

# Evaluation of Consolidants for the Treatment of Red Rot on Vegetable Tanned Leather



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## INTRODUCTION

Inspired by an interest in finding both a natural material alternative as well as a successful treatment approach to powdering leather surfaces on a Native American object, a comparative study of two novel treatment materials and two established consolidants for leather with red rot was undertaken. The study focused on evaluating each material's consolidation performance, the visual and physical changes observed on the leather, and the chemical stability of the consolidant following heat and light aging.

## RATIONALE

There is a remarkable amount of objects in museums and libraries that are made in part of vegetable tanned leather due to the desirable visual and physical properties of the leather produced. Vegetable tannins, especially the condensed variety, are particularly susceptible to "red rot".

**Red Rot** is the name for the distinct acidic deterioration of the collagen fibers in vegetable tanned leather due to the hydrolysis of condensed tannins (Florian 2007). It is a fast and aggressive deterioration that is exhibited by continual powdering, reduced strength, a lowered hydrothermal stability, as well as increased acidity and red color.

Once active, however, intervention in the form of consolidation is the most common treatment.

Image below shows tearing of leather on the object affected by red rot



## CONSOLIDANTS

### Novel Consolidants

- Neri** (major components, L-rhamnose, D-galacturonic acid and D-glucuronic acid) is an aqueous mucilage most commonly extracted from the roots of the *aiyika* plant that is used in the traditional production of Japanese paper.
- Chitosan** (1-4, 2-amino-2-deoxy-β-D-glucan) is the main derivative of the natural polymer chitin, which has recently been applied in treatments of archaeological silk and paper.

### Established Consolidants

- Klucel G** (hydroxypropyl cellulose) *with Sc6000* (blend of waxes and an acrylic resin emulsified in aqueous isopropanol) is also known as the "red rot cocktail".
- Cellugel** (hydroxypropyl cellulose) is a pre-made solution of with added unknown fragrance in 100% isopropanol manufactured by Preservation Solutions Inc.

Consolidant	Concentration	Solvent	Appearance
Chitosan	0.5 % (w/v)	Deionized water/ ethanol (1:1)	Clear, slightly yellow, 5.5 pH when applied
Chitosan	0.5 % (w/v)	isopropanol	clear, slightly yellow
Neri	0.1 % (w/v)	Deionized water/ ethanol (1:1)	Clear, colorless
Cellugel	unknown	isopropanol	Clear colorless
Klucel G with SC600	2%, 1:1 ratio	isopropanol	Somewhat opaque, yellowish

## EXPERIMENTAL PARAMETERS

- Consolidants were applied to samples of red rot taken from a pair of deteriorating moccasins donated to the project.

- Consolidants were brushed onto glass slides for accelerated aging that included dry heat and light.

Consolidants were compared and ranked based on results in the following criteria:

**Performance:** observations of ease of application, visual and physical changes to the leather as well as colorimetry results.

**Chemical Stability:** changes observed in Fourier Transfer Infrared Spectroscopy results as well as yellowness and opacity changes in colorimetry.

## RESULTS

Leather Samples After Consolidant was Applied. Bottom row of each column is control. L to R: Klucel G with SC6000, Cellugel, chitosan in deionized water, neri, chitosan in isopropanol



Average overall color changes calculated for leather after consolidants were applied

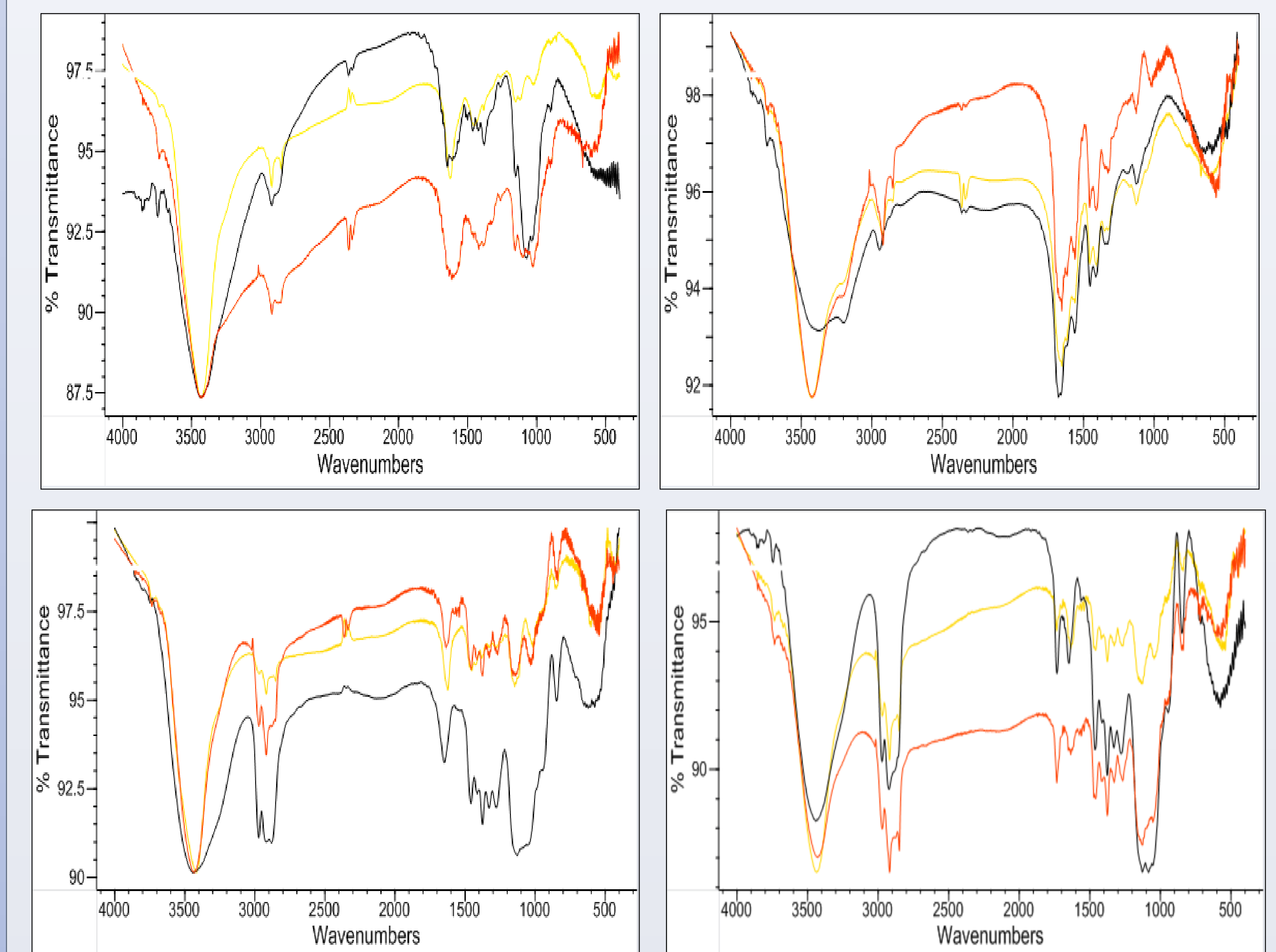
Sample	ΔL*	Δa*	Δb*	ΔE'00	ΔE'94	ΔE'76
Chitosan in H2O/ETOH	-10.80	-9.50	-18.40	13.72	15.67	23.27
Chitosan in isopropanol	-4.49	0.32	-3.21	4.13	4.86	5.55
Neri in H2O/ETOH	-9.38	-6.25	-17.02	11.91	13.28	20.54
Cellugel in isopropanol	-1.62	0.136	-1.34	1.69	1.82	2.22
Klucel G with SC6000 in isopropanol	-1.44	-0.172	-1.68	1.51	1.68	2.26
Control Variance	±0.368	±0.315	±0.845	±0.66	±0.60	±1.04

Average overall color changes calculated for slides after accelerated aging

Sample	ΔL*	Δa*	Δb*	ΔE'00	ΔE'94	ΔE'76
Chitosan in H2O/ETOH	0.39	0.24	0.7	0.86	0.93	0.96
Neri in H2O/ETOH	0.35	0.03	0.11	0.31	0.43	0.47
Cellugel in isopropanol	0.10	0.02	0.05	0.09	0.12	0.12
Klucel G with SC6000 in isopropanol	0.27	0.06	0.11	0.23	0.30	0.31
Control Variance	±0.25	±0.18	±0.15	±0.24	±0.33	±0.33

## RESULTS (CONTINUED)

FTIR spectra showing Unaged (blue), heat aged (red) and light aged (yellow) for each consolidant. L to R: chitosan, neri, Cellugel, and Klucel G with SC6000



## DISCUSSION

- Neri has a stringy quality that is difficult to apply. The leather darkened and denatured upon application. Neri would not solubilize in any solvent other than water, which is not appropriate for leather. However, neri did show high level of stability to heat and light aging.
- When chitosan was applied to the leather, there was minimal appearance change and the leather was adequately stabilized. Unfortunately, chitosan showed the greatest amount of chemical instability. Both light and heat aging produced yellowing and lightening.
- Both Klucel G with SC6000 wax and Cellugel were easy to apply and consolidated the leather. Cellugel produced the least amount of color change when applied to the leather. It also had the least amount of color change after heat and light aging. Changes in the FTIR spectra of Klucel G and Cellugel may indicate chain scissioning.

## CONCLUSIONS

Although neri proved to have excellent chemical stability, it is not recommended for leather due to unavoidable water content and unsatisfactory working properties. Though chitosan had no adverse effects towards the appearance and feel of the leather, it is not recommended as a consolidant until further research is conducted on its chemical stability. The Klucel G with SC6000 mixture had great application properties but the wax component is questionable due to the opacity change of the aged wax. Cellugel demonstrated the most desirable properties in performance and chemical stability; therefore it was selected as the consolidant for the treatment on the Native American object. Experimental results indicate that the natural materials evaluated may be recommended as alternatives to synthetic consolidants following additional research

## Author Information



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