Teacher and Technician Sheet

In this practical students will:

- Learn about how lake pigment paints are made, using key terms such as **pigment, binder** or **liquid medium, lake pigment, organic, inorganic** and **fugitive.**
- Prepare lake pigment paints, analysing any property changes and indications that a chemical reaction has occurred.
- Evaluate the quality of their paints on different surfaces, determining which binder produced the best paint.

Introduction for teachers:

(This topic could start with a group discussion on everyday coloured substances and the components of paint. During this discussion the teacher introduces the following ideas especially the words in bold.)

A paint is easy to make since a **basic paint** has only two components; the **coloured** part known as a **pigment**, **mixed** with a **liquid medium** (**binder**) that sticks the pigment to a surface.

The pigment can be a mineral or rock that keeps its colour, but sometimes a dye is used and this is known as a **lake pigment**. A lake pigment is a pigment manufactured by precipitating the dye with an inert (unreactive) '**mordant'**, which is usually a metal compound. This means that lake pigments are **organic**, unlike pigments from minerals which are **inorganic.**

A basic lake pigment is easy to make. The basic principle is to precipitate the dye, e.g. plant juice, on to aluminium hydrate or aluminium sulfate. For younger students this process can be described as the alum 'grabbing' the dye colour.

Artists refer to many lake pigments as being **fugitive**. This means they lose their colour in the light.

(This practical is best done as a science club activity since it takes a long time to complete and requires some experimentation to get the right conditions. It is best for students to work in groups of three to discuss the approaches.)

Curriculum range:

This practical is really designed for secondary students and the aim is to gain some understanding of the way the artist used science methods to create pigments. It links with:

- setting up simple practical enquiries, comparative and fair tests;
- reporting on findings from enquiries and observations, including oral and written explanations, displays or presentations of results and conclusions;

- using straightforward scientific evidence to answer questions or to support their findings;
- building a more systematic understanding of the chemistry of paint by exploring the way coloured materials can be used to make a paint;
- asking questions and develop a line of enquiry based on observations of the real world, alongside prior knowledge and experience;
- using appropriate techniques, apparatus, and materials during laboratory work, paying attention to health and safety;
- making and recording observations using a range of methods for different investigations; and evaluate the reliability of methods and suggest possible improvements;
- presenting observations using appropriate methods;
- interpreting observations and identifying patterns using those observations to draw conclusions;
- presenting reasoned explanations, including explaining data in relation to predictions and hypotheses; and
- learning about the concept of precipitation, chromophores and mordents.

Hazard warnings:

The hazards in this practical are from boiling liquids and thorns on the plant. With younger students it is probably better to use the juice from the berries to save them extracting the juice and risk damage from the thorns.

The chemicals are not toxic but the potassium carbonate can be an irritant when made into a solution so plastic gloves are recommended. Also the juice can stain the skin.

Safety glasses should be worn during the practical.

If using dyes then avoid raising the dust or provide students with strong solutions of the dyes.

Equipment:

(per group of students)

- 30 g potassium aluminium sulfate, also known as alum
- 25 g potassium carbonate IRRITANT
- 200 cm^3 ripe buckthorn berries or juice or alternative(s) provided

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- 2 beakers (600 cm^3)
- 500 cm^3 water
- 2 Bunsen burners
- 2 heat resistant mats
- 2 tripods
- 2 gauzes
- 2 thermometers (0-110 °C)
- 2 stirring rods
- 1 filter paper
- 1 filter funnel
- 1 conical flask (250 cm^3)
- 1 jar with lid for the product
- 1 dropping pipette
- 1 mortar and pestle

Technical notes:

Alum is the most accessible mordant for students. The use of alum salt solutions is safe.

Any plant berry can be tried. However, historically the most common plants used for lake pigments are madder root, woad and cochineal food dye, which can all be bought on the internet. This experiment can also be carried out with more accessible materials, such as onion skins, flower petals or red cabbage to make the lake pigment.

The approach to making a lake pigment is similar for each material, but some dyes may need to be boiled while for others, such as madder, boiling can ruin the colour. This can only be found out by experimentation. Also the quantities of alum and alkali will vary depending on the dye being used so some experimentation will be needed to get the quantities right for the dye being used.

If you want to start with a plant one of the most common plants that can be used is the purging or common buckthorn' (*Rhamnus cathartica*). Buckthorn can be found in woodlands in the UK and the purple-black berries can be collected at the end of the summer (Figure 1).

The berries can be crushed using two wooden boards - one on top and another below - over a bowl to catch the juice. Add some water into a bag and crush carefully. Cut a corner off so only the fluid runs into the bowl. The collected juice can be heated to concentrate it, but be very careful not to boil it. With younger students it is probably better to provide them with the concentrated juice to eliminate the risk of them hurting themselves on the thorns.

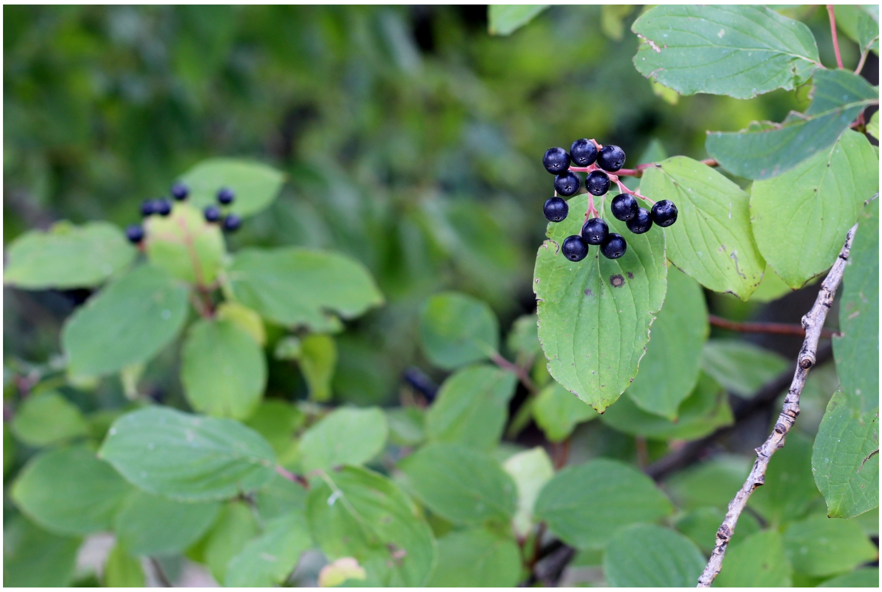

Figure 1: common buckthorn. © Shutterstock

Results:

Whatever material is used the extracted dye colours the alum. This can be used as a lake pigment and mixed with a binder such as egg yolk or linseed oil. If using buckthorn you will get sap green, if using woad it gives you blue, madder you get red and cochineal you will get crimson red. These were important colours for the Renaissance artists.

With egg yolk they apply well, have a slight difference in colour due to the egg yolk and a slight sheen.

- Stays on paper;
- Scrapes off wood;
- Stays on canvas.

With linseed oil they have a good colour and a higher sheen.

- Doesn't stay on paper;
- Wipes off wood;
- Stays on canvas.

Going further:

Students can evaluate the lake pigment for colour fastness with regard to light. This would require them to design an investigation. They could try using onion skins, flower petals or red cabbage to make a lake pigment, which may also be more accessible.

Interested in seeing the final product? Go to this blog to see some of the steps of the practical and examples of the buckthorn berry lake pigments.

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