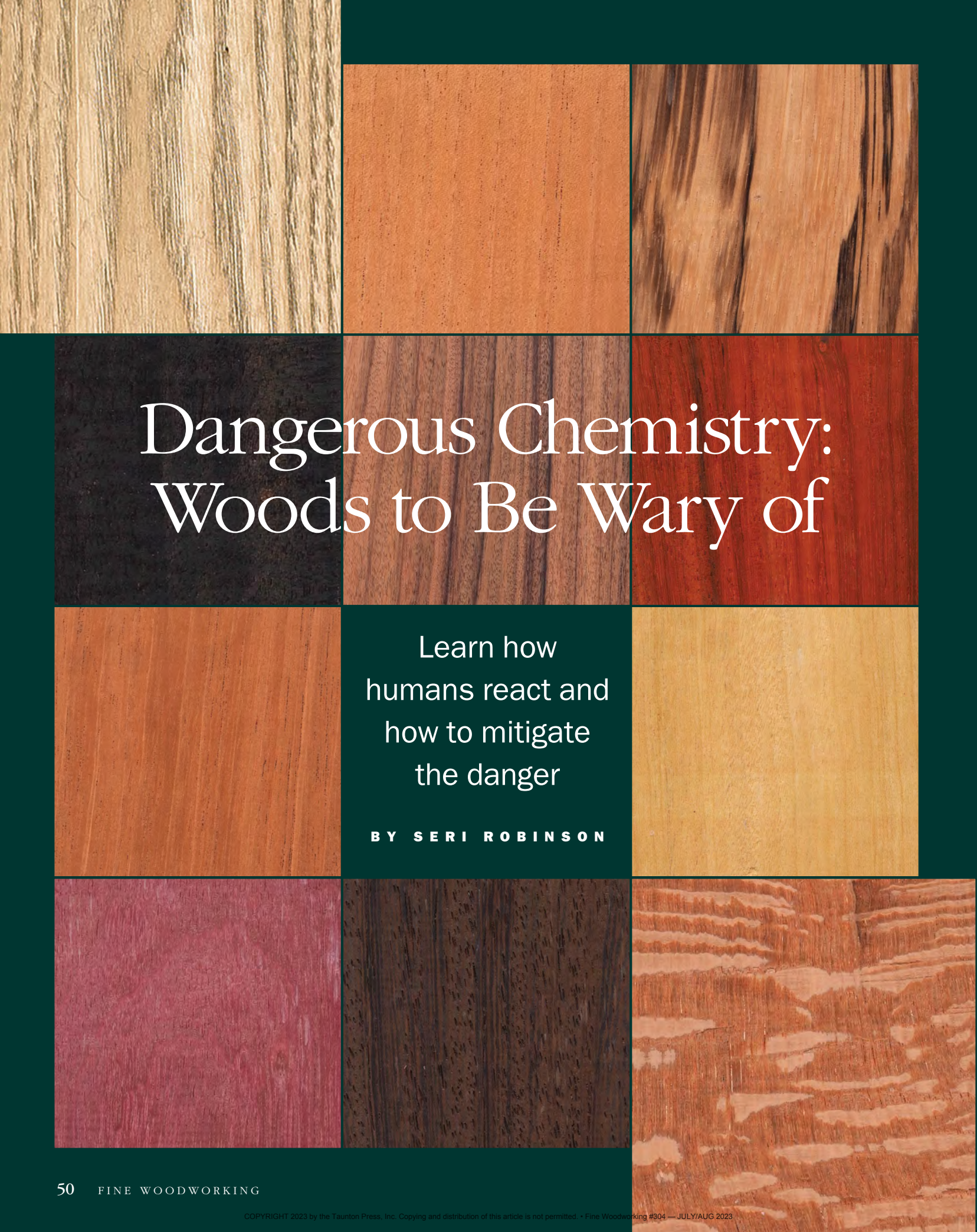


Dangerous Chemistry: Woods to Be Wary of

Learn how humans react and how to mitigate the danger

BY SERI ROBINSON

Wood contains certain compounds, called extractives, that range from being benign to all humans, to allergy-inducing for some, to acutely toxic to all. A sensitivity or allergy can be endured to a point, while toxicity can, in the most extreme cases, end in organ failure and even death. This article will break down the science and terminology around these bioactive compounds in wood, identify their negative effects, and explain how to mitigate them.

Part of what complicates the matter is that different people react to the same compounds differently, making it hard to sort out whether a wood is toxic or just irritating. Also, research in human subjects is limited for many woods, so in some cases we are left to draw conclusions from animal studies and anecdotal evidence.

When it comes to allergies and toxicity, wood scientists like me talk mostly about end-use—specifically skin contact and ingestion, as opposed to breathing in dust during manufacturing. But anything that will cause problems when touched or ingested will cause worse problems as dust, which has much more surface area for transferring those dangerous compounds, and can be breathed into airways and lungs—warm, moist environments that make the transfer more effective.

It's important to note here that wood dust is a known carcinogen, no matter the species—so collecting it at the source and filtering it properly are critical for all woodworkers.

Understanding the basic terms

Let's start with the types of reactions people have to wood, which can be a little confusing. The first type is a sensitivity. Some medical literature defines sensitivities as reactions without an immune response, while other researchers define sensitivities as delayed immune responses.

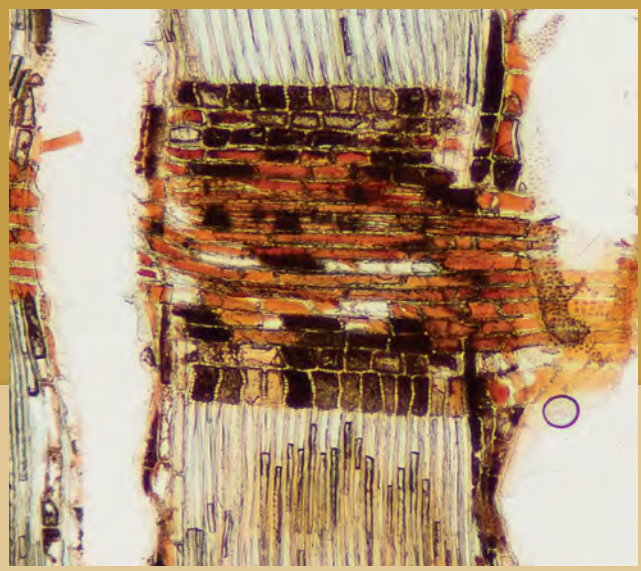
In practice, sensitivity is a catch-all term, used when a person is having a reaction but can't identify why. For example, of the people who report adverse reactions to gluten, many do not have celiac disease, IBS, or any other known cause.

With sensitivities being difficult or impossible to diagnose, I'll focus on quantifiable reactions, namely, allergies and toxicity.

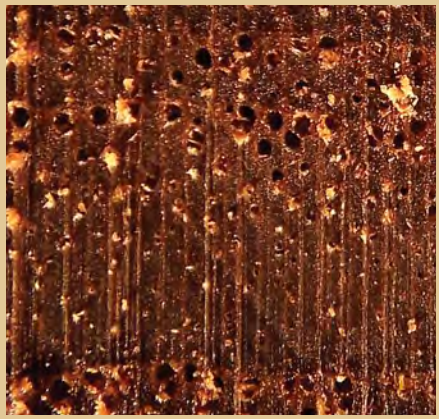
Allergies vary for different people— An allergy is a histamine response. Humans can be allergic to practically anything, from

Extractives are the culprit

Trees store nutrients in stacked ray cells that radiate out from the center of the trunk. When sapwood turns into heartwood, excess nutrients are converted into extractives, which act to ward off pests and decay, especially important in wet, tropical environments.



Extractives are formed in the rays. *Dark extractives fill almost every ray cell in this tropical wood.*



Tropical woods have more extractives. *Teak, found throughout Asia, Africa, and the Caribbean, contains a number of extractives that produce its dark color and oily feel. These characteristics are evident on the surface of a board (left). In a magnified cross-section (right), all of the brown color and tinting are extractives.*

Extractives can be transported by water. *Extractives can be transferred to humans either through dust breathed in when milling or sanding, or via contact with skin, food, or saliva. And water can transfer extractives. After being boiled for 30 minutes, the water around a block of hard maple (left) is clear, due to the wood's relative lack of extractives. The same test conducted on walnut (right), which has more extractives, turns water brown.*

Photos, this page: courtesy of Sarath Vega Gutierrez

Protecting end users

Here's how to protect users from toxic or allergy-inducing woods.

Play it safe with kid stuff. *Young kids often chew on their toys and furniture, so use safe, durable woods for projects like these. This chair is made from red oak, and the table is cherry.*

peanuts and pollen to dust and dander. And allergic responses tend to build with multiple contacts. For example, the first time you work with eastern red cedar you might not react, but the second time you might break out in hives. This process of becoming more allergic to a compound over time is known as becoming "sensitized" (not to be confused with a sensitivity). There are many compounds in wood that can build a heightened allergic response over time—particularly in aromatic woods, such as the cedars. Whether you react on your first or fifth exposure is a product of your unique biology.

Once you are allergic to something, your body's response can be similar to a toxic response, so in many applications, you should treat allergens similarly to toxic compounds.

Toxicity is universal—The term toxic indicates that the response to a compound is similar for all humans. If every woodworker sneezed in the presence of cedar, it would not only be considered an allergen but also toxic. Toxic reactions range from drowsiness, contact dermatitis, hives, and respiratory issues to genotoxicity—the potential to damage DNA and chromosomes, which can be passed down genetically.

There are some toxic compounds that can be released from wood, such as safrole from sassafras (see p. 57). While raw wood isn't currently regulated by the FDA, some of these released compounds are. So it's easier to find information on them.

How and why trees make extractives

Wood is made of lengthwise vertical vessels that look like drinking straws, which carry water, sugars, and other compounds up and down the tree. There are also thinner, shorter, stacked vessels (which look more like coffee stirrers) that radiate outward from the tree's center. Called "rays," these serve a variety of purposes, one of which is nutrient storage.

The tree is also broken into two main circular sections: a ring of sapwood (the living portion of the tree) around the outside, and the heartwood (the dead portion) in the center. The heartwood, which is denser, serves to keep the tree upright; you will sometimes see a fallen tree that looks perfectly fine from the outside, but has rotted heartwood within.

Hence, it's in a tree's best interest to keep fungi out of its heartwood. To help accomplish this, when wood transitions from sapwood to heartwood, unused nutrients in the rays get converted into other materials. These new compounds—extractives—vary by species and growing conditions, but they have one goal: to keep pests and decay away.

Extractives make each species unique—Extractives are what create the color, smell, taste, and feel of any given wood. The colors of purpleheart and bloodwood are created by extractives. The oily feeling of teak, the smell of cedar, and the taste of traditional root beer are all wood extractives. Most extractives are benign to larger organisms like humans, but some are irritants, and others can be downright deadly.

These chemical compounds are called extractives because they can be carried away—extracted—by solvents, including water. Place a piece of black walnut in plain water, wait a half-hour, and the

Photos, except where noted: staff

The same goes for bowls and spoons. *Hot water accelerates the transfer of wood extractives, so avoid problematic woods in cookware.*

Protect users with a film-forming finish. *These jewelry boxes (by Lucinda Daly, p. 70, FWW #301) contain lacewood and sapele, tropical woods that can cause skin and respiratory problems. A protective finish makes them safe to use and handle.*

water will turn brown. That dark color is all extractives. Thankfully, one of them won't be juglone, an extractive in walnut that is a known carcinogen but is not released with water. The dark color will be composed of a number of other compounds. Add heat and/or pressure to the wet environment, and even more extractives will be released.

Tropical woods are the most troublesome—Generally speaking, the darker, heavier, and more aromatic a wood is, the more extractives it contains. Tropical woods are exposed to a greater variety of pests than temperate woods, so many have evolved more extractives to help deal with the greater prevalence of fungi and insects (and longer growing seasons).

There are plenty of low-extractive tropical woods, however, so it is also likely that our view of high-extractive tropicals is informed by the dark, pretty woods that

Use a hardening oil on some cutting boards. *It's best to finish cutting boards with a food-safe oil, or leave them unfinished, but problematic woods need a film-forming oil finish that will fully dry and help prevent the transfer of extractives.*

Protecting yourself

Wood dust created by machining and sanding hangs in the air, where it can be breathed into your airways, a warm, moist environment that encourages the transfer of troublesome compounds into the bloodstream. Skin contact with some types of dust can create hives or dermatitis.

Collect as much as you can. *In high-enough quantities, any type of wood dust can be a carcinogen, so it's essential to collect it at the source with HEPA-level filtration.*

Wear a respirator for troublesome woods. *When working with toxic or allergy-inducing woods, protect your lungs with a tight-fitting respirator. One that includes a face mask is even better.*

are commercially exported. Conversely, there are plenty of temperate woods with enough extractives to be toxic, and others that are irritating enough to be a nuisance to humans and pets.

Check the lists in this article to find out which woods are benign and which might spell trouble.

How to protect yourself

So what can woodworkers and end users do to mitigate the effects of problematic wood extractives? For the woodworker, the easiest approach is to avoid working with woods known to cause allergies. However, since you can become sensitized and allergic to almost any wood over time, it's a good idea to wear an N95 mask whenever you're woodworking—the type with two straps that go around your head. Anything that hooks behind your ears won't be very effective.

A respirator is a must when working with any of the woods on the toxic list, and I recommend one for any of the woods known to cause allergies. Adding a full face shield will make sure that fine dust won't cling to your eyelashes and end up in your eyes.

That said, if you collect dust at its source, on every power tool in your shop, with HEPA-level filtration, you might be able to get by without a respirator when working with allergy-inducing woods.

If you are working with a known allergen, or you happen to have very reactive skin, you might be tempted to wear long sleeves. But those can invite danger from spinning blades and bits. Instead, put a

Relatively safe woods

There is a wide range of woods that cause limited reactivity in humans and pets. Generally light-colored and moderately dense, these include the hard and soft maples, many temperate oaks, and a variety of other North American and European deciduous trees, including fruit woods like cherry and apple (but not olive wood).

Conifers are a mixed bag—Coniferous trees (softwoods) can be broken into two groups, those that often contain resin canals, and those that do not. The resin, or pitch, can be irritating to the skin of sensitive people, and especially children, and should be avoided in toys if possible. Resin is also problematic in cookware, where it can leach out when the wood is exposed to repeated drying and wetting cycles.

The pines, spruces, larches, and Douglas fir all routinely contain resin canals. While the cedars, true firs, and hemlock are far more free of resin, that doesn't mean they're any better for projects that receive hard use. Some are just too soft, and most are prone to splintering.

Two great choices for food- and kid-related items—Two woods that check all the boxes for high wear, child safety, and food contact are hard maple and beech.

***Acer saccharum,* often called hard or rock maple, is the creamy white, medium-density wood frequently used for furniture, flooring, and cabinetry. It's also great for children's toys, including those used for teething. Hard maple is tapped for maple syrup, a good indication that whatever extractives it has are benign to humans.**

European beech (*Fagus sylvatica*), a durable, pale to silvery hardwood, is another favorite for high-end toys and furniture, and a classic choice for school furniture. The related "southern beeches" (*Nothofagus*) and American beech (*Fagus grandifolia*) are put to similar uses.

BENIGN WOODS

- Apple
- Ash
- Alders (but not black alder)
- Aspens
- Basswoods (American and European)
- Beeches (American and European)
- Cherry
- Chestnut
- Maples (sugar maple, red maple, big leaf maple, silver maple, etc.)
- Firs (true firs, not Douglas fir)
- Pear
- Poplars
- Red oaks
- White oaks

layer of unscented lotion on your exposed skin before heading into the shop.

And think about the end user. Any wood product meant for hot and/or wet environments should only be made with the relatively safe, light-colored woods listed above, which have low extractive content. For dry projects made with toxic or allergy-inducing woods, you can protect users by applying a film-forming finish that completely seals the wood.

Cutting boards made from dark woods, including tropicals but also walnut, should have multiple coats of a hardening oil on them to minimize exposure to their extractives. Mineral oil and other edible oils, which never fully dry, won't do the job.

For more information on wood safety, check out my book, *Living with Wood: A Guide for Toymakers, Hobbyists, Crafters, and Parents* (Schiffer, 2020).

Seri Robinson, PhD, is a professor of wood anatomy, an avid woodturner, and the author of numerous books on turning, spalting, and wood technology.

Woods that irritate and build allergies

Exposure to any wood species can build to an allergy over time, at least theoretically, but there are definitely some species that drive more reactions than others. The list includes most of the aromatic woods, especially those sold under the "cedar" umbrella.

In fact, almost all tropical woods sold commercially are known allergic sensitizers—as are many other woods with dark or bright colors—meaning they can cause both contact dermatitis and respiratory issues. A few of the lighter-colored woods cause these problems as well, at least for some people, butternut and Douglas fir among them.

Spanish cedar has a troublesome extractive—Spanish cedar is a sub-tropical hardwood frequently used for cigar humidor linings.

As you might guess from its species name, *Cedrela odorata*, Spanish cedar has aromatic extractives, including cedrol, which is common to many true and false cedars. While there are no serious ingestion or skin reactions from cedrol (it's approved by the FDA as a flavoring component), the smell has a sedative effect and can induce sleep. Obviously, drowsiness is not ideal in a workshop.

Cedrol is also an allergen for many people, credited in 2016 with making a sizable portion of the FBI sick when a large, unfinished cedar sculpture was placed in the bureau's headquarters.

Take care with teak—Teak (*Tectona grandis*) is a tropical wood used primarily for decking and outdoor furniture these days, due to its heavy load of extractives and natural durability.

Many of the extractives in teak are bioactive. Some of these are just general irritants, but there are numerous reports of teak allergies, and its extractives, notably deoxylapachol and lapachpol, have caused hives in some people. Teak also contains silica, which can irritate airways when it becomes airborne during machining and sanding.

Black walnut is still a question mark—Black walnut (*Juglans nigra*) works as beautifully as it looks, and is often used for furniture, cutting boards, cooking spoons, cabinetry, and children's toys. But walnut heartwood causes contact dermatitis in some people, and one of its extractives, "juglone," is a known carcinogen. While juglone does not readily extract from walnut heartwood via cold or hot water, many other yet-unidentified extractives do come out with water contact. That means they are easily transferred to woodworkers who breathe walnut dust.

So while juglone may not be a concern for food contact and teething toys, research needs to be done on the walnut extractives that are water-soluble.

By the way, all species of the walnut family produce juglone—including butternut, the hickories, and pecan—but black walnut has the most by far.

ALLERGIC SENSITIZERS

Note that some of the following woods are also toxic to all humans (see section on toxic woods)

- Afromosia
- Black limba
- Black walnut
- Bloodwood
- Bubinga
- Camphor
- Canarywood
- Cedars
- Dark cumaru
- Ebonies
- Ipé
- Iroko
- Jatoba
- Lacewood
- Leopard wood
- Mahoganies (genuine, khaya, Philippine)
- Makore
- Osage orange
- Padauk (a.k.a. padouk)
- Purpleheart
- Redwood
- Rosewoods
- Rubberwood
- Santos mahogany
- Sassafras
- Sapele
- Shedua
- Spanish cedar
- Teak
- Tigerwood
- Wenge
- Yellowheart
- Zebrawood

Woods with known toxicity

There are a number of woods that present documented toxicity to humans. We lack research on humans for many other woods with high extractive loads, but we find enough evidence of toxicity in animal studies to add some of them to the toxic list. The use of certain woods in traditional medicine can be another warning sign. Based on these types of evidence, the woods listed at right are dangerous choices for toys and cookware, and woodworkers should protect their skin, faces, and airways when milling and sanding them.

TOXIC WOODS

- Camphor
- Canarywood
- Ceylon ebony
- Cocobolo
- Lacewood (Allanblackia floribunda)
- Redwood
- Rosewood (Dalbergia latifolia and Dalbergia sissoo)
- Sassafras
- Zebrawood

Toxicity can take many forms. Redwood, for example, while mostly harmless to the end user, presents unique toxicity and allergy issues to the woodworker. A known sensitizer, it can cause asthma or even tachycardia in those who mill it without protective measures in place.

Rosewoods range from troublesome to toxic—"Rosewood" is a catch-all trade name applied to numerous tropical species with a deep reddish-brown color, used for their showy impact in knife handles, decorative boxes, and furniture. Both true and false rosewoods have a lot of bioactivity. At the very least, exposure can build to an allergic response over time.

The extractives of Braziian and East Indian rosewood, *Dalbergia nigra* and *Dalbergia latifolia,* are under investigation for their pharmacological properties, and some extracts of *D. latifolia* are cytotoxic (toxic to living cells). The extractives in the bark of *Dalbergia sissoo* have been shown to decrease sperm count and sperm motility (movement). And *Acacia melanoxylon* (often sold as rosewood) is well known as not only a cause of contact dermatitis, but asthma as well.

Sassafras has a dangerous extractive—Sassafras contains safrole, an ingredient historically used in root beer, soaps, and other fragrances. The FDA lists safrole as a carcinogen, and it has caused liver damage in rats. It also appears to be genotoxic, with the potential to damage DNA and chromosomes.

Like most extractives, safrole can be transferred to woodworkers who breathe the dust of sassafras, and carried out of the wood in water or other liquids. So it's very dangerous in cookware, home-brew root beer, and children's toys. Finished projects, however, pose little danger.

Avoid camphor altogether—One toxic wood to be very wary of is camphor laurel (*Cinnamomum camphora*). Camphor wood has many bioactive compounds and a long history of use in traditional medicine. Its main extract, camphor, exists in the wood and bark, but is usually extracted from the latter, where it is more heavily concentrated. Camphor is also an ingredient in modern medicine, in topicals like vapor rubs and other ointments.

The USDA restricts the amount of camphor extractives and oils in products, as ingestion and over-application can cause severe distress and death in children. It can have severe effects on adults as well, such as tremors, seizures, apnea, coma, and even death.

Camphor can also affect sperm motility, and it can reduce milk production in lactating mothers, induce abortion, and affect embryo development. Camphor also contains safrole, the same carcinogen found in sassafras.