

Investigation into an Orchil Lichen Dye

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INTRODUCTION



Umbilicaria mammulata lichen species

Lichen dyes were widely used throughout history for textile dyeing and select species are the source of "orchil" purple. This project focused on the investigation and analysis of textile samples dyed with the *Umbilicaria mammulata* lichen. Species identification was confirmed and specific methods of dye extraction and textile dyeing were determined. Analyses included accelerated light aging, spectrophotometry, gas chromatography-mass spectrometry, and fibre optic reflectance spectroscopy. Recipes following both historical methods and contemporary recreation methods were used to create two ammonia-based dye bath solutions of urine and ammonium hydroxide, that dyed fabric samples of wool, silk and linen.



Dye solution (left) and dyeing process (right)

EXPERIMENTAL

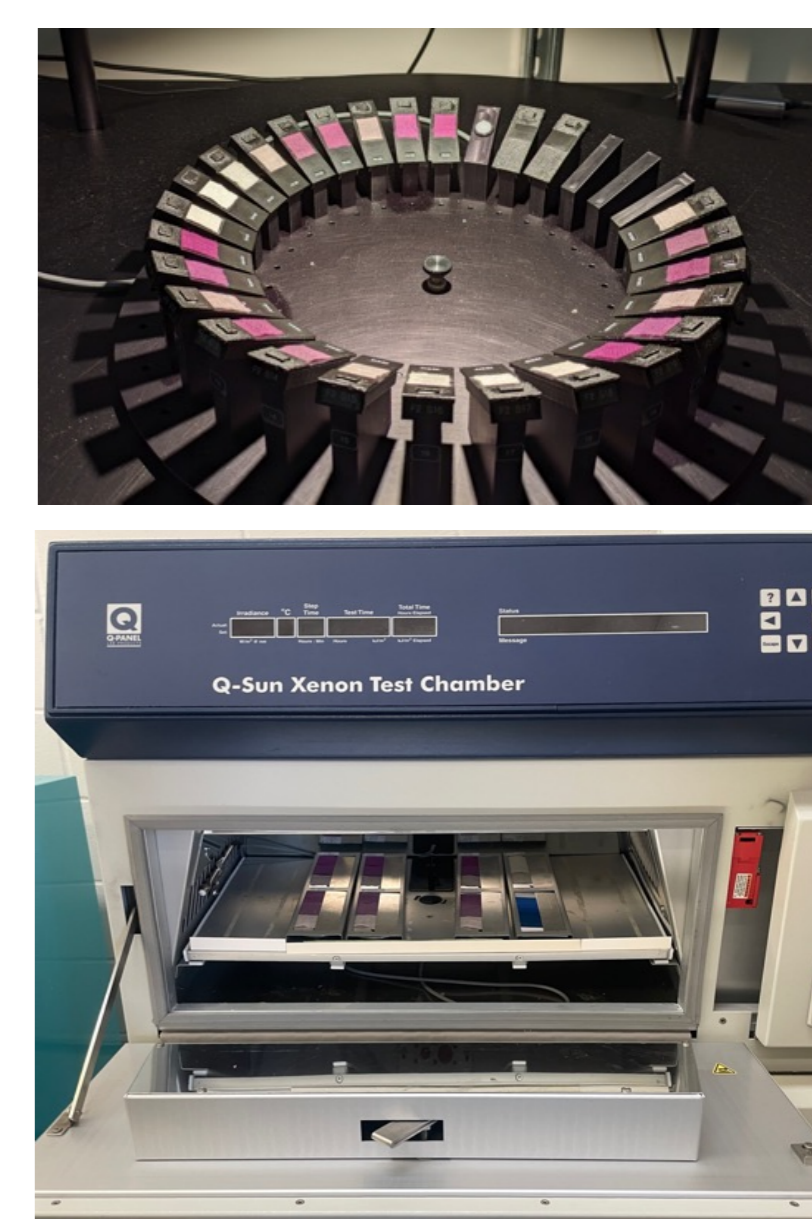
Orchil lichen species were identified and two dye baths in ammonia solutions were created over the course of four months with daily agitation. Textile samples were dyed, and their colour values documented with photography, colour spectrophotometry and Fibre optic reflectance spectroscopy (FORS).



Spectrophotometry conducted before Q-Sun accelerated aging test

Accelerated light ageing was undertaken at Queen's University using a Q-SUN test chamber and in collaboration with Eric Hagan at the Canadian Conservation Institute (CCI) in a custom LED fadeometer. Colour spectrophotometry quantified colour changes from the two different lighting conditions.

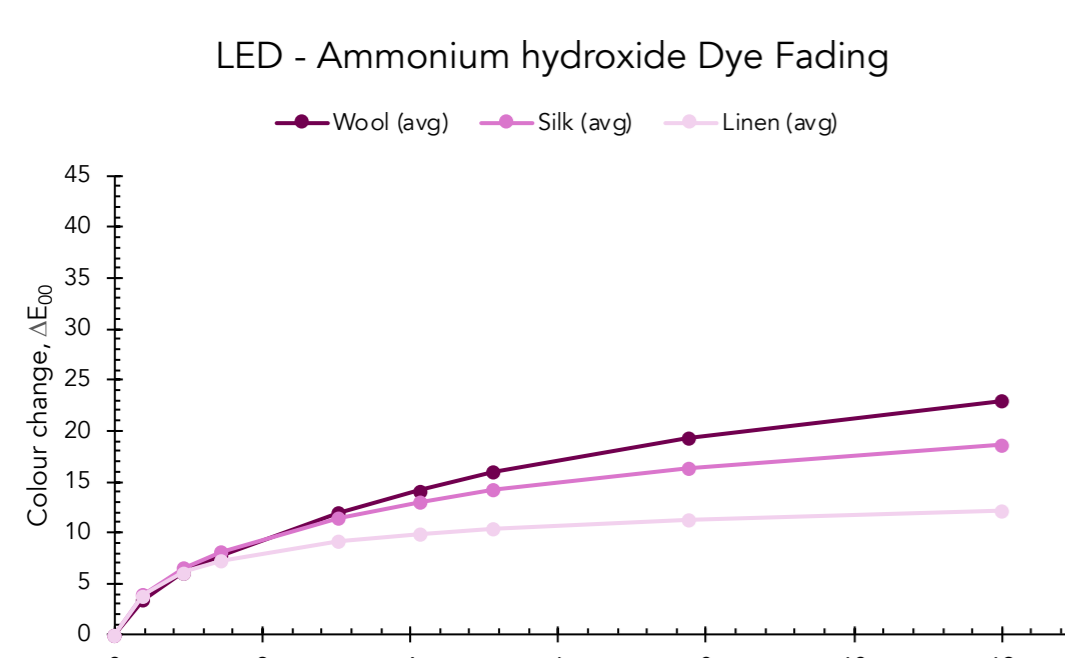
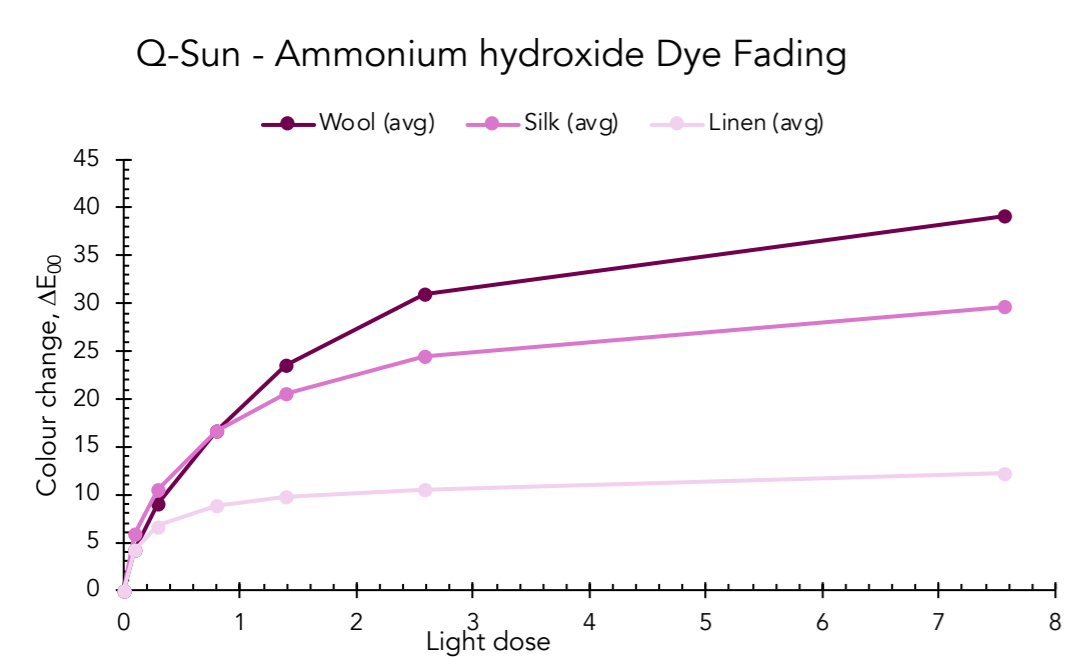
Gas chromatography-mass spectrometry (GC-MS) was done by Jennifer Poulin at CCI with a two-step extraction method to identify dye marker compounds in the textile samples and the lichen plant matter, as well as to offer any comparative dye analysis of the two ammonia-based dye bath solutions. FORS was used as a non-invasive technique to identify colourants present by their absorption band wavelength peaks in the unfaded and faded samples.



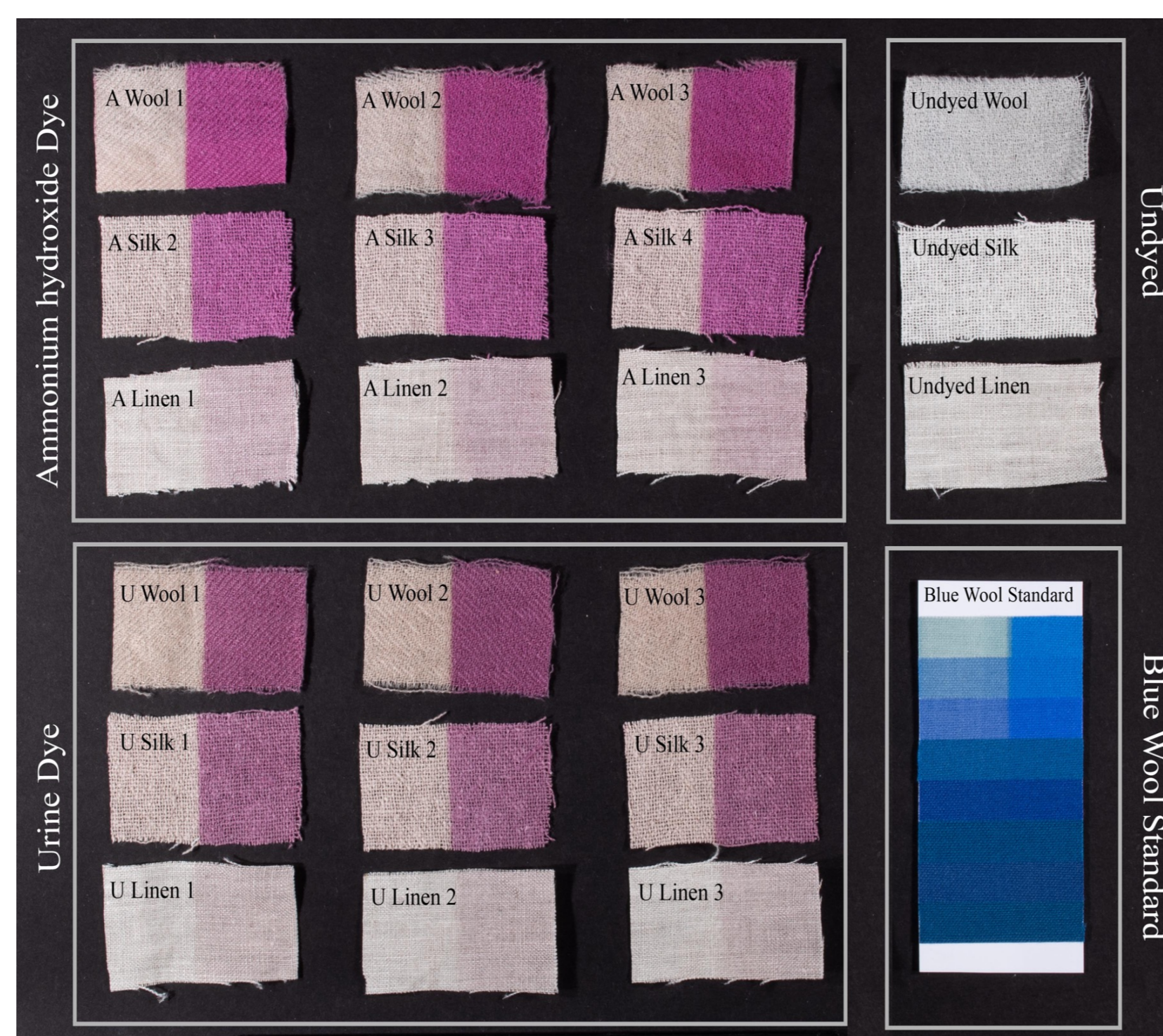
Samples in Fadeometer and Q-Sun

RESULTS AND DISCUSSION

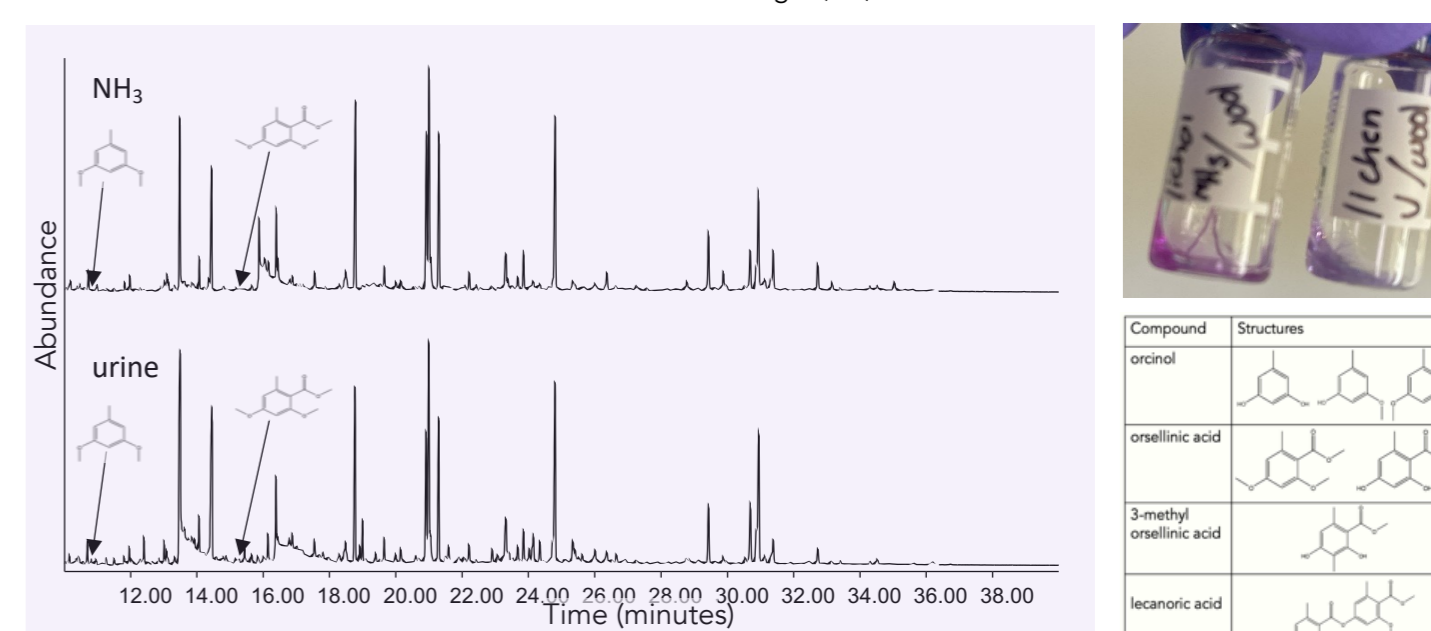
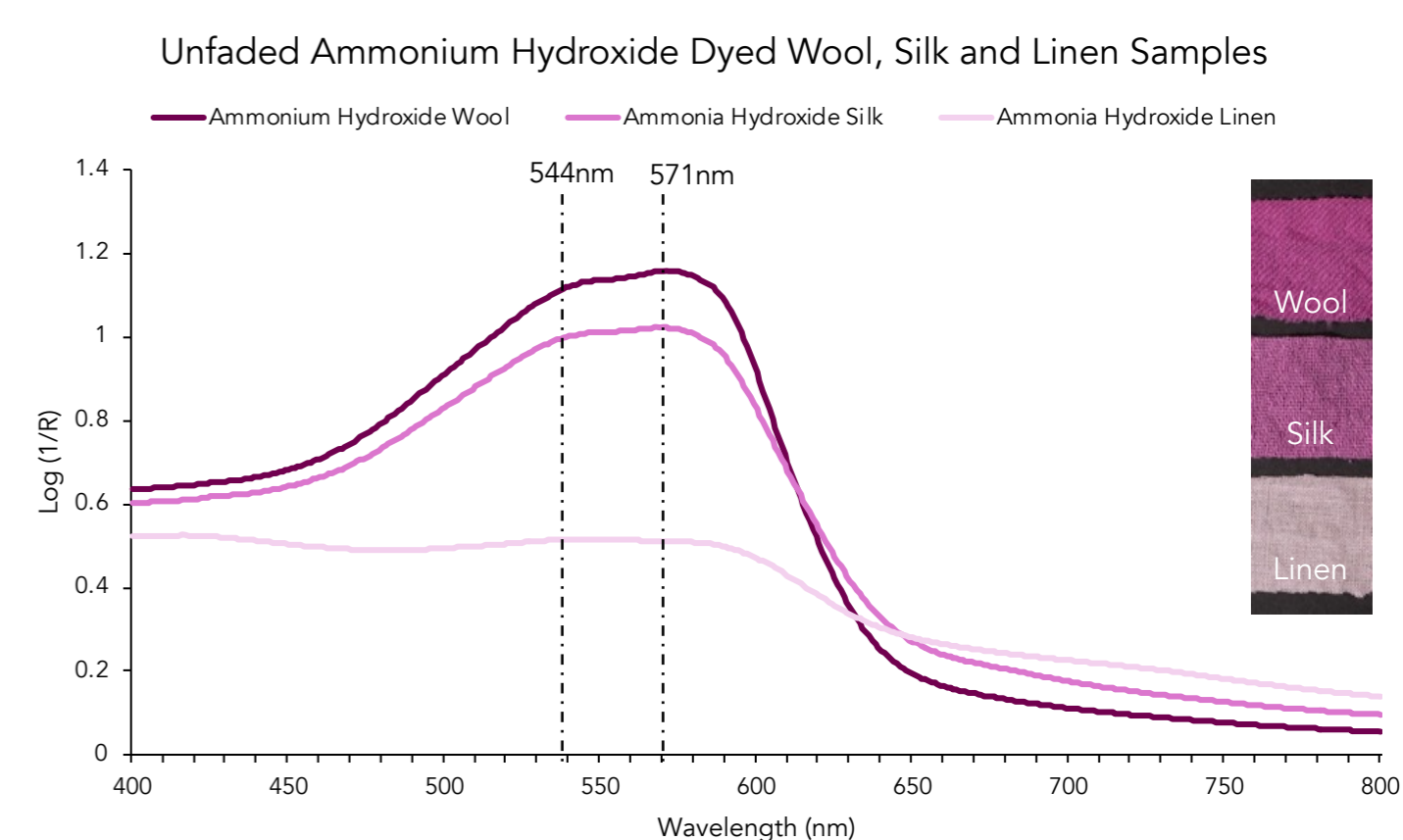
All samples faded rapidly in both accelerated aging tests, more in the Q-Sun than the fadeometer. The proteinaceous textile substrates (wool, silk) had a much higher affinity to the dye compounds than the cellulose based (linen). FORS identified peaks of 544nm & 571nm, and an inflection point of 604nm. Orsellinic acid depsides and orcinol were identified through GC-MS. Orcinol reacts with ammonia to produce orceins, the main colourant of orchil dyes.



Fading curves of dyed samples



Samples after Q-Sun aging. Left side of samples was exposed to light.



GC-MS chromatogram data for dye markers in wool sample

CONCLUSIONS

Accelerated aging tests and analysis determined that the lichen dyed samples had very low lightfastness that matched the fading rate for the most fugitive comparison, Blue Wool1. FORS revealed specific absorption bands present in the spectra in the dyed and faded samples that could contribute to the identification of this dye in textiles. GC-MS analysis determined the chemical compounds of the colourants and confirmed key components based on orcinol. This investigation into the *Umbilicaria mammulata* species contributes to the characterization of orchil lichen dyed textiles.

REFERENCES

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- Casselman, Karen Leigh. *Lichen Dyes: the New Source Book*. 2nd rev. ed. Mineola, N.Y: Dover, 2001.
- Hagan, Eric, Itxel Castro-Soto, Marianne Breault, and Jennifer Poulin. "The Lightfastness of Early Synthetic Organic Dyes." *Heritage science* 10, no. 1 (2022).

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