

CHAPTER III

FIBERS

The myriad choice of fibers for papermaking is very exciting and can lead to years of experimentation. The statement that paper is made from cellulose fiber gives no indication of the extent of possible choices. Almost any plant source is suitable for SOME aspect of inclusion in paper. Although, technically speaking, all paper fibers come from the plant world, there are varying degrees of these sources. Thus, there are:

- Plants you may harvest from your garden;
- Those which come in a dried state and are available from a supplier; and
- Those which are already processed to the point where the plant source is no longer visible.

This latter category includes woven cloth, yarns, "used" materials such as newspapers, junk mail, egg cartons, construction paper, old prints and photos, old paintings, and the "virgin" fibers that are processed and ready for your "instant" use. The most common of these virgin fibers are cotton linters and abaca, and while less common but readily available, flax and sisal. What makes these fibers "instant" is that they can be used as-is with only beating and no prior cooking, bleaching or other processing. Although not the BEST way to use them, they CAN be put immediately into a blender, whirled up and used for paper all in a five-minute time span. These fibers are available from papermaking suppliers, some mail-order art supply companies, a few art supply stores (most likely at college bookstores where papermaking is taught), and local paper artists.

Technically speaking, a simplified description of a papermaking fiber is to liken it to a drinking straw. Along the outer side of the shaft there are hair-like projections called fibrils. During the beating, the fibrils are roughened (called fibrillation) so that during the matting part of sheet formation, they can intertwine and form connections much like Velcro tape. During beating, water penetrates the wall (called hydration) of the fiber and releases a substance known as hemicellulose. It has a certain amount of glue-like properties which aids in the bonding of the fibers. This technical bit of information is important because it can determine to a certain extent what you will do as a papermaker. While all good papermaking fibers will bond without complete fibrillation and hydration, ONLY those which have been thoroughly (and knowledgeably) processed will produce QUALITY papers suitable for truly fine printmaking, book and watercolor papers. Under MOST circumstances, the only way these quality papers can be produced is with the complete processing that a Hollander beater provides. A stamper will provide this complete form of beating for inner bark fibers. All of this is NOT to say that your own papers won't be suitable for any of the above purposes. What it DOES say is that if you intend at some point to SELL QUALITY papers to professional people, you must do further investigation and make the investment in professional equipment.

While all plant fibers may be used IN paper, not all plant materials have suitable characteristics for the total use of that fiber as a sheet of paper with traditional uses. A quick

assessment of virgin fibers leads to two basic categories: those which you can buy from suppliers, and those which you harvest. Those which come from a supplier have the test of time, you'll generally get no disastrous results if you follow directions, they're reasonably priced, and easy to use without lengthy procedures. Cotton, flax and abaca (also known as manilla hemp) are the most common fibers which come in a ready-to-beat sheet form. When available, Indian hemp and sisal also come in this form. Abaca and sisal also come in a crumbly form called "chipped," which somewhat resembles oatmeal. Both forms work equally well. Most of these fibers come bleached or unbleached. While slightly cheaper, the unbleached forms produce papers that are an off-white to tan color and are not always desirable for later use with color.

PREPARED COMMERCIAL FIBERS

Cotton Linters

Those fibers which are too short for spinning thread and weaving fabric are blown away from the seed pod, cleaned, partially beaten, and processed into a blotter-like sheet form known as linters.

Cotton linters come in several fiber lengths, which are usually referred to as first or second cut, with first cut being the longest. Some companies refer to their linters by their own numbering systems or names such as sculpture pulp. There are different kinds of linters for different purposes and they each exhibit different characteristics of "freeness" (how readily the pulp drains on the mould) and require different beating times (and possibly even be unsuitable for some kinds of beaters). First-cut may contain long strands which wrap around blender blades. Linter sheet weight varies from company to company, some weighing as little as five ounces, while a sheet of the same "cut" from another company may weigh one pound. When shopping for bargains, buy by the pound and not by the sheet. Also keep in mind that the lowest priced linters may be very short fibers which may turn out to be unsuitable for your purposes. Buy a sheet of each fiber length and use it for several purposes such as sculpture (be aware that what works in a wood cast may be unsuitable used in a plastic cast) or book, painting, or printing paper. Cotton is suitable for Western and Nepalese techniques. It can be beaten in a blender, radial mixer, hydropulper, or Hollander. It may be dyed or mixed with pigments for color work. It is the best fiber for sculpture works done in casts.

Characteristics

- Soft and fuzzy.
- Complete beating will produce a harder paper but it will always have a softer, more fabric-like touch than Japanese papers.
- Opaque.
- White or tan.
- Medium shrinkage.
- Matte surface unless highly calendared or topically sized.
- Tends to "hide" effects of pearlescent and metallic micas.

Flax

Flax is a long silky fiber from either the seed fluff or from the inner stem of the flax plant (commonly known as linen). It is used Western or Nepalese style and produces a paper that is crisper and smoother than cotton. It takes long beating to completely hydrate, but is suitable for blender use. Accepts dyes beautifully and is also suitable for use with pigments.

Characteristics

- Shinier and silkier than cotton.
- Produces a thinner pulp in vat.
- Severe shrinkage and very susceptible to warping under humidity changes.
- Good mixed with cotton for sculpture or with abaca for a fine painting or drawing surface.
- Lighter than cotton but extremely strong.
- Can be beaten to a fine translucent state.

NOTE: Another form of flax is known as flax line; it is dark tan and resembles coarse hair. It is NOT an "instant" form; it must be cut fine and cooked prior to use.

***Abaca
(Manilla
Hemp)***

This fiber is from a type of banana tree grown in the Philippines and South America. It is a long-leaf fiber which is smoother and shinier than flax, but somewhat fuzzy if beaten only a short time in a blender. Depending on types and times of beating, it can produce a soft, limp paper or a crisp paper with surfaces similar to cotton and flax. It can be used Western, Nepalese, or Japanese style. It dyes with a lovely brilliance and also works well with pigments and micas.

Characteristics

- Lustrous, especially after being dyed.
- Silky feel.
- Few shrinkage characteristics.
- Can be beaten to a very translucent stage.
- Produces both heavy "cover stock" papers and tissues.
- Excellent for use as "pulp painting."
- Blends well with other fibers.
- Not recommended for sculpture castings.
- Its fuzzy "hairs" can prove troublesome when used for intaglio prints.

***Sisal, Indian
Hemp, Kenaf***

At this writing, only sisal is readily available, though market changes may someday bring back the other two. Sisal is very similar to abaca, somewhat softer and whiter, but not as lustrous. From the agavé plant, it can be substituted in most other cases for abaca because its characteristics are so similar.

***Other
Commercially
Available
Fibers***

Cotton rag and the Japanese bark fibers are available from the papermaking suppliers. Silk yarns and threads and ramie are available from yarn and weaving suppliers.

Cotton rag contains the longest and strongest cotton fibers. It has already been woven into cloth, so requires strenuous processing to turn it into pulp. It comes in a shredded form or in a partially beaten form called "half-stuff." **DO NOT ORDER RAG IF YOU'RE USING A BLENDER.** The one exception to this rule would be if you want to experiment with a highly textured pulp and would mix this directly with already beaten pulp just for the visual effect the lumps and bumps would provide.

Characteristics

- Rag provides fiber that is long, strong, and very supple.
- Excellent fiber for printmaking, watercolor, and book papers.
- Should be Hollander-beaten.

THE JAPANESE INNERBARK FIBERS

These fibers are from the branches and main stem of special trees and shrubs. The fiber lies between the outer brown or black bark and the inner woody core. Also known as **bast** fibers, they are mainly imported from Japan, but some can also come from other Asian countries such as Nepal, Thailand and Korea. In the country of origin they are raised as cash crops for papermaking purposes. After harvesting, the branches are scraped of their outer bark, then steamed so that the inner bast fibers may be pulled away from the core. That fiber is then dried and shipped to suppliers. When you order it, you will receive long dried and sinewy strands of fiber which must be cooked before use. Directions for processing these fibers appear in the Japanese techniques section.

Japanese fibers are, as a group, very long and strong. They produce papers which have an entirely different appearance and feel, and sometimes uses, from Western papers. Throughout the ages they have been greatly revered in Japan, to the extent that they have been given personality characteristics.

Kozo This fiber is the longest and strongest of the bast fibers. It is from a type of fruitless mulberry and is the source of most Japanese art papers. It is what is commonly referred to as "rice" paper, probably because of its milky whiteness. It has been labeled the most masculine fiber because of its strength. It has been used in architecture, clothing, artworks, and even as balloons to carry bombs during World War II.

There are several varieties, and in professional circles, some are more highly prized or recommended than others. Usually, however, you will get whatever the supplier is able to obtain, and the botanical variety will be unknown to you. Sometimes you will get a rather tender white form; at other times it is a tough dark green form.

Characteristics

- Very tough, requiring long cooking and a strong alkali to break apart the fibers.
- Very long fibers that can wrap around the blades of a blender.
- Best beaten by hand.
- Produces very heavy, thick, supple papers, as well as tissue-thin papers.
- Many decorative uses for the partially beaten strands of fiber.
- Dyes beautifully.

Gampi

This fiber produces a paper with a greatly pronounced luster. It is crisp with a VERY silky, smooth surface. Since it is the only fiber which cannot be cultivated and we are dependent on Mother Nature's bounty for our supply, it is highly prized. In tissue form it is almost transparent, which enables it to be used for "washes" over other fibers or papers. It dyes with an unusual warmth and glow, but its special characteristics can be lessened with pigments. Using mica pearls and metals with it greatly enhances the best characteristics of both mica and fiber. Its severe shrinkage characteristics can work for or against you; for you if you're doing the type of sculpture produced by Winifred Lutz, against you by causing severe warpage unless restrained in some way during drying.

Characteristics

- VERY lustrous and translucent.
- At its best in thin filmy sheets or used as washes.
- Very fragile and easily overbeaten.
- Excellent for chine colle techniques in printmaking.
- Severe shrinkage.

Mitsumata

This fiber is the softest of the Japanese fibers, thereby earning it the title of the most feminine paper. It is a light tan color. It is rare to find an imported sheet that is 100 percent mitsumata. It is usually mixed with sulfite, a chemically processed wood pulp. When dyed, the colors are slightly "off" due to its natural beige color.

Characteristics

- Very easy to work with.
- Makes a nice, delicate tissue.
- Not as crisp as gampi, so it doesn't have the wrinkling or shrinking problems.
- Good for chine colle.
- Easily overbeaten.

OTHER FIBERS

Silk

While silk is produced by caterpillars feeding on plants, it is mostly a protein fiber. Therefore, it does not have the same type of bonding capabilities as cellulose fiber. It is extremely sensitive to temperature changes. Although New York Central Supply carries a paper of 100 percent silk, the silk fibers available to the average papermaker must be mixed with abaca or one of the bast fibers to accomplish bonding. The kinds of silk available vary from year to year, probably due to fashion uses. At the time the first edition of this book was published, a lovely silk called combed Tussah was widely available at weaving supply stores. It is rare now, but when available it produces a nice subtle sparkle in papers made of bast fibers or abaca. It must be cut VERY fine, sprinkled little by little into water, and put directly into the vat rather than blended. With the current fashion in elegant sweaters, a wide variety of richly colored silk yarns are now available. These yarns can be cut to one-quarter-inch lengths and broken down in a blender with other fibers. (Directions for use are in the Japanese techniques section.)

Misc. Fibers

Hemp, jute, raffia and seagrass are fibers which can be used for papermaking but are not usually sold by papermaking suppliers. Jute and sisal can be purchased in most supermarkets, in the form of string or rope, and at some craft and weaving supply stores. Before purchasing, be sure to read the label to find out if the fiber has been waterproofed. Hemp is very rare. If you find it in plant form, it is harvested in the same way as the bast fibers. Most people have found these rope and string sources to be rather unsatisfactory since they require a very long cooking time, are difficult to beat, and they have low yield; but they provide interesting textures when included with other fibers. Raffia and seagrass (a type of palm) are available at some weaving supply stores, and they, too, require cooking.

NOTE: Beginning papermakers who are excited by experimentation frequently throw in medicinal cotton or laundry lint, often with very sad consequences, such as burning out their blender. Although laundry lint tends to wad up once it gets wet, and also contains too much polyester for proper bonding, it can be laminated or felted to freshly made sheets for very interesting surfaces. Cotton balls and medicinal-use cotton will just wad up and be a great problem in a blender. However, some innovative artists use them in laminating or in mixing into already beaten pulps.

Commercial Papers

Commercial papers can be recycled, provided a strong hardening sizing was not used in the original paper. Magazine and other glossy surface papers are not suitable for recycling; they tend not to go back into solution and may cause a strain on a home blender, although some papermakers have had success if they cooked the commercial papers before blending. Newsprint papers and some book papers are so highly acid and of such short fiber length that not much is to be gained by the effort.

However, some artists believe in recycling as their prime value and so use these materials and sacrifice longevity of the final work. The best papers for recycling are rag printmaking, drawing, and watercolor papers. Some watercolor papers contain a great deal of sizing and require either a week-long soak or cooking. When recycling, you must keep in mind that the original paper's fiber length was at its ideal length for its purpose, and recycling may shorten the fiber to a degree that the recycled paper may not be used for the same purpose as the original sheet. Japanese papers often yield a lovely recycled paper, but great care must be exercised. Some Japanese papers are made of very long sinewy fibers which wrap around the blades of a blender and cause the motor to burn out. Some inexpensive Japanese calligraphy papers contain a large percentage of wood pulp and have the same acidity problems as newsprint.

Found Objects

Most found objects should not be put into a blender or any other form of beater. But many kinds of things can be mixed with various kinds of pulps. Not everything will produce spectacular or even pleasing results, but if a certain amount of restraint is exercised, dried flowers, feathers, beads, bits of ribbon, pencil or wood shavings can produce very attractive papers. Believing in a very temporary art form, some artists have used seeds which then sprout in the finished paper and finally decompose. Others have used iron rods or shavings knowing full well that they will rust and discolor the paper, as well as also possibly gradually disintegrate it. Leathers, fabrics, bones, twigs, and even stones have been used in lamination. Good design principles need to be kept in mind or these items can only lead to a *mess*.

SELF-HARVESTED PLANT FIBERS

Local plant fibers provide a wide variety of colors and textures not available in commercial papers and have the great advantage of being free. The "price" of using local plants is the labor of harvesting, cooking and cleaning.

Plant sources fall into four basic categories: Grass, leaf, seed, and inner bark (also called bast fiber), with leaf and inner bark being the most common fibers used by the self-harvester.

All plants have some cellulose content, but which one to choose for papermaking depends on several factors:

1. The amount of available cellulose in the plant.
2. Ease in harvesting and/or processing.
3. Length of the individual fibers and the number of fibrils along the fiber shaft.
4. Poisonous or allergenic qualities of the plant.
5. The inherent characteristics of each type of fiber and the qualities desired in the finished paper.

Bast fibers are sandwiched between the brown outer bark of some trees and some woody shrubs and weeds, and the inner core or pith of the branch or stem. Plants and trees which have suitable bast fiber yield a large percentage of fiber, especially when harvested at the end of the growing season or during dormancy.

Leaf fibers are generally derived from plants which have sword-like leaves and not from the leaves of trees, which contain extremely short, brittle fibers. Some leaf fibers, such as yucca, New Zealand flax, agavé, bird of paradise, and philodendron require a very strong alkali to release them from the connecting fibers, and a great deal of excoriating to loosen the individual fibers for bonding. When all of the connecting fiber is removed, the fiber appears as a very thin, long thread, somewhat like monofilament fishing line. The yield is much less than from bast fibers. **The final paper yield of bast fibers is approximately five times greater than from the same amount of leaf or grass fibers.** Many papermakers use all of the connective fiber as well, and the resulting paper is much weaker and often is rough and "hairy" in appearance. Some leaves such as iris and gladiola have much more tender fiber and great care must be taken not to over-cook and/or over-beat the fiber; these fibers, while attractive, do not produce as strong a paper as the other leaf fibers. Although not suitable in pure form, tree leaves may be cooked and mixed with a strong base fiber such as cotton linters or abaca to produce interesting color and texture effects.

Common garden-variety grasses are composed of short, weak fibers, but make interesting papers when mixed with a base fiber. Bamboo and sugarcane are extremely tough, require a lot of processing and usually produce a paper that is coarse and rough unless processed with lye and beaten in either a Hollander beater or a ball mill. Wheat straw is easily processed and produces a lovely golden paper which can range from silky to rough, depending on the amount of beating. Papyrus produces a very attractive paper, but many people have experienced difficulty in releasing it from the couching cloth.

While bast and leaf fibers carry water and nutrients to the plant, seed fibers are coated with waxes which make them water-resistant; this water resistance is designed to protect the seed from moisture during maturation of the plant and until the time the seed reaches the soil. Cotton must be very strenuously processed before it can be used for spinning or compressed into linters form. Occasionally a tan, fuzzy form of cotton comes along; be aware that this form still has a lot of wax on the fiber. It may only go into a tight wad when put into water, and when the blender is run it wraps around the blades. If it does manage to go into a pulp solution and a sheet is made, one often finds that, when dry, the sheet will not hold together. This same phenomenon occurs with the seed fluff of milkweed and cattail. However, this problem can be solved by mixing the brown cotton and other seed fluffs with a good base fiber. Coconut fiber is not fuzzy and, even after long cooking, it is difficult to beat and remains very stringy. It is best used with a base fiber.

Although not listed in the primary plant fiber categories, some peels and vegetables have been used for papermaking. Since their fibers are quite short, they produce papers which are more suited for collage/assemblage or decorative purposes than for writing, drawing or printmaking. However, when mixed with a strong fiber, they provide interesting color and texture.

NOTE: Not all fibers deemed "suitable" produce equal results. Some fibers produce a very brittle paper which will not be very strong and may not be long-lasting under some conditions. Lillian Bell's book lists the length of each fiber. Generally speaking, the longer the fiber, the better the quality of paper produced. Each fiber will have different folding endurance and durability, and are better for some purposes than others. The way each fiber is processed, formed into a sheet, and pressed will also determine its suitability for various purposes. Some fibers, while meeting the

technical definition of "paper," do not produce the kind of smooth, flat substance on which we usually write or paint. A great many of these fibers produce a substance which has a primitive woodsy appearance, often resembling a pile of miniature twigs. These types of "papers" are most commonly used in sculpture or such things as baskets or collage. For several years people have searched for a term to acknowledge the difference between a fairly traditional paper used in ways we most associate with that term, and the more primitive or sculptural forms. Some people have begun to use the phrase "papier suameme," meaning paper in and of itself as an art form. However, it still doesn't really indicate the difference since it retains the word paper. And it is a foreign term which creates mystery instead of the openness needed in this new field. Some papermakers who are making bas-relief or three-dimensional pieces are calling their work cellulose sculpture, but that doesn't solve the problem for other work. So this remains a question; does it need to be solved? Perhaps calling the work rag and paint, or gampi, watercolor and mica, for instance, would help alleviate the problem. A very frustrating experience is that of seeing an exhibition or catalogue that merely labels everything "handmade paper" when there are obvious differences that the viewer would like to have identified. Equally frustrating is a new practice of labeling the ingredients as, for example, "cellulose, abaca, and cedar," when it is actually ALL cellulose.

The following chart lists fibers which have been researched by Lillian Bell and this author. Lillian's research included laboratory and conservation testing. Fibers were tested for length, their ability to form a sheet, coloration, and whether it was brittle or supple. Although this list is extensive, it is not a "dictionary" of every fiber that is useable. Almost every time there is an exhibition of paper or paper art, you will see some new fiber being used. Kudzu and kapok are now being seen on a frequent basis.

Unusual fiber blends have been the mark of distinction of many mills throughout papermaking history. Several fibers may be mixed together in the vat for unusual paper blends. Do not beat them together in the blender since they have different lengths and cellular structure which require different beating times. The only rules of thumb for mixing fibers are to be sure to use a combination which is appropriate to the technique being used, and to take care that the characteristics of one fiber do not completely hide the special qualities of the other(s). Furs or hairs of various kinds have been used, usually with cotton. Do not cook or put furs in a blender; mix them in the vat slurry.

CHART I

| <i>INNER BARK</i> (Bast Fibers) | <i>LEAF FIBERS</i> | <i>SEED FIBERS</i> (Use uncooked, mixed with base fiber) |
|---|--|---|
| <u>Tan/Gold</u> | <u>Tan/Gold</u> | <u>White</u> |
| * Sagebrush Scotch Broom | Banana | Cotton Milkweed |
| * Hemp Flax Hollyhock | * Ginger * Iris * New Zealand Flax * Cornhusk | <u>Tan</u> |
| <u>White/Cream</u> | <u>White/Cream</u> | Cattail Cotton |
| * Mulberry * Fig Milkweed * Kozo * Mitsumata * Gampi Akia Wisteria | Abaca Sisal * Sansevieria (Mother- in-Law's Tongue) * New Zealand Flax * Yucca Pineapple | <u>Brown</u> |
| * Mallow Okra Hau (Hibiscus) * Daphne Wauke Breadfruit | <u>Brown</u> | Coconut (Sennet) |
| <u>Brown</u> | <u>Brown</u> | |
| * Chinese Elm * Weeping Willow * Silver-Dollar Eucalyptus * Cypress Western Red Cedar Juniper * Burdock Hazelnut/Filbert * Ornamental Fig | <u>GRASS FIBERS</u> | |
| | <u>Tan/Gold</u> | |
| | * Wheat Straw Corn * Papyrus Shore Grass * Pampas Feather Grass * Bamboo | |
| | <u>Brown</u> | |
| | Sugarcane | |

* Starred items indicate those which break down with the use of mild alkali (not lye).

NOTE: Not all papers will retain their colors. Greens may turn white, tan or brown. Red flowers may turn brown with time.

CHART I

- CONTINUED -

Fibers from other sources--must be used with a strong base fiber such as cotton, flax, or abaca.

| <i>PEELS</i> (Cooked) | <i>VEGETABLES</i> (Cooked) | <i>FLOWERS</i> (Dried) | <i>OTHERS</i> (Dried) |
|---|--|--|--|
| Avocado Banana Jicama Cantaloupe | Pea Pods Artichoke Carrot Asparagus | Rose Carnation Freesia Heather Rose of Sharon Strawflowers Calendula | Stream Moss Palm "Hair" "Oregon Grape" berries Mushrooms Redwood Shag Bark |

* * * * *

The following fibers may be harvested and cooked, but since they are very tough and stringy they cannot be beaten in a blender. These fibers will not hold together to form a sheet; however, they can be hand-beaten and mixed with a base fiber such as cotton or abaca to provide interesting visual effects.

DIFFICULT FIBERS

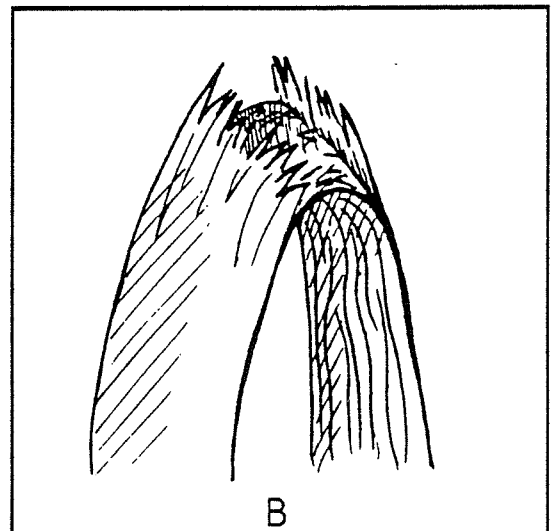
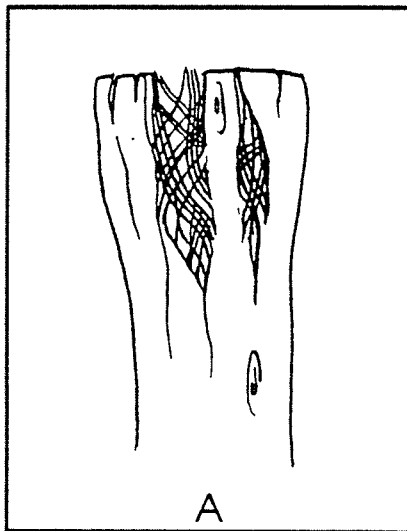
| | | | |
|--|---|--|--|
| Liquidamber Sycamore Acacia Birch | Pittosporum Hopseed Bush Escalonia Avocado | Olive Evergreen Pear Purple-leaf Plum Citrus--all kinds | Fruit trees--all except Fig Grapevine Myoporum |
|--|---|--|--|

NOTE: All of these fiber sources are cooked with a weak alkali.

HARVESTING AND PREPARATION OF PLANT FIBERS

Plant fibers are usually harvested at the end of their growing season (annuals and weeds) or during dormancy (trees) in order to obtain the largest amount of available fiber, although some plant fiber may be harvested year-round. In Southern California, weeping willow, silver-dollar eucalyptus, mulberry and fig were harvested in midsummer and produced very fine papers. However, mulberry fiber harvested in early spring was mushy and produced an extremely brittle paper. Some plants such as mallow and mustard appear in early spring and, due to a very short growing period, may be harvested as soon as the stalk is big enough to have enough fiber to make your efforts worthwhile; although bigger is usually better, a plant of about a foot high will be fine if your desired yield is not too great, or if you have a lot of plant material available. There are many variables which affect the quality of plant and tree fibers: soil and weather conditions, age of the plant, and geographic locations. The same species of plant or tree grown in two different geographic locations can produce very different papers. The same kind of paper differences can occur from one tree in your yard according to different harvest times or climactic changes from year to year.

For plants not on Chart I there is no easy way of determining their suitability. Quite frequently you can only determine how well it will work by going through the whole process and examining the final paper to determine how well it meets your needs. Some inner barks will peel away from the core in a smooth ribbon and, when slightly crushed, show the ideal fiber construction (see Drawing A), but is too stringy after beating and cooking. So something that looks promising does not always yield good results. If the raw fiber breaks, as in Drawing B, do not bother cooking if your desire is to have a smooth paper suitable for writing; it may, however, be perfectly fine for collage or other art uses.



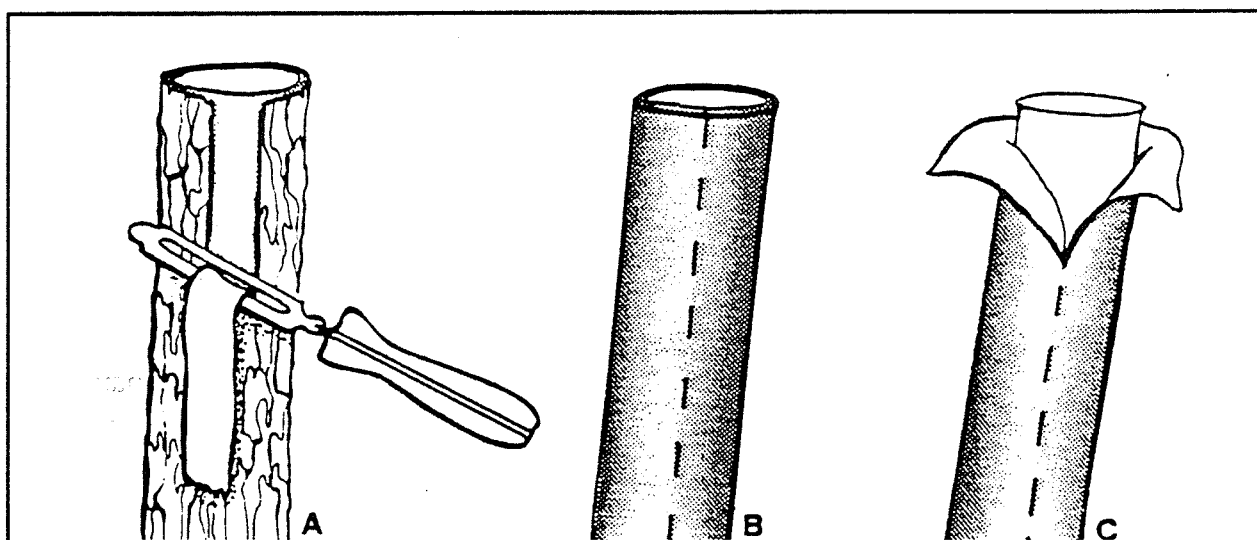
Directions for Fiber Separation

Bast Fibers

1. Select a tree branch that is one-quarter to one inch in diameter. Branches need not be processed immediately after cutting, but if storage is necessary, it is advisable to completely submerge the branch in water. If the water is changed every other day, the branch will stay fresh for about two weeks.
2. Discard leaves. Small thin branches may be saved for Chiri; that is, papers which contain the outer bark along with the inner fibers. Using a potato peeler, peel the outer brown bark in the same manner you would peel a potato or carrot. The outer brown bark is usually quite thin, somewhat like potato peels, so use a light pressure on the branch and be careful not to peel too deeply. (Some people scrape with a knife, but I feel the peeler works faster and easier.)
3. Test the fiber's willingness to separate from the core by making a slit through the fiber down to the core and then try to peel it away in much the same fashion as you peel a banana. If it does not separate readily, the branch will have to be steamed. If you harvest a branch in summer, it will usually separate; in winter the same branch has to be steamed.
4. To steam, cut branches to a size which will fit your cooking utensil, place an inch or two of water in the pot with the branches, cover and cook over low heat for about 20 minutes. The branches must be peeled immediately after steaming. In order to handle them you can run warm water on them, but do not give them a cold soak or allow them to air-cool, or else you will have to steam again.

NOTE: Never use an aluminum cooking utensil. Always use either stainless steel or enamel. A large enamel pasta or corn cooker is inexpensive enough to be used exclusively for fiber preparation.

5. Make a slit through the fiber with a knife or your fingernail, and peel the inner bark from the core.



A - peel outer bark; B - make cut through inner bark; C - peel inner bark from core

6. The fiber can now be cooked or dried for later use. If you dry the fiber, be sure to have good air circulation and make sure it is completely dry before storing. Never store in an airtight plastic bag because the fiber has a tendency to mildew; poking a few holes in the bag will solve the problem.

Small Plants

For small plants such as milkweed and mallow, the process is the same, with the exception that the branches are thin and spindly and it is more difficult to peel the outer bark, and the layer of inner bark is often very thin. You can use the whole plant if the branches are thin. Paper may be rough and fibrous.

Leaf Fibers

Many papermakers merely cut the leaves in small chunks and proceed with the cooking process, especially with the lighter-weight leaves. With the heavier leaves, such as New Zealand flax, sansevieria (Mother-in-law's Tongue), and agavé, some papermakers completely scrape the connecting fiber away and cook only the long thread-like strands.

Grass Fibers

With the exception of bamboo, most grasses do not need any preparation before cooking. Bamboo stems must be crushed to allow chemical penetration during cooking. The ancient Chinese papermakers retted the fiber in a pit with lime for several months before cooking.

PROCESSING

Cooking removes gums, lignens and noncellulose materials, as well as softening and partially hydrating the fiber. These directions are for dried materials, such as the Japanese fibers, seagrass, hemp, jute and sisal ropes and string, your own dried materials, and wheat straw, as well as freshly harvested fibers. An alkali is almost always necessary to remove the above impurities.

Some people have beaten dried fiber and formed a sheet without cooking it. IF it holds together, you MAY be able to go ahead and use this material for some art purposes such as collage. However, there may be some invisible molds, fungus, bacteria or creepy-crawly creatures in this material. When this material is framed, especially if sealed in a Plexiglas box, strange things can grow or crawl out and die. This HAS happened to some artists! It is usually safe to include bits of dried leaves, flowers, twigs, or grasses into pulp or laminated into a sheet. Be aware that this is not going to be 100 percent archival, even though your pulp may be.

Alkalies

Alkalies range from mild to extremely caustic. **WARNING:** Lye is not only extremely caustic and should always be handled only with very heavy rubber gloves, protective aprons, and goggles, but also *gives off poisonous fumes when cooked*. If used, it is best to cook outdoors or in an open garage. Do not let the pot boil and spill over. Some of the fibers mentioned in other sources (such as pine cones) will only break down with lye. You must make the decision whether you need that fiber desperately enough to use lye. Many of the tough fibers break down faster if you use lye. *Never use lye around children.*

Washing soda, sodium carbonate, and soda ash are different names for the SAME chemical. They are relatively mild, and although they de-fat and dry the skin, they rarely cause irritation. If you have sensitive skin, wear rubber gloves. Cooking fumes are unpleasant to smell, but are not dangerous. Arm and Hammer washing soda has recently undergone a formula change and is not recommended. You can purchase the pure chemical from a chemical supply house (if they sell retail) or from Straw Into Gold, or from papermaking suppliers. Pure sodium carbonate is four times stronger than Arm and Hammer. TSP (trisodium phosphate), another mild alkali, is a good substitute for washing soda. It is available in the cleaning products section of most supermarkets; however, it is not the original formula, which is stronger. The original formula is available at some paint and hardware stores.

Cooking

1. Many people soak their dried fibers for 24 hours prior to cooking, but I have not found this to be necessary, though it may shorten cooking time. Since cooking and cleaning (rinsing and picking out stray pieces of bark) is a tedious process, I try to cook as much as possible at one time. When using Japanese fibers, I cook approximately one-quarter pound of dry fiber in a ten-quart kettle.
2. Place dry fiber in an ENAMEL or STAINLESS STEEL pot, fill with water to within two inches of the top (or if cooking only a small amount of fiber, cover with one inch of water above the fiber), and put in one tablespoon of alkali for every quart of water, or for every 100 grams of dry fiber use 18 to 20 grams of alkali.
3. Cover, bring to a boil over high heat, reduce heat and cook one to several hours. Cooking times are dependent on the type of alkali and the toughness of the fiber. Mulberry, kozo, seagrass, bamboo, sugarcane, and New Zealand flax are some of the strong fibers which people have reported cooking seven hours to several days. Many people use a crockpot, which is very slow cooking (reports of 24 hours to five days), but has the advantage of not having to be a "watched pot." A weak alkali requires a longer cooking time. The tender fibers, such as gampi and mitsumata, may require only one or two hours of cooking. If a weak alkali is used with very tough fibers, you may want to double the amount used.
4. An alternative cooking method for working with very tough fibers and/or for obtaining a very light fiber is to cook the fibers as described above for one or two hours (a half hour to one hour for gampi or mitsumata when light fiber is desired), drain the fiber and rinse several times, then start the cooking process again with fresh water and alkali.

5. Fiber is "done" when it pulls apart easily. It will be somewhat like cooked celery. It is possible to overcook some of the tender fibers; you do not want them to fall apart like stewed rhubarb. Once cooking is completed, immediately drain the brackish water and rinse the fiber. If you leave the fiber in the cooking water, it will turn dark. If you can't proceed immediately to the rinsing and cleaning processes, rinse the fibers in a collander for a few minutes, then place the fibers in water (cover by at least one inch) and refrigerate.
6. Fiber saved for Chiri (bark paper) should be cooked separately since the outer bark will dye the fiber.

Rinsing and Cleaning

Rinsing must be very thorough in order to remove any traces of the gums and lignens as well as all traces of alkali.

1. Pour fibers directly from cooking pot into a collander or sieve and let running water go through them for a minute or two.
2. Put fibers into a large bowl, basin or sink filled with water. Swish fibers around several times, drain water, and repeat process, possibly even two or three times.
3. Fill basin with fibers and water once more and begin the cleaning/picking process. At this point you want to remove any traces of outer bark. (This step is necessary with the Japanese fibers and bast fibers, but not with fibers such as seagrass, jute, etc., and the other plant fibers.) This step is tedious and you will probably work out your own way. I first remove all the very clean, bark-free fibers; these are usually the lightest fibers and I reserve them in a separate container with water. I then pick a strand of the heavier fiber, and either pick off all the pieces of bark individually, or I pull away all the clean fiber. In gampi, the bark pieces cling to the cuticle layer (the layer immediately beneath the outer bark) which usually separates easily from the layer next to the branch core. Picking out the individual pieces of bark is more tedious, but more fiber and the cuticle layer are saved with the bulk of the fiber. Separating the cuticle layer is faster, but there are those who believe the cuticle layer helps keep the paper insect-free and gives luster to the paper. The cuticle layer is most noticeable in gampi. You may not see it at all with kozo and mitsumata, or you may have peeled it off with the brown bark in fibers you have harvested. It is impossible to see in dark fibers such as willow and eucalyptus. Some bark and/or cuticle layer fiber may be saved for Chiri paper.
4. Cleaned fiber is now ready to use or to be stored.

Fiber Storage

1. Linter fibers and dried plant fibers can be stored indefinitely. Whether in bark, linter, or crumbly form, fibers stored in locations such as garages may be eaten or used as nesting materials by mice or silverfish. Due to mildew problems, if you store in plastic bags, leave the end open or put a few holes in the bag. Cardboard boxes sealed with tape are fine containers for bark fibers, but their acid content makes them unsuitable for storing linters, etc. This problem can be overcome by lining the box with a plastic bag.

2. Once fibers have been cooked with an alkali, they should not be dried because they will never again absorb the same amount of water. Cooked fibers can be covered with water and stored in the refrigerator for at least a week, oftentimes quite a bit longer, but it is wise to check them periodically because in effect they are "vegetable" material. Cooked fibers may be frozen indefinitely. They may be drained of water and put into plastic bags, or they may be put into plastic freezer containers, covered with water, and frozen. Frozen fibers may be thawed at room temperature, in the microwave oven, or by putting the frozen block in a pan of water and heating.
3. During the winter months, beaten cotton, flax and abaca linters may be kept in the vat or in plastic buckets for a week or more. When dyed, the salts and chemicals in the dye seem to preserve these fibers even longer. I have left them in buckets in the garage for as long as four weeks. It is advisable to check them every few days, though. Since these fibers are like "rag," during warm weather they can sour rather quickly. Dyed fibers can withstand the heat better than undyed. To avoid spoiling during warm weather, refrigerate fibers if you can't use them again the next day.

The plant fibers are like vegetable material and will therefore spoil much more readily. In winter they can be left a day or two (check them). In summer they should be refrigerated immediately after use.

NOTE: Since freezing partially "explodes" the cell walls of vegetables, it may do the same thing to papermaking fibers. Therefore, frozen fibers may require less beating. The papers may be of inferior quality, but the difference would be noted only by a paper chemist.

NOTE: Unbleached abaca and cotton will sour or spoil rather quickly, often within 24 hours, if not refrigerated after use. Unbleached fibers are said to be stronger than bleached.