Flowchart for Papermaking from Plant Fibers

Leaf fibers — Bast fibers

Cut the leaves or branches from the plant

(If bast fiber, use newest growth possible and cut stems no bigger around than your thumb)

Cut and digestion

Cut leaves into two inch segments and place in a stainless steel or porcelain (with no cracks) pot. Boil with lye (~2 Tbls.) until the fiber falls apart in running water. Add lye to water (not the opposite).

Testing the fibers

Periodically during the lye boil, remove test fibers with wooden spoon or stainless steel tongs. Run these test fibers under water, taking care that the lye does not burn your skin (use rubber gloves). Check to make sure that the fibers are falling apart and that other plant parts are being digested.

Pouring off the lye

After digestion (retting), pour the pulp through a screen to remove the lye. Use a strong stream of water and plenty of it. Rinse and wring out at least five times. Be sure to use rubber gloves for this. After you feel you have rinsed enough, remove a glove and test the fiber. If it is still slick to the touch, rinse some more. Fibers should be completely disbursed by this time.

Beating the fiber

Fibers can be beat in any number of ways, some requiring more beating than others. Typically, leaf fibers can be beat in a household blender. Bast fibers are stronger and typically require hand beating OR beating in specialized equipment. If you blender beat a bast fiber, be sure to cut it into small (2 in) segments. Use a blender you don't mind ruining.

Blender beating-take ~tablespoon of fiber, place in household blender half full of water and blend until fibers are dispersed well. Add to the vat.

Beating by hand-place wet pulp in container (5gal) and beat with wooden ball bats or mallets. Check periodically using the *quart jar test* to see if fibers are dispersed well enough.

Cut to peel

Cut stems into four or six inch segments and place in a stainless steel or porcelain (with no cracks) pot. Boil until the bark begins to fall off. Alternately, you can degrade (ret) the fiber in a pot filled with water over time, through this makes for smelly processing. Some fibers can be peeled at the time of harvest (Kozo) and don't need to be boiled.

Peel

Pour off boiling water and replace with cold. Strip the bark, peeling the new bark off of the woody core. If possible, also peel off the outer bark at this time. Otherwise, strip it off with a knife held flat while holding the bark strip on your towel covered thigh. A longer boil time may make peeling the outer bark off easier. Discard the outer bark, place the inner bark in a stainless steel pot, covered slightly with water (do not let dry out). Depending on time of harvest, you may be able to strip the bark (inner and outer) off the woody core without boiling. However, you may still need to boil to remove the outer bark.

Digestion (retting) and testing the fibers

Cover the peeled bark fully with water, add 2 or 3 Tbls of lye and boil for an additional two hours, testing the fibers periodically as mentioned with the leaf fibers.

Storage of fibers:

-After harvest of leaf fibers, let dry naturally until brown and store in a paper bag in dry, dark conditions. Watch for mold as the fibers dry.

-Store digested (retted) leaf or bast fibers wet in the refrigerator for up to 3 months.

-Dry peeled bast fibers and store indefinitely in a paper bag in dry, dark conditions.

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Making paper from pulp

You might wonder why it's necessary to beat pulp. This has to do with the structure and chemistry of the plant parts from which we make paper. The thing that papermakers call fiber is actually cellulose microfibrils – part of the plant's anatomy that makes the carriage of water and nutrients possible. As you beat the fiber, the coiled cellulose microfibrils separate from each other, flatten, and fray. Flattening the cellulose microfibril increases the surface area of the fiber. This is particularly helpful, because with an increased surface area, there are increased chemical bonds that can occur from fiber to water first in the vat and then from fiber to fiber as the sheet emerges from the vat.

After the pulp has been beaten, you are ready to make paper. However, learning when pulp is beaten enough takes time and experience. With a hand beaten fiber, you can easily perform the *Quart Jar Test* to see if fibers are well dispersed enough. Watch my YouTube channel (SEEthnobotany) for this demonstration.

If all this seems like too much work for you, remember that you can easily buy wet or processed pulp or any stage in between. Additionally, you can purchase many fibers in thick sheets-in which case, using them just requires tearing apart and soaking in water for at least 24 hours. Pulp in sheets should not require beating, though it may require vigorous mixing easiest to achieve in a blender. If you want to illustrate the importance of recycling, you can simply create pulp by tearing up and soaking sheets of paper to be recycled. If this is the path you choose, take care not to use too much recycled paper in creation of the vat. Recycled paper typically has much shorter fibers than first run paper and thus may not make good sheets.

There are general guidelines found in some sources for the proper amount of pulp to water in the vat. However, pulps vary in quality, so learning from observation, experience, and other papermakers is desired. A general rule of thumb may be to add more as opposed to less, making the thickness of sheet formation easier to control.

Once the pulp is beaten sufficiently (or you run out of frustrations to pound out of yourself ☺), it's time to add the chemicals necessary to make paper. A short list of chemicals typically added to paper and their function is included at the end of this document.

Paper sheet formation-There are many ways to form sheets of paper. As far as I am aware, most involved a mould and deckle, though how these things are arranged varies. See my videos for demonstrations. Carriage House Paper has a wonderful DVD on paper sheet formation around the world and several other DVD's that may help you learn.

Quart Jar Test:

To test whether the fiber has been beaten enough to make good paper, take about a quarter sized piece of pulp that has been beaten. Add this to a blender that is filled ¾ full with water. Shake vigorously. If clumps still appear, the pulp needs to be beaten more. If no clumps appear and the pulp is dispersed well in the jar, then you are ready to make paper!

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Chemicals in papermaking:

Calcium carbonate

Useful for balancing the pH of the vat.

Formation aid

Add to plump up the cellulose microfibrils and as a deflocculant for slowing drainage of the pulp through the screen. This creates more evenly dispersed fibers throughout the vat. Natural formation aid can be made from Okra or certain other Hibiscus plants.

Methyl cellulose

Sometimes added as sizing to the vat, though it is not as good as chemical sizing. Can be used as glue to hold pieces together.

Mica

Small chunks of mica added to 3/4 filled blender will make a nice but not overwhelming decorative 'glitter' to the paper.

*Pigment*s

For color-though the original fiber color is also beautiful!

Retention aid

Typically added to vats when dye is added as a method of retaining that dye in the paper.

Sizing

Typically added to the vat to prevent ink from running on the finished paper.

Sodium hydroxide (lye)

Used as a chemical retting or digestion agent. Primarily causes break down cross linkages between celluloses, hemicelluloses and lignins and pectins, helping the fiber fall apart. The latter two are typically destroyed in this process. ALWAYS add lye to water, not the reverse. ALWAYS use a non-reactive pot. If you get extreme foaming during the digestion process, your (enamel) pot may well have a crack in it OR you are not using stainless steel. Of all the chemicals in papermaking, this one is the most noxious. Wear gloves to avoid burning skin. Wear a mask when adding to a pot-breathing in lye vapors can cause severe burns!

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