The Plant Mordant Project

Natural Dyes 100% from Plants

Using Symplocos as a mordant
on protein and cellulose fibers

by Sara Goodman, Michel Garcia
and William Ingram

www.plantmordant.org
Bebali Foundation
Sustainable Livelihoods for Indigenous Peoples

The Plant Mordant Project

Bebali Foundation
Sustainable Livelihoods for Indigenous Peoples

The Plant Mordant Project offers natural dyers a unique opportunity to avoid mordants produced by industrial processes and make reliable colors 100% from plants. Powdered leaf from Symplocos trees can replace alum in conventional natural dye recipes and produce some exciting new colors. Natural dyers already chose plant dyes over synthetic dyes because they are aligned with their values, and the Plant Mordant Project offers an opportunity to extend the expression of these values by also using a plant-sourced mordant.

At its source, the Plant Mordant Project builds partnerships for sustainability with rainforest communities and indigenous textile artists in Indonesia. Through its sourcing and sales of Indonesia's traditional plant-sourced dye mordant, the Bebali Foundation (www.bebali.org) alleviates rural poverty and empowers women, saves rainforests, and supports the traditional textile arts. The Bebali Foundation brings to this project a decade of experience in the fields of conservation, indigenous culture, and rural livelihoods, while its partnerships with the Royal Botanical Gardens at Kew and the Indonesian Forestry Department, and its funding from the Ford Foundation bring world class scientific rigor and accountability.

Dyes: Get natural dyes 100% from plants

- Commercial alum is today produced from the chemical processing of alum schists, alunite, bauxite or clays.
- Using a plant mordant avoids these industrial methods, and gives natural dyes that are 100% from plants.
- A plant mordant can replace alum in conventional natural dye recipes and can create some original colors, such as a beautiful blue from logwood.
- Using a plant mordant is quicker than alum and saves energy.

Livelihoods: Alleviate poverty and empower women

- Women are the least empowered of Indonesia's rural poor, and yet bare most of the responsibility for educating their children and maintaining the home.
- The Plant Mordant Project establishes and supports women's harvester groups that collect fallen Symplocos leaves, and pays women directly for their product.
- The rate of payment for Symplocos follows fair trade principles and is better than people receive for the candlenut and coffee harvests that are the mainstays of their income.
- The seasonality of the new Symplocos income means it does not replace any existing work, and so is a pure addition to household livelihoods.

Nature: Save Indonesia's rainforests

- The Plant Mordant Project's community-based sustainable harvesting of fallen leaves gives economic incentives for indigenous peoples to maintain primary forests in eastern Indonesia.
- Where this project has been enacted, communities have passed bylaws protecting Symplocos trees in their forests.
- The Royal Botanical Gardens at Kew has mentored this project in the field and provided lab work to show aluminium levels are highest in the fallen leaves (more than 3% by weight).
- The Indonesian Forestry Department supports and licenses the project, seeing more value in recruiting communities to guard the forests than in trying to guard forests from local communities.

Culture: Support Indonesia's traditional textile arts

- The textile traditions of eastern Indonesia rely on Symplocos bark as the mordant for their natural red dye processes.
- However, the traditional networks for Symplocos trade are breaking down because the harvesting of bark is unsustainable.
- The Bebali Foundation is building a new local trade network for sustainably harvested Symplocos to fulfill the needs of traditional dyers so that they can continue their art.
- International Symplocos sales support the Bebali Foundation's work and reinforce its message to traditional Indonesian dyers that using fallen leaves is better then using bark.

Introduction to the Recipes

1. Experimental Variables

These are basic and reliable recipes for using Symplocos for mordanting. With experience, you will find that there are 4 main variables that affect this process:

- The amount of Symplocos used as a percentage of the dry weight of the fiber (% WOF).
- The amount of time the fiber is heated in a solution of the Symplocos.
- The temperature to which the Symplocos and fiber are heated together.
- The amount of dyestuff used.

You may find, as you become experienced with using Symplocos, that you can use less Symplocos with particular dyestuffs, that you can use a smaller amount of a particular dyestuff and still get good results, or that you can use a lower temperature if you keep the fiber in the bath for a longer amount of time, for example overnight.

In our experiments to develop these recipes we tried using the Symplocos at varying % WOF. We tried: 5%, 10%, 20%, 30%, 50%, 90% and 100%. We started to get good colors with 20% on silk and wool. As we increased the percentage of Symplocos, we continued to get better (darker, richer) colors. This was true with some dyestuffs more than others. For example, with cutch and pomegranate, which are both tannins, increasing the percentage of Symplocos beyond 20% made little difference. With cochineal, osage, weld and especially madder, it made a lot of difference. That is why we are recommending that you begin by using 50% WOF to ensure a good result. It is also true that if you use a large percentage of Symplocos, you can use less dyestuff. This is especially true with logwood.

We encourage you to experiment and to share your results with us!

2. The quality of the water is important

Do not use calcareous water. Any soft water, rain water or distilled water, is appropriate. The calcium and magnesium bicarbonates in “hard” water may interact with the organic aluminum present in the Symplocos and partly neutralize it. By using soft water, the effect of Symplocos will be optimized. To neutralize the calcium present in hard tap water add 0.5g of cream of tartar per liter of water.

3. Additional resources

Consult the following resources for a general introduction to natural dyeing including discussion of: equipment needed, safety precautions, preparing different fibers for dyeing, and the relative differences between plant or cellulose and animal or protein fiber.

The Dharma Trading Guide to Natural Dyes: what they are and how to use them

Jenny Dean, Wild Color: The Complete Guide to Making and Using Natural Dyes

Bebali Foundation
Kubu Roda, Jalan Bisma 3, Ubud, Bali 80571, Indonesia www.bebali.org
info@ypbb.org www.plantmordant.org Tel: +62-361-971214

The Basic Recipe for Silk

1. Clean the silk for mordanting and dyeing

- Determine the dry weight of the fiber. This is WOF.
- Soak the silk in a weak, warm soap solution (such as Marseille soap, olive oil soap, Orvus paste, etc.) at 60ºC/140ºF for 1 hour.
- Rinse well in warm water.

2. Mordanting with Symplocos

- Weigh out an amount of Symplocos equal to half the weight of the fiber or 50% WOF.
- Boil the Symplocos in soft water for 30 minutes, until the Symplocos sinks to the bottom of the pot.
- You may filter this liquid, if you are using yarn. If you are mordanting cloth, it is not necessary to filter, since it is easy to remove the Symplocos particles from the cloth later, by rinsing.
- Soak the silk in the Symplocos liquid for at least 30 minutes at 80ºC (176ºF).
- Rinse the silk in warm water. When rinsed, your fiber will be a pale shade of yellow. This yellow color tells you that the fiber has been successfully mordanted by the Symplocos. The yellow will disappear after dyeing and will not influence the final color.
- At this point, you can dry and store the fiber for dyeing later, or you can proceed to dyeing the fiber.

3. Dyeing process

- Now your fiber is ready to dye! All mordant dyes are usable with this process.
- With dried dye materials use 100% WOF.
- For most concentrated dye extracts use 10% WOF.
  - The exception is logwood extract, of which much less can be used: between 5% for dark shades and 1% for light shades.
- Soak the dyestuff for 30 minutes in warm water at 30ºC (86ºF).
- Add the fiber to the dye bath.
- Raise the temperature slowly, over the course of 1 hour, to 85ºC (185ºF).
- Maintain the temperature at 85ºC for 30 - 60 minutes in order to develop the color completely. Do not boil.
- Let the fiber cool in the dye bath.
- Rinse in warm water.

The Basic Recipe for Wool

1. Clean the wool for mordanting and dyeing

- Determine the dry weight of the fiber. This is WOF.
- The yarn or fabric must be clean and degreased.
- Soak the wool in a weak, warm solution of sodium carbonate (also known as washing soda or soda ash), or in a lye solution from plant ashes, at ph 9 to 9.5, for 30 minutes
- Rinse well in warm water.

2. Mordanting with Symplocos

- Weigh out an amount of Symplocos equal to half the weight of the fiber or 50% WOF.
- Boil the Symplocos in soft water for 30 minutes, until the Symplocos sinks to the bottom of the pot.
- You may filter this liquid, if you are using yarn. If you are mordanting cloth, it is not necessary to filter, since it is easy to remove the Symplocos particles from the cloth later, by rinsing.
- Cool the liquid to 40ºC (104ºF).
- Put the wet wool yarn or fabric into the liquid.
- Heat very gently for an hour, to the simmering point, 95ºC (200ºF).
- Rinse the wool in warm water. Be careful not to shock the wool with cold water, or it will felt. When rinsed, your fiber will be a pale shade of yellow. This yellow color tells you that the fiber has been successfully mordanted by the Symplocos. The yellow will disappear after dyeing and will not influence the final color.
- At this point, you can dry and store the fiber for dyeing later, or you can proceed to dyeing the fiber.

3. Dyeing process

- Now your fiber is ready to dye! All mordant dyes are usable with this process.
- With dried dye materials use 100% WOF.
- For most concentrated dye extracts use 10% WOF.
- The exception is logwood extract, of which much less can be used: between 5% for dark shades and 1% for light shades.
- Soak the dyestuff for 30 minutes in warm water at 30ºC (86ºF).
- Add the fiber to the dye bath.
- Raise the temperature slowly, over the course of 1 hour, to 90ºC (194ºF).
- Maintain the temperature at 90ºC (194ºF) for another 1 hour in order to develop the color completely. Do not boil.
- Let the fiber cool in the dye bath.
- Rinse in warm water.

The Plant Mordant Project

Bebali Foundation
Sustainable Livelihoods for Indigenous Peoples

The Basic Recipe for Cellulose: cotton, linen, and other plant fibers

Dyeing cellulose is more complicated than dyeing protein fibers. There are a myriad recipes from all over the world. What follows is a distillation of these variations. It is a basic recipe for strong, saturated, lightfast colors. If you take the time to dry the fiber thoroughly between each step, you will improve your results.

1. Oiling the cellulose fiber

- Determine the dry weight of the fiber. This is WOF.
- Soak the yarn or fabric in a solution of 10% WOF turkey red oil in water at 60ºC (140ºF) for at least 1 hour.
- Dry thoroughly. This is important because oxidizing the oil turns it rancid, separating the fatty acids from the oil, and fixing it onto the fiber.
- Store the fiber for later use, or proceed to the next step.

2. Tannin process

- Soak the fiber in a solution of gall nut extract 10% WOF at 60ºC (140ºF) for 60 minutes. Gall nut extract is a gallic tannin well suited to protecting the lightfastness of the dye.
- Allow to steep overnight.
- Rinse and then dry thoroughly. Again, you can store the fiber now for later use, or proceed to the next step.

3. Mordanting with Symplocos

- Weigh out an amount of Symplocos equal to half the weight of the fiber or 50% WOF.
- Boil the Symplocos in soft water for 60 minutes, or until the Symplocos sinks to the bottom of the pot.
- You may filter this liquid, if you are using yarn. If you are mordanting cloth, it is not necessary to filter, since it is easy to remove the Symplocos particles from the cloth later, by rinsing.
- Soak the fiber in the Symplocos liquid for at least 30 minutes at 60ºC (140ºF).
- Rinse the fiber in warm water. When rinsed, your fiber will be a pale shade of yellow indicating successful mordanting by the Symplocos. The yellow will disappear after dyeing and will not influence the final color.
- Dry thoroughly. Again, you can store the fiber now for later use, or proceed to the next step.

4. Dyeing process

Now your fiber is ready to dye! All mordant dyes can be used with this process.

For dried or fresh dye materials use 100% WOF

- Boil the fresh or dried dye material, 100% WOF, in water, for at least 30 minutes.
- Filter the dye bath, cool to 60ºC (140ºF), and add the fiber.
- Heat gently, over the course of 1 hour to 90ºC (194ºF), and keep at this temperature for 60 minutes.
- Rinse and dry.

For most concentrated dye extracts use 10% WOF

- Dissolve the extract, 10% WOF, in warm water, add the fiber.
- Heat gently, over the course of 1 hour to 90ºC (194ºF), and keep at this temperature for 60 minutes.
- Rinse and dry.

For Madder

Madder must be treated more gently than other mordant dyes. If it is heated too quickly it will turn brown.

- Dilute finely powdered madder root 100% WOF, or madder extract 10% WOF, in warm water 40ºC (104ºF).
- Add the fiber. Warm very slowly, over the course of 1 hour, to 60ºC (140ºF).
- Over the next hour, heat to 80ºC (176ºF).
- Cool the fiber in the dye bath.
- Then rinse and dry.

For logwood and cochineal extracts

- With logwood extract much less can be used: between 5% for dark shades and 1% for light shades.
- With cochineal extract much less can be used: between 5% for dark shades and 2.5% for light shades.

Printing with Symplocos Paste

Symplocos Powder can be made into a paste to be used for silkscreening, block printing, or painting. First, a concentrated solution is made with the powder and water, then it must be thickened. We recommend using guar gum as a thickener, though gum tragacanth would also work. The guar gum powder can be added directly to the Symplocos solution and then stirred. Alternatively, the guar gum can be made into a paste first and then this pudding-like substance can be added to the Symplocos. This dissolves much easier than the plain guar gum powder. Guar Gum is available at the grocery store in the baking section, or from dye suppliers. Prepare the thickener paste a few hours, or even the day, before you need to use it. This recipe will make 1 liter (1 quart) of thickener. (Reduce appropriately if you do not need the full amount).

- Measure 1000 ml (1 quart) of water at room temperature, 25ºC (75ºF).
- In a separate dry container measure 100 grams (1 cup) of guar gum.
- Using an electric hand mixer (you will not be able to mix this by hand), start blending just the water. Then gradually sprinkle in the guar gum. Continue blending until well mixed.
- Allow to stand for several hours or overnight for a smooth paste. NOTE: This thickener will keep for only three days. It is also possible to put the guar gum into several small containers to freeze for later use.

On Cotton

Symplocos paste recipe for printing on cotton

- Add 50 grams of Symplocos powder to 300 ml of water.
- Boil for 30 minutes. Add more water as necessary.
- Filter the liquid, squeezing all liquid from the Symplocos pulp.
- Add more water to the liquid until its volume is equal to 300 ml again.
- Add 3 grams of dry guar gum or about 1 tablespoon of guar gum paste and stir continuously until all the lumps are gone. Add more if it is not thick enough.

Preparing the cloth

- Using cloth that has been properly cleaned, determine the dry weight of the cloth. This is WOF.
- Soak the cloth in turkey red castor oil 10% WOF and enough water to cover the cloth at 60ºC (140ºF) for 1 hour.
- Dry the cloth.
- Soak the cloth in a preparation of 10% WOF tannin and enough water to cover the cloth at 60ºC (140ºF) for at least 1 hour or overnight.
- Dry the cloth again.
- Print with the prepared Symplocos paste and dry thoroughly.
- Rinse in a solution of hot tap water and a handful of wheat bran. The phosphates in the wheat bran will
- set the mordant on the cloth.
- Now the cloth is ready for dyeing, using the usual methods.

On Silk

Symplocos paste recipe for printing on silk

- Add 50 grams of Symplocos powder to 300 ml of water.
- Boil for 30 minutes. Add more water as necessary.
- Filter the liquid, squeezing all liquid from the Symplocos pulp.
- Add more water to the liquid until its volume is equal to 300 ml again.
- Add 3 grams of dry guar gum or about 1 tablespoon of guar gum paste and stir continuously until all the lumps are gone. Add more if it is not thick enough.

Preparing the cloth

- Start with clean/scoured silk fabric that has been washed in a warm soap solution.
- Print with the prepared Symplocos print paste and dry thoroughly.
- Rinse in a solution of hot tap water and a handful of wheat bran. The phosphates in the wheat bran will set the mordant on the cloth.
- Now the cloth is ready for dyeing, using the usual methods.

Plant Mordant Project history

During 2005 and 2006, the Bebali Foundation received World Bank funding to hold two weeklong festivals for natural-dye traditional weavers from across Indonesia. Each festival was held in an indigenous weaving community, bringing together a hundred weavers for facilitated discussion to identify common concerns and aspirations, and open workshops for the sharing of dye and weaving knowledge.

A key issue raised through these festivals concerned the supply of a dye plant known by many weavers as *loba* and used as a mordant with the red dye they obtained from the bark of the roots of Morinda citrifolia trees. *Loba* was sold as dried leaves wrapped in dried bark and supplies were dwindling in the markets while prices were rising rapidly. None of the weavers had ever seen a growing tree, they did not know what the plant was or where it grew, and nobody selling *loba* was willing to divulge their sources. The weavers all knew that their red dyes depended on this plant and that their incomes depended on making dependable red dyes. They gave the Bebali Foundation a mandate to identify the plant, find out where it was from, and rebuild a sustainable supply.

With funding from the Ford Foundation (www.fordfoundation.org) and the help of ethnobotanist Dr Tony Cunningham from People and Plants International (www.peopleandplants.org) and taxonomists from Royal Botanic Gardens at Kew (www.kew.org), *loba* was found to be a Symplocos tree from a genus known for its aluminium hyper-accumulation and favoring habitats in old forest above 600 meters (2,000 feet) elevation. During a year of tracing marketing chains back across the islands, we found many severely degraded Symplocos stands, damaged both by deforestation and by harvesting the bark in a way that killed the trees.

We found the largest accessible Symplocos stands in southeast Indonesia in the protected Kembang Boleng forest, along the high ridges of the mountain range that runs from the center of the island of Flores to its eastern shores. With further help from the biology labs at Kew, we determined that old fallen leaves had higher aluminium content than the fresh leaves, the bark, or the wood. This offered a wonderful, sustainable solution to the traditional weavers' problems.

Three communities within this forest, and with close links to weavers' cooperatives the Bebali Foundation was already working with, were identified as potential Symplocos suppliers and a pilot project was started. With the support of the Ende regional department of forestry, we began a two-year consultation with the neighboring villagers of Mbo Bhenga and Oja that resulted in the establishment of the Loba Na'a Ana women's collectors group and the establishment of customary laws protecting the Symplocos trees. Throughout the Kembang Boleng forest, villages' customary *adat* laws and their associated sanctions can govern land use far more effectively than statutory law. A significant problem in traditional communities is that the nationalization of the nation's forests in the 1970s emasculated the customary *adat* institutions and *adat* leaders are still striving to establish appropriate roles under the new conditions. In all the communities where the Plant Mordant Project has been discussed, these *adat* leaders are among its most enthusiastic supporters.

For the professional government foresters, Symplocos also offered an exciting opportunity. With few staff they have the impossible job of protecting the forest from encroachment. Across the NTT province, 38% of land is listed as forest. In practice, much of the listed forest has no trees. As the department of forestry readily admits, over 700,000 hectares of forest (38% of all forests) are damaged and the rate of destruction is more than 15,000 hectares per year. This is why the foresters are looking for non-timber forest products that people can harvest sustainably and that give communities an economic reason to maintain the woodlands. Symplocos fit the bill. With tens of thousands of Symplocos trees across the Kembang Boleng forest dropping hundreds of tons of leaves per year, the few hundred kilograms collected for dye use was insignificant.

In 2009, new regulations allowed the foresters to issue permits for the collection and sale of up to one ton per year of a non-timber forest species. The permit required that unprocessed leaves be shipped, so that the leaves could be identified on inspection. This gave the Bebali Foundation the advantage of being able to ensure quality control at source. From this beginning, the Bebali Foundation facilitated the establishment of a new trade network between the Symplocos leaf collectors and its network of a thousand weavers on eleven islands across Indonesia. As natural dyers beyond Indonesia heard of the work, interest in Symplocos grew internationally. Particular support for developing an international market came from natural dyers Esme Hedrick-Wong (www.esmelivingcolour.com) and Sara Goodman (www.saragoodmanfiberstudio.com) until the Plant Mordant Project was born in 2012.

About the Bebali Foundation

The Bebali Foundation (known as the Yayasan Pecinta Budaya Bebali in Indonesian) is an Indonesian non-profit organization established in 2002 to help hundreds of weavers who live in remote, under-developed villages turn textiles, crafts, and other expressions of their local cultures into badly needed income in a way that is environmentally sustainable, promotes cultural integrity, and empowers women. Our partners have provided us with a "mandate" of issues that they want addressed, in three general areas: incubating community businesses, managing forests and natural resources, and nurturing traditional culture.

Incubating Community Businesses for the Rural Poor

Promoting investment, innovation, and entrepreneurship in a real market environment can empower women, get and keep children in school, and improve health by raising incomes and creating skilled jobs. Because these jobs often depend on aspects of culture that are unique and inseparable from their rural location, much of this growth stays in small villages. And because these businesses serve real markets, they sustain themselves without further aid or patronage.

Initiating Community Forest Stewardship and Forest Product Management

Sustainable businesses require sustainable resources. With botanical research and field workshops, YPBB helps communities fully understand the resources they use and develop management plans that preserve their forests and raise their incomes. The growing YPBB herbarium collection forms a buffer against the loss of botanical knowledge in our partner communities. YPBB also facilitates dialogue with local governments in order to formalize community use of non-timber forest products.

Nurturing Aspects of Traditional Culture that Strengthen Contemporary Society

All traditional cultures have aspects that create meaning and opportunity; some have aspects that are at odds with modern society. YPBB works in some communities that are undemocratic, or male-dominated, or discriminate by wealth or caste. It is not for us to dictate cultural change. But we work to help traditional people strengthen the aspects of their culture that they feel are in accord with a prosperous, just, and free society.

Left: Sorting Symplocos leaves in Mbo Bhenga
Right: The Loba Na'a Ana women's collectors group