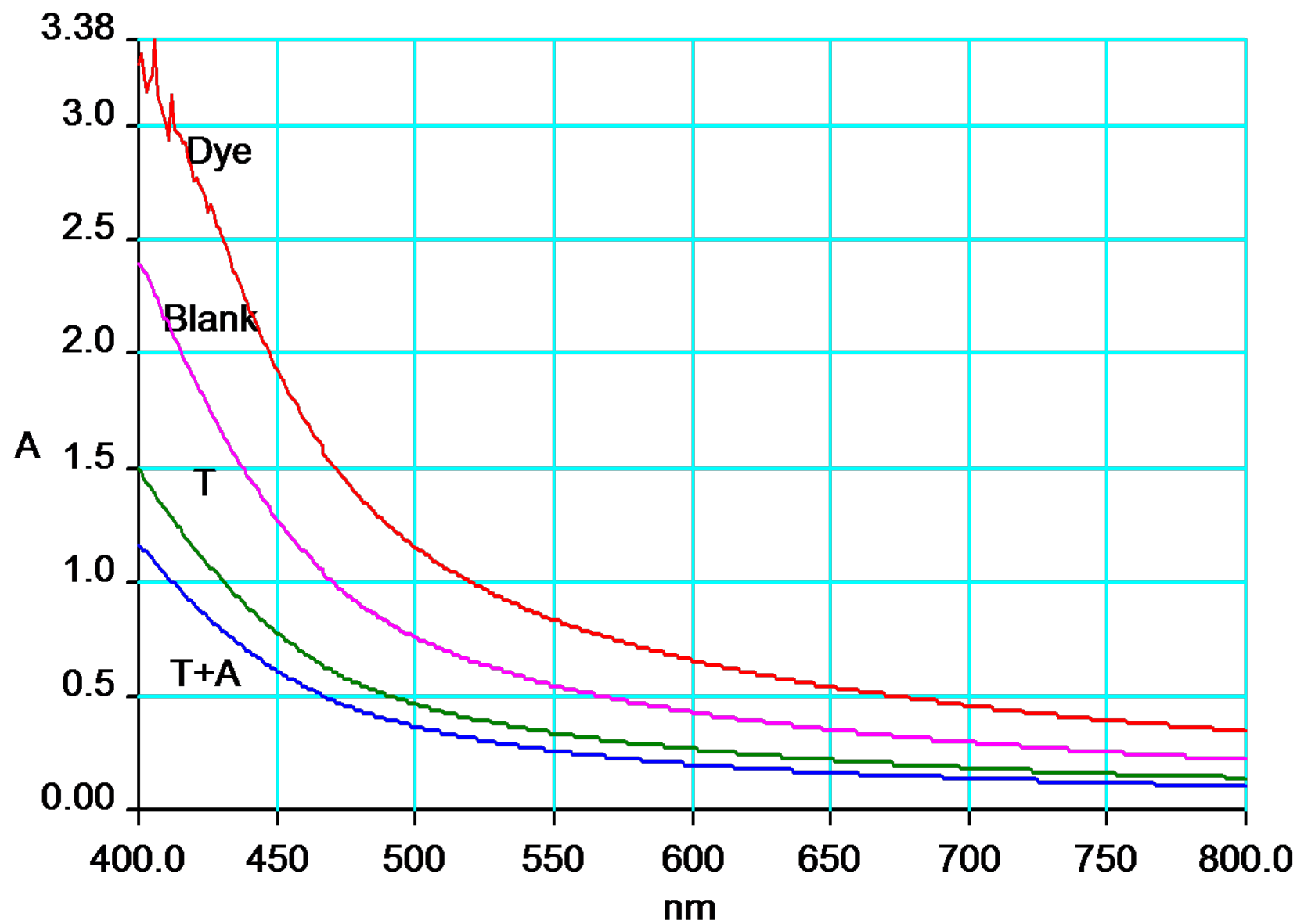
- **Alum** (potassium aluminum sulfate) is the most common mordant. If you are not sure what you want to do, mordant with alum, and use the others as additives. Alum does not affect color. It is usually used with cream of tartar, which helps evenness and brightens slightly. Three 3:1 of alum: cream of tartar is a good start; if heavy wool is used 4 of alum can be used safely. Too much alum makes wool sticky.  
Alum
- **Iron** (ferrous sulfate) is called copperas. It will sadden or darken colors, bringing out green shades. Usually cotton and wool is dyed before mordanting with iron when darker shades are required. Simmering dye-bath for ½ hour, too much iron will harden wool and make it streak.
- **Tin** (stannous chloride) blooms or brightens colors, especially reds, oranges and yellows. Almost always used with cream of tartar —Simmering for an hour and rinse in soapy water before dyeing. Tin is a good additive mordant. Too much tin makes wool brittle. It is caustic, be sure to handle carefully and clean up thoroughly.
- **Blue vitriol** (copper sulfate) saddens colors and brings out greens. It is a good additive. Used alone, one ounce will mordant a pound of wool. Rinse fiber well, store wet or dry. Blue vitriol is poisonous so care should be taken when using it.

## Common Mordants

- **Tannic acid** is a good mordant if one want tans or browns, or for cotton or linen (vegetable fibers). Wool mordanted with tannic acid before dyeing tends to darken with age.
- **Glauber's salts** are a leveling agent, not a mordant. Adding ½ cup to the dye-bath prevents streaking. Color will change slightly. Cotton and wool dyed to slightly different shades with the same dyestuff can be brought to a more even color with Glauber's salts. Addition of one cup of Glauber's salts to the dye-bath, when dissolved, and fabric is simmered for ½ to one hour, until the different shades have blended into uniformity. The final color will be a little duller but will have even-ness.
- **Cream of tartar** is also used in some cases as additive to help in getting evenness and brightens slightly. Sometimes adding cream of tartar to the dye bath will improve the colors developed, with chrome mordanted fiber. The cream of tartar is to be added to the dye bath before entering the fiber.

## Test for evaluating the effect of mordant

A study was carried out to see the effect of mordant on dye uptake and enhancement of fastness properties. The figure shows that treatment of the fabric with only tannic acid, tannic acid and alum show gradual increase in dye uptake, although blank(un-mordanted) fabric shows good dye uptake but it all washes off thereby showing the importance of mordanting.



# Cotton mordanting

Treatment with tannic acid helps the cotton fabric to absorb all types of metallic mordants. The metallic mordants form complex with the carboxylic groups of tannic acid.

Frequently the purpose of preparing the cotton fibers with tannin is not so much to fix the coloring matter, although that is the final goal, as to fix certain metallic salts such as alum, copper, tin and iron in the form of insoluble tannates.

The metal tannates present on the fabric form insoluble lakes with the natural dyes during dyeing.