

## Dyeing with Natural Indigo, Using Reducing Agents from Plants

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### Abstract

All over the world, natural indigo is considered as the most interesting blue dye from plants, used for very popular textile creations, including tie and dye, batik and shibori. Most of the time, the quick preparations of the indigo vats is ensured by the addition of some chemical ingredients as sodium dithionite or thiourea dioxide to ensure the correct reduction of the pigment. On the other hand, the traditional indigo vat, obtained by the fermentation of organic matters, is sometimes considered as confidential, too slow, or difficult to maintain during several months.

An alternative to these vats is presented here, consisting on quick organic vats for medium-scale productions.

In order to be successful with these natural vats, during this one day workshop, some of the most efficient ingredients have been selected here: the basic component used here is Calcium hydroxide ( $\text{Ca}(\text{OH})_2$ , called "calx"), and the reducing process is ensured by natural sugar from fruits (fructose and glucose) or fruit juices, and/or various decoctions of plants containing flavonoids or quinonic components, such as henna leaves (*Lawsonia inermis*) or madder roots (*Rubia tinctorum*). These matters are recommended here as supplies both efficient, non polluting and easy to find. The right parameters to prepare these vats are detailed in this course, while the non polluting character of such vats and the quality of the so obtained dyes are discussed here. The ecological point of view will be commented during this course.

In order to realize some white designs on a blue background, or various shades of blue dyes on a same piece, the fabrication of a specific resist paste will be presented, made of Arabic gum and natural clay (Illite). Otherwise, this practice is attractive because it allows the subsequent inclusion of mordant dyes from various plants, together with indigo blue, in order to create polychromatic effects on a same piece of textile

### Introduction

Travelling in various countries in Europe, Asia and North America, the author discovered a large range of possibilities to prepare natural indigo vats

Indigo is a "vat dye"

Generally speaking, vat dye extracts are prepared with basic components and reducing agents

In order to dye natural textiles with indigo, the pigment non soluble by itself in ordinary water must be put in suspension in water, while the solution of this dye will be ensured by the addition of a basic component together with a reducing agent. For industrial purposes, the base is generally NaOH (Caustic soda), or some weakly basic soda salts as  $\text{NaCO}_3$  (sodium Carbonate), while the reducing agents are sodium dithionite or thiourea dioxide.

These vats are promptly prepared and efficient. However, the ingredients, considered as polluting and/or noxious agents may be replaced as follows: the calcium hydroxide ( $\text{Ca}(\text{OH})_2$ ) will be used in this course for its basic properties, while some natural organic

antioxidant matters, as sugars from fruits, flavonoids and quinonic components from dye plants (Henna leaves), can be used for a satisfying reduction of the indigo pigment. Such vats are prepared with one part of indigo, (by weight), two parts of calx ( $\text{Ca}(\text{OH})_2$ ) and three parts of organic reducing agents. The use of dried leaves of henna, or crystallized fructose allows the choice of these proportions, while the use of fruit juices or boiled fruit wastes requires a bigger amount of vegetal substances. To be successful with such vats, depending on the type of textile you intend to dye, the crucial point is to get the right pH: Use pH paper to control the pH. To dye wool, the suited pH is between 9 and 10; silk may be dyed between 9 and 11; cotton must be dyed at pH 11 to 12. For example, the pH of a 2g/l indigo vat is about 11. If necessary, in order to increase the pH, add a small amount of lime. For this course, we will be focused on cellulosic fibers.

The introduction of the ingredients in water must be done carefully, avoiding to introduce an excess of air in the vat

In these vats, for the best results, a 15mn dip is suitable, which may be followed by another dip after 15m of oxidation of the piece to the air: dip the piece of fabric. After 15mn, press it and rinse immediately in cold water, then hang it for 15mn before another dip, if a dark color is suited.

Discovering the most important demand from craftsmen and small companies concerning a non expensive and safe method to prepare the indigo vats, by using, if possible local products, I was looking for a simple process allowing some adaptations to the local conditions and materials. Realizing that a lot of plants are actually studied as good antioxidants, I decided to try to use them as reducing agents, in order to prepare some safe indigo vats. Numerous assays have been tried, allowing some attractive and efficient results. For this course, some small vats will be prepared, but the scale-up is even possible, by keeping exactly the same ratio and proportions of ingredients.

### Methodology

Ingredients:

a- For the preparation of the indigo vats: The indigo pigment comes from Maiwa Handprints company (Vancouver, Canada). It is produced in India, from *Indigofera tinctoria*.

The Calcium Hydroxyde is produced in France (Apt), from burned calcareous stones.

The henna leaves come from cultivated *Lawsonia inermis* plants in Morocco.

Fructose sugar has been bought in France, in a diet shop, while some pomegranate fruits has been bought in Provence and may be available as well in Hong Kong;

b- For the preparation of the resist paste: magnesium sulfate from a technical grade comes from a local supplier for agriculture, whinegreen clay (Illite), comes from a diet shop in Provence, Arabic gum from acacia

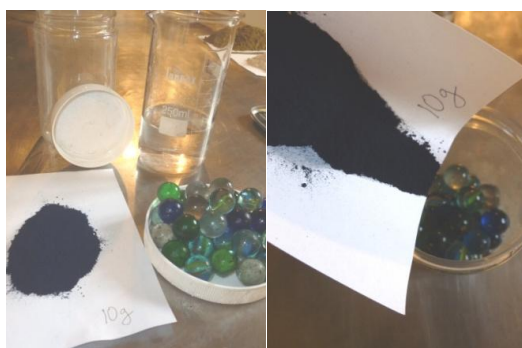
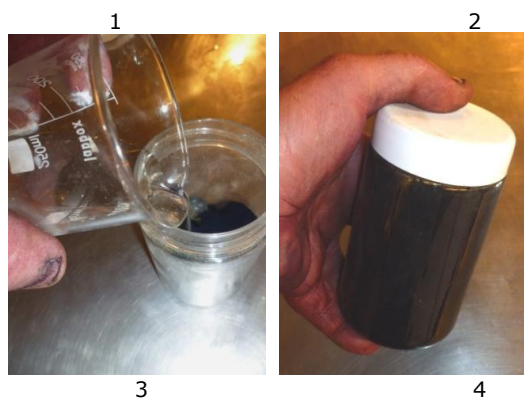
nilotica Have been bought at Emiga Company, in the city of Gardanne, France.

Material: Thermometer, pH paper Mercx 1 to 14 pH; ordinary hot water, plastic buckets, stainless steel pot (to heat the water), glass pots, brushes.

Method: Two vats will be prepared as follows:  
Techniques and processes

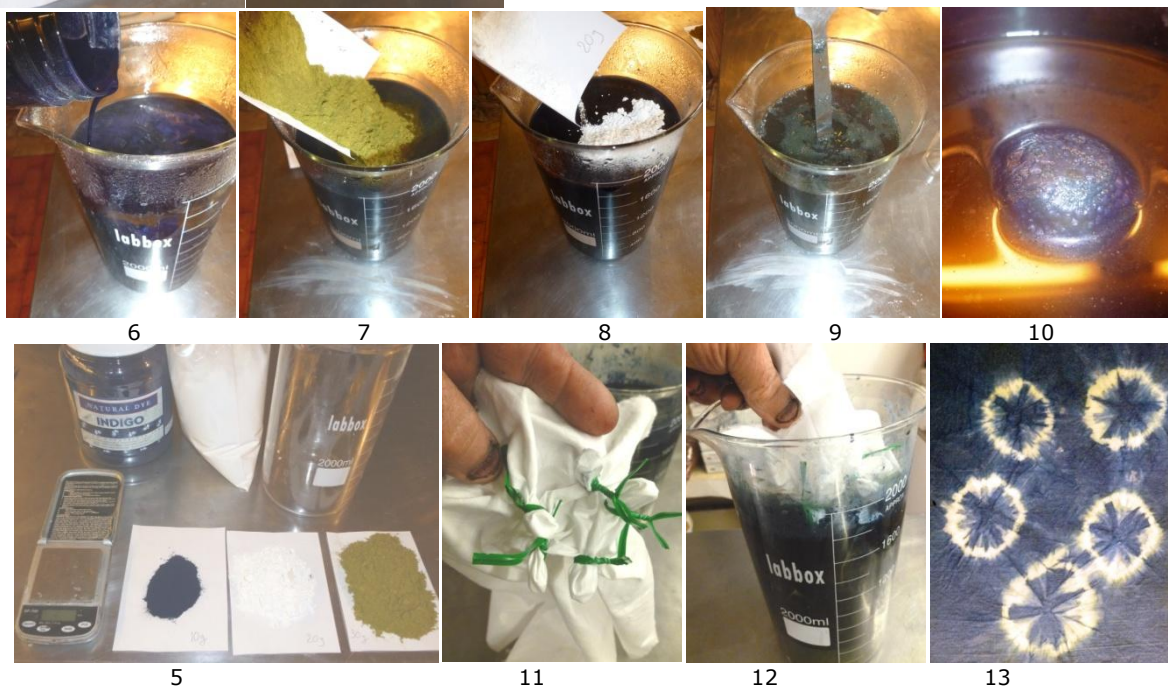
**Preparation of the indigo pigment**

We need powdered indigo, water, glass marbles and a plastic box (1). The powdered indigo pigment is crushed into a polyethylene flask with ordinary glass marbles (bought in a toys store): fill half of the pot with marbles, add the indigo (2). Add some water (3), in order to cover the marbles (not more), then close the pot and shake it strongly during a couple of minutes (4): the indigo will be efficiently crushed and hydrated by this method. For vat 1, this liquid is added to the hot water in first, while for vat 2, the indigo liquid is added to the filtered decoction of fruit



**The henna vat**

We need, by weight, One part of indigo pigment, two parts of calx (  $Ca(OH)_2$  ) and Three parts of powdered henna leaves. ( 5). Fill the 2 liters glass pot with boiling water, then add the hydrated indigo ( 6), then add 30g of powdered henna leaves (7), stirring gently, then add 20g of powdered calx (8). Then stir gently (9), until the surface will take the appearance of copper, and some blue bubbles will appear at the center (10). Wait for 15 mn before testing the vat. Fore example, here, I did test the henna vat with a simple resist (11 to 13), by immersion. In fact, I must tell you that this vat will be much efficient after 24 hours. To dye printed resist pieces, allow the vat to cool (until the temperature reaches about 20° Celsius, or at room temperature) before dipping the resist printed pieces



**The fruit vat:**

For a ten liters bucket: boil some peeled pomegranate fruits (5 to 10 fruits) during 15mn and fill the bucket with the filtered juice. (Some other seasonal fruits such as bananas, pears, or any sweet fruit are available as well) Add the hydrated indigo powder, then add the calx, stir gently and wait for 15mn before dyeing the cotton samples by immersion; allow the vat to cool (until the temperature reaches about 20° Celsius) before dipping the resist printed pieces

The resist paste: Ingredients: Dissolve first the Magnesium sulfate ( $MgSO_4$ ), then, the Arabic gum, then the clay ( Illite) (14). In 200ml of cold water, dissolve first 20g of magnesium sulfate, (15) then add 40g of powdered Arabic gum (16), and stir carefully to avoid lumps, then add 40g of powdered clay. This resist can be used promptly, but it is much better after 24 hours.