Gellan Gum Residues and the Effect of Calcium Acetate Content

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Introduction

Rigid polysaccharide gels are a relatively recent entry into the paper conservator's repertoire. Gels are an effective technique for spot cleaning, removal of auxiliary supports, and overall washing as a replacement for immersion baths on objects with soluble media. Gellan gum, one of the main gels used in paper conservation, leaves more residue on the object than other gel treatments when applied without an intermediary tissue layer. This study explored how calcium acetate content influences the residue in 2% w/v gellan gum and whether higher concentrations of calcium acetate cause the residue to become harmful over time. The research also integrated a comparison of three gellan gum formations available to conservators: Kelcogel CG-LA, Kelcogel F, and Ticagel L-6.

Experimental

Analysis:

Measured before gel treatment, after gel treatment, and after aging:

- Ultraviolet and Visible Light Imaging, Foster and Freeman VSC 8000
- Spectrophotometry, Konica Minolta Handheld Spectrophotometer
- Fourier Transform Infrared Spectrometer (ATR), Thermo Scientific Nicolet iS5

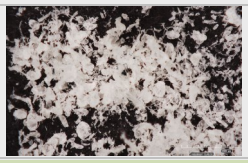
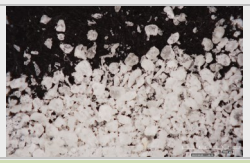
Materials:

Paper

- Whatman Filter
- Arches Aquarelle Watercolor (HP)
- Mohawk Superfine White

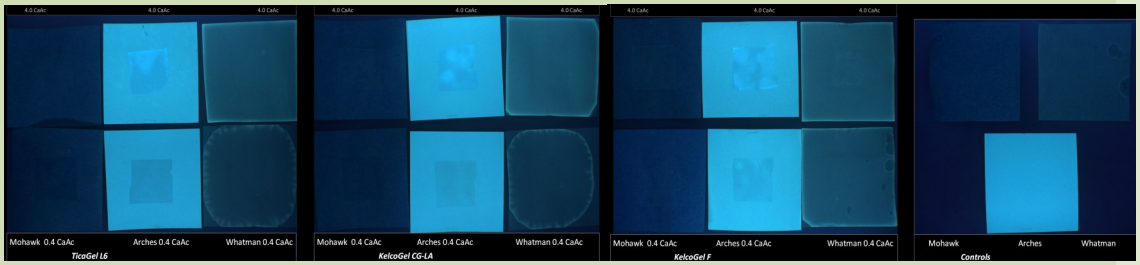
Methods:

- Low Acyl Gellan Gum: 2% g/L for all gels
- Calcium Acetate Concentrations: 0.4 g/L or 4.0 g/L
- Artificial Aging: 3 weeks at 80°C ± 2° and 65% RH ± 2%

Gels	KelcoGel CG-LA	Ticagel L-6 by Ingredion	KelcoGel F
Particles			

Results & Discussion

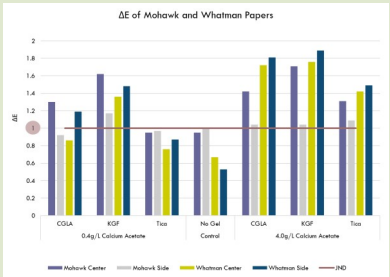
Ultraviolet Imaging

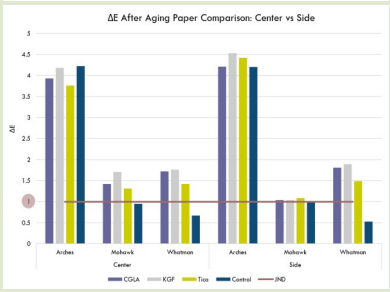


- The gels with 4.0 g/L calcium acetate completely wet-out the Whatman paper, while those with 0.4 g/L calcium acetate did not, consequently exhibiting a tideline ring at the wet-dry interface.
- KGF seems to leave more residue than the other gels.
- **The overall trend showed the 4.0 g/L concentrations of calcium acetate left more residue than those of the 0.4 g/L.**
- The Whatman paper with KGF 0.4 g/L more closely resembled the 4.0g/L Whatman papers (all three) than to the other two 0.4g/L Whatman papers.

Spectrophotometer

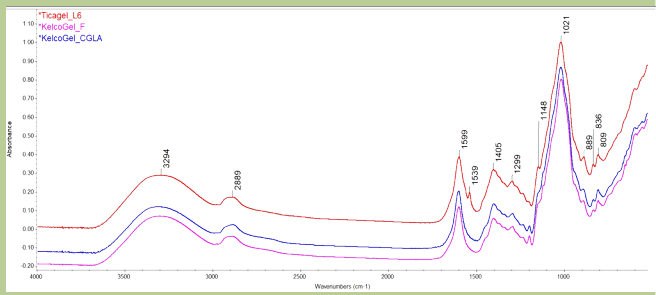
- **There were no significant color changes recorded due to the gel application.**
- The general trend demonstrated increases in b* values after aging meaning all the papers yellowed due to the aging process.
- The control papers exhibited smaller ΔE than the sample papers.
- **Between the 0.4 g/L and 4.0 g/L calcium acetate concentrations, the 4.0g/L regularly produced a higher average ΔE.**
- *Arches papers yellowed significantly in the aging chamber. The values for these samples don't accurately represent the gel residue behavior.





FTIR

- Variance is weak for all spectral comparisons which indicates very little change has occurred between measurements.
- **Due to the similarity of gum and paper spectra, changes caused by the presence of the gels on paper or its changes upon aging could not be reliably detected.**
- The spectra below shows how Ticagel differs in chemical composition from the two KelcoGels. The Ticagel exhibits a peak at 1539 cm^{-1}.



Conclusions

This study explored the role of calcium acetate in low acyl gellan gum at low concentrations. The study concluded that larger percentages of calcium acetate in gellan gum causes more residue deposit by a small margin. Calcium acetate most likely contributes to the severity of gellan gum residues because the ion concentration affects the gel's pore size and ability to wet the paper substrate. The gel formation that left the most residue was KelcoGel F; however, this had a very minor effect on the sample papers' color. The results indicate gellan gum residue marginally accelerates the deterioration of cellulose, independent of paper sizing. Continued research will include the addition of soluble media and testing of historic papers to record calcium acetate's interaction with paper made using historic paper making practices.

A special thank you to Crystal Maitland, Michelle Sullivan, Anne Maheux, Alison Murray, and Rosaleen Hill for all their support.

This research was supported by the Canadian Conservation Institute who generously shared their aging chambers. Thanks also to Scott Williams, Diogenes Vedoy, and Eric Hagan for their valuable time and input. All KelcoGel products were graciously donated by CP Kelco.

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