

# Evidence stacks up for poisonous books containing toxic dyes

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Leila Ais cuts a sample from a book cover to test for toxic dyes. Credit: Kristy Jones

If you come across brightly colored, cloth-bound books from the Victorian era, you might want to handle them gently, or even steer clear

altogether. Some of their attractive hues come from dyes that could pose a health risk to readers, collectors or librarians.

The latest research on these poisonous books used three techniques—including one that hasn't previously been applied to books—to assess dangerous dyes in a university collection and found some volumes may be unsafe to handle.

The researchers present their results at the fall meeting of the [American Chemical Society](#).

"These [old books](#) with toxic dyes may be in universities, public libraries and private collections," says Abigail Hoermann, an undergraduate studying chemistry at Lipscomb University. Users can be put at risk if pigments from the cloth covers rub onto their hands or become airborne and are inhaled.

"So, we want to find a way to make it easy for everyone to be able to find what their exposure is to these books, and how to safely store them." Hoermann, recent graduate Jafer Aljorani, and undergraduate Leila Ais have been conducting the study with Joseph Weinstein-Webb, an assistant chemistry professor at Lipscomb.

The study began after Lipscomb librarians Jan Cohu and Michaela Rutledge approached the university's chemistry department to test brilliantly colored 19th- and early-20th-century fabric-covered books from the school's Beaman Library. Weinstein-Webb was intrigued to hear about how the Winterthur Museum, Garden & Library had previously examined its own 19th-century books for the presence of an arsenic compound known as copper acetoarsenite.

This emerald-green pigment was used in Victorian-era wallpaper, garments and—as Winterthur found out—in cloth book covers. This

discovery led to the launch of the Poison Book Project, a crowdsourced research effort that uses X-ray fluorescence (XRF), Raman spectroscopy and other techniques to reveal toxic pigments in books around the world. Weinstein-Webb and the Lipscomb students he recruited launched their own investigation in 2022.

For the Lipscomb book project, the team used three spectroscopic techniques:

- XRF to qualitatively check whether arsenic or other heavy metals were present in any of the book covers.
- Inductively coupled plasma optical emission spectroscopy (ICP-OES) to determine the concentration of those metals.
- X-ray diffraction (XRD) to identify the pigment molecules that contain those metals.

Although XRD has been previously used to examine paintings and wallpaper, this is the first time it has been used to check for poison in books, Ais says. The XRD testing is being done in collaboration with Janet Macdonald at Vanderbilt University.

Recently, researchers used XRF data to show that lead and chromium were present in some of the Lipscomb books. To quantify the amounts, they snipped samples roughly the size of a small paperclip from the cloth covers and then dissolved them in nitric acid.

Their analysis by ICP-OES showed that lead and chromium were both present at high levels in some samples. Subsequent XRD testing indicated that in some instances these heavy metals were in the form of lead(II) chromate, one of the compounds that contributes to the chrome yellow pigment favored by Vincent van Gogh in his sunflower paintings.

However, there was far more lead than chromium in the book covers,

which is somewhat mystifying, since lead(II) chromate contains equal amounts of lead and chromium. The researchers speculate that the dyes used to color the books contain other lead-based pigments that lack chromium, such as lead(II) oxide or lead(II) sulfide. The team is working to identify those other compounds in the yellow pigments.

Weinstein-Webb and the students also wanted to find out whether the levels of [heavy metals](#) in the Lipscomb books could be harmful for librarians who might handle them. For some of the book covers, the researchers discovered metal concentrations above acceptable limits for chronic exposure, according to standards set by the Centers for Disease Control and Prevention (CDC).

In the dissolved sample from the most contaminated cover, the lead concentration was more than twice the CDC limit, and the chromium concentration was almost six times the limit. Chronic exposure to inhaled lead or chromium could lead to health effects such as cancer, lung damage or fertility issues.

"I find it fascinating to know what previous generations thought was safe, and then we learn, oh, actually, that might not have been a great idea to use these brilliant dyes," Weinstein-Webb says.

The findings led the Lipscomb library to seal colorful 19th-century books that have not yet been tested in plastic zip-close bags for handling and storage. Meanwhile, books confirmed to contain dangerous dyes have also been sealed in bags and removed from public circulation.

Once the researchers have done some more testing, they plan to contribute their results to the Poison Book Project and to help spread awareness on safe handling, conservation and storage of these books among librarians and collectors.

They also hope others will follow their lead and begin using XRD, because it doesn't require investigators to cut samples from books. "Moving forward," says Hoermann, "we want libraries to be able to test their collections without destroying them."

**More information:** Multimodal detection of toxic metals in Victorian era book cloths as part of the Beaman library collection, ACS Fall 2024.

Provided by American Chemical Society

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