Wood Hazards

From BME Encyclopedia

This article is courtesy of Michael Sims and Erica Skadsen:

> With the proliferation of wood jewelry manufacturers on the market, Esoteric Body, Organic LLC, and Spectrum Craft have been working in partnership to study various chemical compositions of individual hardwoods and their effects on the human body, in hopes of providing you with some information that could assist you in your wood jewelry selection. Over the past few years we have undertaken extensive research on wearable hardwoods and have found numerous woods not to be suitable. These potentially harmful species have documented medical reactions that may result in contact dermatitis. We're not talking about respiratory reactions to sawdust, but rather skin reactions due to direct contact with the wood. It amazes us that jewelry manufactures don't take the responsibility to research their products before they offer them to you the public; few even know the scientific names of the species they use. This message is not intended to inflame nor is it directed to any specific manufacturing companies, but rather we hope for it to be an aid to you and a guide with which you can use to navigate the vast jewelry market. We just felt the need to pass along information that we have gathered as we hope it could prevent hardwood jewelry enthusiasts from having an unnecessarily bad experience with wood. We encourage you to undertake your own research, to find your own answers. We caution you not to believe a product is safe just because someone offers it to the public. Many manufactures pick their woods because they are pretty but often they know little about the wood itself. There are many wearable woods out there that are very safe, but unfortunately there are also many hardwood species that are simply not safe to wear.

Contents

Health Concerns and Risks

With the ever increasing amount of suppliers trying to break into the wood jewelry market, it has become a necessity to supply the industry with this helpful guide to choosing safer wood products by knowing what the hazards are. While most of the research available to woodworkers is a good starting point, it was not designed as a guide to wearable woods. The problem is that the research is specific to wood dust and not actual skin contact with wood. Wood dust produces an extremely large amount of surface area, which has the potential to produce much more extreme reactions than exposure to the amount of surface area that is in contact with the skin in the case of worn wood.

Interestingly, most research seems to be reported based on only a few case studies, many of which go back up to 100 years, some of which only list common names and not specific species; these results are not obtained by clinical studies with large sample groups. However, these isolated cases should not be entirely dismissed; they are very interesting in showing patterns of cross-sensitivities, and many have been accompanied by positive patch tests from extracts of the offending compounds.

Only 2% to 5% of the population will develop an allergic sensitivity to one or more compounds found in wood. Contact dermatitis from timbers is usually attributable to contamination of the skin during machining. Handling of solid wood rarely induces dermatitis, however any species that contains quinones, especially Dalbergia species, may do so. (Calnan 1972).[1]

"The structural components of wood are cellulose, hemicellulose, and lignin, but it is the accessory substances or "extractives" found mainly in the heartwood that are responsible for most toxic effects. Vorreiter (1949/1958) classifies these as follows: 1) fats, resins, oils, and waxes; 2) proteins, gums, latex, mucus, starch, and sugars; 3) alkaloids, bitter principles, dyes, tannins, glycosides, camphor, perfumes, etc.; 4) inorganic and organic acids and salts; 5) minerals."[1]

"Some of these act as food reserves for latent growth periods, some as hardening agents, and others protect against mechanical injuries or attack by bacteria, fungi, insects and larger animals (Dietrichs, 1958). Some are metabolic by-products or end-products of no apparent use to the tree."[1]

"The main effect is *irritation*." (An irritant is "something that can cause inflammation" or irritation.) ..."This can be caused by skin contact with the wood, its dust, its bark, its sap, or even lichens growing on the bark. Irritation can, in some species of wood, lead to nettle rashes or irritant dermatitis. These effects tend to appear on the forearm, backs of the hands, the face (particularly eyelids) neck, scalp and the genitals. On average, they take 15 days to develop."[2] Latency periods can range from a few hours to several months. "Symptoms usually only persist as long as the affected skin site remains in contact with the source of irritation... Symptoms subside when contact with the irritant is removed.

Sensitization dermatitis
is more problematic and is usually caused by skin exposure to fine wood dust of certain species." (Sensitization is "an allergic reaction to a substance which is usually irreversible" resulting in hypersensitivity and susceptibility to being overly responsive.) ..."This is also referred to as allergic contact dermatitis and results in similar skin effects to those produced by skin irritants. Once sensitized, the body sets up an allergic reaction, and the skin may react severely if subsequently exposed to very small amounts of the wood dust. Cross-sensitization may develop where other woods or even non-wood materials produce a similar response."[2]

Allergic Response

An allergy is basically the negative health effects which result from the stimulation of specific immune responses. Allergic contact dermatitis is a form of delayed-type hypersensitivity reaction which is dependent upon cell-mediated immune function and the activity of T lymphocytes. The most frequent form of allergic reaction is to small molecular weight materials such as chemicals and proteins. These reactions are better known as contact hypersensitivity, skin sensitization, and allergic contact dermatitis.

This occurs in 2 stages:

Stage I (Induction Phase): Initial contact may result in the allergen penetrating the stratified squamous epithelial cells of the skin and binding to large dendritic (branched) white blood cells in the epidermis called Langerhans cells. The Langerhans cell (with the allergen on its membrane) migrates to a nearby lymph node where special white blood cells, called effector T-cells, are programmed to recognize the allergen. There are literally millions of effector T-cells roaming throughout the blood and lymphatic system, each with special receptor molecules on their membranes for a particular allergenic chemical. T-cells patrol our circulatory system looking for invading cells and viruses.[3]

Stage II (Elicitation Phase): If you come in contact with the offending allergen during a subsequent encounter, an effector T-cell may encounter it bound to a Langerhans cell and attach to it by a complicated and specific recognition system. The effector T-cell then produces multiple clones and releases special proteins called lymphokines which attract a legion of different white blood cells, including macrophages and cytotoxic ("killer") T-cells. The new army of white blood cells releases cytokines or proteins which destroy everything in the vicinity including other skin cells, thus producing a blistering rash.[3]

Milder effects range from redness (vasodilation) and itching (nerve injury) to small blisters (vesicles and bullae). Stronger effects can result in anaphylaxis, which can occur in response to any allergen; while anaphylaxis occurs infrequently, it is life-threatening and can occur at any time. Risks include prior history of any type of allergic reaction.

HAZARDOUS SUBSTANCES

Quinones

The culprit behind these allergies is a group of chemicals called quinones, often used to make dyes (for example, lawsone, the active ingredient in *Lawsonia inermis* or *L. alba*
aka henna, is the red-orange colored pigment 2-hydroxy-1,4-naphthaquinone, a molecule known as hennotannic acid). These naturally occurring chemicals are

produced as defensive agents against fungal and predator attacks (including woodworkers and jewelry collectors). Though they also have potential medicinal uses in non-allergic humans, quinones play a major role in allergic contact dermatitis caused by plants.

The primary "allergens are benzoquinones or naphthoquinones but also compounds, such as catechols, coumarins, and other phenolic or flavonoid compounds, which are bioconverted [metabolized] into ortho-quinones or para-quinones." These derivatives can covalently bond to skin proteins. Since they are not recognized by the immune system, they are attacked. Catechol is a main constituent of urushiol, which is the allergen in poison ivy.[3] Certain types of coumarins can also be sensitizers when they form ortho-quinones via enzymatic oxidation within the skin.

It is possible that once sensitized to one of these quinones that cross reactions to similar quinones and/or structures can develop. Included at the bottom of this page is a list of some of the more popular woods that are not suitable to wear due to these risks. There are other hardwoods that are notorious for causing dangerous reactions (which may include surprisingly strong reactions such as cardiac and nervous system effects, cancer, and genotoxicity), such as: **afromosia** (*Periocopsis elata*), **Australian blackwood** (*Acacia melanoxylon*), **greenheart** (*Chlorocardium rodiei*), **mansonia** (*Mansonia altissima*), **sassafras** (*Sassafras albidum*), and **satinwood** (*Chloroxylon swietenia*), as well as various softwoods such as: **cedar** (*Thuja spp.*), **hemlock** (*Tsuga spp.*), **pine** (*Pinus spp.*), and **yew** (*Taxus spp.*); however, these are not discussed here because we have fortunately not seen their attempted use in body jewelry.

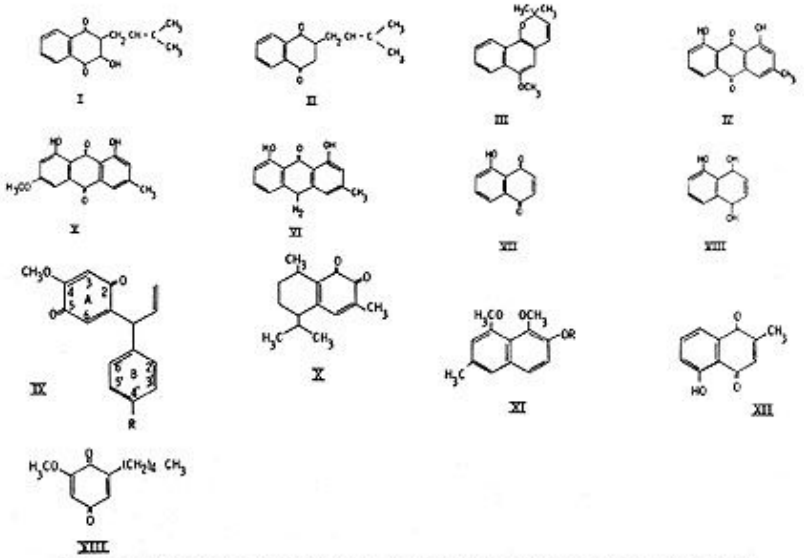

FIGURE 3. Quinones and related substances. I. Lapachol; II. Desoxylapachol; III. Lapachenol (lapachonone); IV. Chrysophanic acid; V. Physcion; VI. Chrysophanic acid anthrone; VII. Juglone; VIII. α-Hydrojuglone; IX. Dalbergiones (4-methoxydalbergione: R = H; 4,4'-dimethoxydalbergione: R = OCH_3; 4'-hydroxy 4-methoxydalbergione: R = OH); X. Mansonone-A; XI. Makassars (makassar II: R = H; makassar III: R = CH_3); XII. Plumbagin; XIII. Primin.

Other compounds

Some of the other compounds that are known to cause harmful responses include: alkaloids and glycosides (systemic effects, pharmacological rather than allergic), saponins (effective through broken skin only), phenols (the strongest skin-sensitizers, especially the catechols of the poison-ivy family), stilbenes (which occur in allergenic woods, but only chlorophorin and coniferyl benzoate are known to sensitize), terpenes (including delta-3-carene from turpentine, sesquiterpene lactones and other sensitizing liverworts found on bark, and euphorbol and other complex terpenes of uncertain toxicity found in the latex of Euphorbiaceae), coumarins and furocoumarins (photosensitizing and may be partly responsible for skin reactions but has yet to be proven), and dalbergiones (severe skin irritants).

List of popular woods to avoid, to minimize the risk of adverse effects.

Most of this information is taken from: *Botanical Dermatology: Plants and Plant Products Injurious to the Skin.*[4]

We will continue to expand this list as we further our research. Note that we are listing research specific to the heartwood of trees; toxins can be found in a species that is not found in its wood. For example, cyanide is found in apple seeds, but the fruit is edible, even though it is in close proximity to this toxin. "Toxic activity is specific to a wood species. Knowing the exact species is important in establishing what the potential toxic effects may be. Individual wood species... are very easily confused. For example, 'rosewood' may be used for up to 30 different species; and an individual species may have up to ten different trade names (Hausen 1981). An additional difficulty is that trees vary within a species. One specimen may contain low levels of its toxic agent and the next contain much higher levels. So experience may not be a reliable guide."[5]

- *Dalbergia spp*: (**Rosewoods**) "The discovery of sensitizing quinones in other woods such as teak...led Schulz and Dietrichs (1962) to look for similar substances in Dalbergia nigra and Dalbergia retusa. They found three quinones which they called Dalbergia quinones A, B and C, and demonstrated by patch tests on patients that these were the sensitizers, the strongest being R-3,4-dimethoxydalbergione... They have now been found in most other Dalbergia spp."[4]
- *Dalbergia cearensis*: (**Kingwood, de Violette, Violet Wood, Violetta**) contains a dalbergione, described as a very severe skin irritant, often leading to persistent ulceration.[4]
- *Dalbergia cochinchinensis*: (**Laos Rosewood, Thai Rosewood, Cochin Rosewood**) contain R-4-methoxydalbergione and other quinones.[4]
- *Dalbergia congestiflora*: (**Mexican Kingwood**) contains a dalbergione.[4]
- *Dalbergia cultrate*: (**Burmese Rosewood**) contains a dalbergione.[4]
- *Dalbergia decipularis and Dalbergia frutescens*: (**Tulipwood**) contains a dalbergione.[4]
- *Dalbergia latifolia*: (**East Indian Rosewood, Sonokoling**) contain R-4-methoxydalbergione and other quinones.[4]
- *Dalbergia maritime*: (**Madagascar Rosewood, Bois de Rose**) contains a dalbergione.[4]

- *Dalbergia melanoxylon*: (**African Blackwood**) contains several quinones including S-4'-hydroxy-4-methoxydalbergione and S-4-methoxydalbergione.[4]
- *Dalbergia nigra*: (**Brazilian Rosewood**) contains R-4-methoxydalbergione and other quinones.[4] Also endangered.
- *Dalbergia retusa*: (**Cocobolo**) contains S-4'-hydroxy-4-methoxydalbergione, R-4-methoxydalbergione, obtusaquinone, and other quinones and phenols.[4]
- *Dalbergia stevensonii*: (**Honduran Rosewood, Nagaed Wood, Palissandre Honduras**) contains a dalbergione.[4]
- *Acer saccharum*: (**Sugar Maple**) "This species has been found to contain 2,6-dimethoxy-1,4-benzoquinone which is a known contact allergen."[7]
- Betula *spp*: (**Birch**) contains salicylates such as methyl salicylate, cross-sensitivities could occur in those with aspirin allergies. Birch also listed as sensitizer.[5]
- *Cinnamomum camphora*: (**Camphorwood**) The wood contains camphor and borneol. Following cases of serious toxicity and even death in children, products containing more than trace quantities of camphor have now largely been withdrawn from the market (Reynolds 1996). "Can cause dermatitis and shortness of breath" and camphor causes mild heart stimulant activity. Topically applied, it can penetrate the skin.[4]
- *Cordia dodecandra*: (**Zericote, Ziricote**) Cross reactions are possible with this species once sensitivity to R-3,4-dimethoxydalbergione (found in pao ferro and Dalbergia species), obtusaquinone (found in cocobolo), and macassar quinone (found in macassar ebony) have developed.[4]
- *Cordia elaeagnoides*: (**Bocote, Becote**) Cross reactions are possible with this species once sensitivity to R-3,4-dimethoxydalbergione (found in pao ferro and Dalbergia species), obtusaquinone (found in cocobolo), and macassar quinone (found in macassar ebony) have developed.[4]
- *Diospyros celebica*: (**Macassar Ebony**) contains macassar II, a ß-naphthol "derivative that may become oxidised in vivo to macassar quinone. This compound has been shown to have sensitizing properties... Cross-sensitivity to other naphthoquinones" (three found in zericote, pao ferro, cocobolo, becote, and padauk) are possible.

  "Later testing confirmed sensitivity to R-3,4-dimethoxydalbergione (found in pao ferro), obtusaquinone (found in cocobolo), and macassar quinone (found in macassar ebony)."

  Wood of this species is one of the only ones that these substances have been proven to be found in.

  "The yellow naphthoquinone pigment, plumbagin (methyl juglone) occurs in a colourless combined form and is liberated from root tissue by acid treatment. (Harborne 1966)... Plumbagin is also found in some species of the families Droseraceae, Ebenaceae, and Euphorbiaceae (Thomson 1971).... Plumbagin has an irritating odor and causes sneezing; it stains the skin to a purple color and has a vesicant action."[4]
- *Guibourtia tessmannii*: (**Bubinga**) "Dermatitis, possibly caused by sensitizing quinones."[6]

- *Machaerium scleroxylon*: (**Pau Ferro**) has R-3,4-dimethoxydalbergione[7], a strong sensitizer and irritant. It can cause dermatitis, itching, swelling, redness of face, scrotum, and hands.[4]
- *Milletia laurentii*: (**Wenge**) can have central nervous system effects, give dermatitis, irritate skin, is listed as a sensitizer, and is oily.[5] Wenge contains 2.6-dimethoxybenzoquinone.[7]
- *Peltogyne densiflora*: (**Purpleheart**) "Dalbergiones have been isolated from the wood."[4]
- *Pterocarpus soyauxii*: (**Padauk**) can cause irritation of the skin, dermatitis, and sensitization. It can have naphthoquinones. Cross-sensitivity may occur with use of bocote when sensitivity has been developed to related quinones.[5]
- *Salix spp*: (**Willow**) contains salicin, a phenolic glucoside, and is a precursor of aspirin; also has saligenin, a known contact allergen. Willow is also listed as a sensitizer.[5]
- *Tectona grandis*: (**Teak**) The "dermatic compounds" (sensitizers) lapachol (aka tecomin, a quinone), desoxylapachol, and lapachonole (aka lapachonone) where found in Tectona wood.

  Lapachol has been called "a known elicitor of contact dermatitis" and a "sensitizing agent."
  "Deoxylapachol and lapachenole...are potent contact allergens."
  "Local races of teak and even individual trees vary greatly in desoxylapachol content."
  "Lapachenole has been shown to be both irritant and sensitizing" by Sandermann & Barghoorn (1955). "Indonesian natives have long distinguished three grades of the wood, the poorest (Djati sempoerna) being liable to cause skin irritation."[4]
- *Tetraclinis articulata*: (**Thuya Burl**) The heartwood of this species is known to contain several dermatologically active compounds including thymoquinone, carvacrol, and ß- and ?-thujaplicins.[4]

Other wood related products

Dymondwood(R) is a manufactured plywood product consisting of laminated layers of hardwood (likely birch) veneer which have been colored with mono-azo acid dyes and then compressed under intense heat and pressure with phenol formaldehyde resin into a dense, durable, highly polished material. Interestingly, Bakelite, a type of early thermoset synthetic resin, is a polymer of phenol with formaldehyde. Many Dymondwood(R) varieties go by cute trade names, but it can usually be identified by it's appearance as a brightly colored wood product with consistently spaced stripes in contrasting colors not normally appearing in untreated wood. Besides cropping up periodically in the body piercing world as earplugs, it is common to find it utilized in other products such as pipes and bracelets.

Phenol, also known as carbolic acid or hydroxybenzene, is toxic and corrosive. The dangers posed by formaldehyde, including it's role as a carcinogen, are also substantial. According to the MSDS for Dymondwood(R), "Phenol and formaldehyde may be released in small quantities from product under normal conditions." "Some people may develop dermatitis from repeated and prolonged exposure to unfinished product." "Laboratory data indicates that certain acid dyes may be mutagenic in animals."[8]
The azo dyes (azo is a chemical compound containing one pair nitrogen atoms with a double bond between them) may release aromatic amines if the azo linkages are broken down via enzymes, or possibly via heat and photochemical reactions, though intact azo dyes are unlikely to be absorbed by the skin. However, these aromatic amines have been linked to serious long-term health effects, including links to cancer in humans, so the possibility of their presence is of grave concern. Incidently, azo dyes are sometimes used as pigments in tattoo ink.

Unfortunately, dyes are also commonly used overseas to make lighter woods appear as black ebony. These commonly include aniline or PPD. **Aniline** is a blood toxin that is easily absorbed through the skin, which may cause allergic skin reactions and irritation, contact dermatitis, sensitization, is a possible carcinogen, and is considered very toxic to terrestrial and aquatic life.[9] **PPD** (para-Phenylenediamine, aka para-Aminoaniline, 1,4-Benzenediamine, or 1,4-Diaminobenzene), is an aromatic amine dye, used to color hair, and used extensively in SouthEast Asia to apply temporary black "henna" "tattoos." It is easily absorbed through the skin, and has been called a significant allergen and toxin. It can cause allergic contact dermatitis, cross-sensitization to other chemcals, rash, blisters, chemical burns, permanent skin changes such as scarring, renal failure, anaphalactic shock, or even death.

Conclusion

After lengthy research we have put together this guide to help educate shop owners, end users, and hopefully some of the manufacturers producing potentially dangerous products. While reactions will not occur in all individuals, they can range from irritating to life-threatening, and the possibility that these effects may be elicited, along with the risk of becoming cross-sensitized to other materials, should be taken very seriously. It is up to you to be informed about what you are buying and putting into contact with the human body. Wood jewelry is one of the most comfortable and grounding materials we have available to us, and can be both an aesthetically pleasing and safe material if potential hazards are idenfied, understood, and avoided.

Footnotes

1. Woods, Brian and Calnan, C.D. "Toxic Woods." *British Journal of Dermatology*, Supplement 13, 1976.

2. Kimber, Ian and Maurer, Thomas. *Toxicology of Hypersensivity*. CRC Press, 1996.

3. Lepoittevin JP, Benezra C. "Allergic contact dermatitis caused by naturally occurring quinones." *Pharmaceutisch Weekblad Scientific Edition* 1991 June 21;13(3):119-22. Review.

4. Mitchell, John and Rook, Arthur. *Botanical Dermatology: Plants and Plant Products Injurious to the Skin*. Greengrass, 1979. Summary also available at [1] (http://bodd.cf.ac.uk)

5. HSE (http://www.hse.gov.uk) Information Sheet: *Toxic Woods, Woodworking Sheet No. 30 (http://www.hse.gov.uk/pubns/wis30.pdf)* , reprinted December 2003.

6. Author unknown. *World of Wood*. March 2000: 8-12.

7. Schulz, KH, Garbe, I, Hausen BM, and Simatupang, MH. "Sensitizing capacity of naturally occurring quinones. V. 2,6-Dimethoxy-p-benzoquinone: occurrence and significance as a contact allergen." Contact Dermatitis, Volume 4, August 1978: 204-213, and Archives of Dermatological Research, Volume 264, Number 3, January 1979: 275-286.

8. MSDS Dymondwood(R).

9. MSDS Aniline (http://www.uiowa.edu/%7Echemsafe/MSDS/Aniline.htm)

Additional References

- Author unknown. *American Woodturner*. June 1990. Also available online; it has been quoted, modified, and reposted on numerous websites.
- Hausen BM (1981) *Woods Injurious to Human Health: A manual.* Berlin: Walter de Gruyter & Co., 1981.
- MSDS p-Phenylenediamine.