Chemists probe secrets in ancient textile dyes from China, Peru

April 1 2005

Chemists journey to Gobi region for samples, discover novel dye in textiles from Peru

Although searching for 3,000-year-old mummy textiles in tombs under the blazing sun of a western Chinese desert may seem more Indiana Jones than analytical chemist, two Boston University researchers recently did just that. Traveling along the ancient Silk Road in Xinjiang Province on their quest, they found the ancient fabrics – and hit upon a research adventure that combined chemistry, archaeology, anthropology, botany, and art.

The chemists, Richard Laursen, a professor in the Boston University Department of Chemistry, and Xian Zhang, a chemistry graduate student, have refined a technique that helps archaeologists and anthropologists identify the plant species that ancient people used to make fabric dyes. Their technique has not only provided researchers with a new, more powerful tool for analyzing previously known dye types, it also has led to the discovery of at least one never-before described dye. In addition, the BU chemists have started a catalogue of plant sample characteristics for use by dye researchers around the world.

Historically, researchers have used a hydrochloric acid mixture to extract the delicate dyes from fabrics such as wool and silk. But, according to Laursen, hydrochloric acid cleaves glycosidic linkages, the bonds that hold sugar-like molecules to many dye molecules. Without these sugars, researchers lose valuable clues to which plants were used to give the dyes

their color.

Keeping these clues intact is especially important when analyzing yellow, flavonoid dyes, not only because such dyes are chemically more delicate than red or blue dyes, but also because they can be derived from a greater variety of different plant sources -- from onion skins to pagoda tree buds.

Laursen and Zhang tested dye extraction methods using both ethylenediaminetetraacetic acid (EDTA) and formic acid instead of hydrochloric acid. These "gentler" extraction solutions leave the glycosidic linkages in place. The chemists analyzed the dye extracts using a combination of high-performance liquid chromatography, mass spectrometry, and a diode array detector to determine their solubility properties, molecular weight, and exact color absorption in nanometers.

The researchers have already put their new method to the test, even discovering a new type of dye component, a flavonoid sulfate, in textiles found with 1,000-year-old mummies in Peru.

"Nobody could have seen the flavonoid sulfate with the old method," says Laursen. "Every time we analyze something we find something new. It's really kind of exciting."

On a recent trip to China, Laursen and Zhang obtained textile samples from yet another mummy. The chemists were attending a Getty Conservation Institute-sponsored conference at Dunhuang, a town at the edge of the Gobi Desert. A site near the town is honeycombed with caves containing ancient Buddhist art. While at the conference, the BU chemists joined an expedition into the Takla Makan (the name means, "You go in, but you don't come out.") desert. Chinese researchers found the fabric at a Takla Makan burial site, and Zhang, a native of China, convinced a Chinese archaeologist to give her tiny samples of the

3,000-year-old cloth.

According to Laursen, the fabric, and the person entombed with it, are of Indo-European origin, probably linked to ancient migrations west through Central Asia. He plans a trip this spring to collect plants from Central Asia and nearby countries like Turkey, Iran, and Uzbekistan for a chemical comparison with the fabric's dye to find out more about the mummy's origin.

"The people in the area have a long tradition of making carpets and textiles," says Laursen, "there is very little known about what plants were used to dye them. We hope to fill this void by collecting as much plant material as we can."

The plant samples he collects will join hundreds of others in a dye "fingerprint" database that the BU scientists are creating for use by researchers around the globe.

"You get a characteristic spectrum of dye components," Laursen explains. "If we had this library, maybe we could figure out what was used in our Chinese samples. That type of information would be of use to archaeologists and anthropologists who are trying to figure out migration patterns and technologies of ancient people."

Source: Boston University