SUPPLEMENT 1998

TEXTILE CONSERVATION NEWSLETTER

AN INVESTIGATION OF POULTICE MATERIALS FOR TEXTILE CONSERVATION

By
Shawna Lemiski

Biography

This research was completed during the author's Andrew W. Mellon Fellowship in Textile Conservation at the Textile Conservation Center in Lowell, Massachusetts in 1997. Shawna Lemiski has a Master of Science degree in Clothing and Textiles with a specialization in textile conservation. She has recently accepted a six month position as Acting Curatorial Technician for the Clothing and Textiles Collection at the University of Alberta.

TABLE OF CONTENTS

INTRODUCTION 4

BACKGROUND INFORMATION 4

- Capillarity in Cellulose Fibers 4
- Poultices – Theory and Practice 5
  - Principles of Poultices
  - General Application Techniques and Considerations
  - A Review of Poultice Materials Used in Conservation
  - Clays
    - Sepiolite
    - Attapulgite
    - Laponite
  - Cellulose Products
    - Methyl cellulose
    - Arbocel®

ARBOCEL® TRIALS 8

- Objectives 8
  - Materials and Methods
- Observations on Applying Arbocel® Poultices 11
- Evaluation of Arbocel® Poultices 12

CONCLUSIONS 13

REFERENCES 14

SUPPLIERS 14

ACKNOWLEDGEMENTS 15

AN INVESTIGATION OF POULTICE MATERIALS FOR TEXTILE CONSERVATION

Abstract

The purpose of this research was two-fold. The first goal was to explore conservation literature to identify how poultices have been used in the treatment of various types of artifacts. Secondly, the goal was to determine the potential of a particular cellulose product, Arbocel®, for use as a poultice. Arbocel® is a natural cellulose powder that is processed in Germany for numerous industrial applications and is known to have been used in wall painting conservation. This paper provides a brief review of the theories and principles of water transport that are essential to successful poultice use. Conservation literature related to poultice treatments in various disciplines also is explored. Finally, the author's experimental work with two Arbocel® products is discussed.

INTRODUCTION

Poultices are used in many areas of conservation in various forms and applications. Conservators of paintings, ceramics, paper, furniture, and textiles use poultices to draw stains, impurities, and adhesives out of artifact substrates. A list of poultice materials might include Laponite®, sepiolite, methyl cellulose, cotton and linen linters, and more. Some of the many uses of poultices are documented in conservation literature, but many more treatments are performed than are ever published or presented in a public forum.

The purpose of this research was two-fold. The first goal was to explore conservation literature to identify how poultices have been used in the treatment of various types of artifacts. Secondly, the purpose was to determine the potential of a particular cellulose product, Arbocel®, for use as a poultice. Arbocel® is a natural cellulose powder that is processed in Germany for numerous industrial applications and is known to have been used in wall painting conservation.

This paper provides a brief review of the theories and principles of water transport that are essential to successful poultice use. Conservation literature related to poultice treatments in various disciplines also is explored. Finally, the author's experimental work with two Arbocel® products is discussed. The many factors involved in poultice use made it difficult to sufficiently limit the scope of the work to conduct a rigid scientific experiment and still obtain useful information. Thus, the discussion of Arbocel® that follows is based on qualitative, empirical evidence and observations gained through many trials rather than statistical analysis of quantitative data.

BACKGROUND INFORMATION

Capillarity in Cellulose Fibers

Liquid in a cellulose fiber moves between and within the fibers through a combination of forces, the most significant of which is capillary action. Capillarity has been explained as "the attraction between molecules, similar to surface tension (q.v.), which results in the rise of a liquid in small tubes or fibers, or in the wetting of a solid by a liquid" (Hawley, 1981, p. 190). Ashley-Smith and Wilks (1983) described capillarity as the "phenomenon by which liquids are drawn spontaneously into very fine tubes or pores" (p. 47). This pull results when stronger adhesive forces *between* the molecules of the liquid and the solid prevail over the cohesive forces *within* the liquid. The liquid is drawn into the capillary, forming a concave curve (meniscus) as it climbs the walls of the capillary.

A capillary can be any tube, pore, or space that can hold water under tension, and need not be of uniform diameter or shape (Hearle, 1960). The arrangement of capillaries within a structure influences the movement of liquid through the structure: capillary continuity and rate of transport are higher when the capillaries are ordered. Capillary draw also depends upon the liquid,

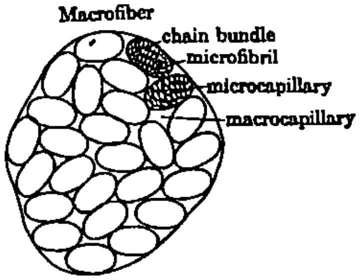

Figure 1. Cross-section of cellulose fiber structure. (Adapted from Scherer, 1954, p. 77).

particularly with polar liquids that form strong intermolecular bonds with solids despite being strongly cohesive (Ashley-Smith & Wilks, 1983).

In cellulose fibers, there are several levels of capillary action that interact to transport liquids through the fibers. The microstructure of cellulose fibers accounts for this capillarity. As Rowland (1977) described, "pores arise from discontinuities of molecular packing… In the case of fibers, pores develop from submicroscopic and subelectron-microscopic imperfections in lateral packing of microstructural elements" (p. 21). As the fiber grows, many long chains of the cellulose molecule pack together to form chain bundles. Groups of these bundles then unite to form *microfibrils* (Scherer, 1954). Many microfibrils pack together to create a cellulose macrofiber (Figure 1). There are oriented and disoriented regions at each level of packing (chain, bundle, microfibril). The spaces or pores in the disordered regions from an interconnected network of fine and coarse capillaries that provides a mechanism for the transport of fluids through the cellulose fiber (Scherer).

Poultices – Theory and Practice

Principles of Poultices

Poultice use is based on theories of capillarity and water movement in textiles. Thomson (1994) explains that poultices work "on the principles of diffusion, evaporation, capillary action, and equilibria, and its action is influenced by its environment" (p. 49). The application of a wet poultice to a dry textile allows the solvent to diffuse into the textile until an equilibrium is established between the solvent concentrations of the poultice and the textile. The solvent that enters the textile acts to solubilize or soften soils. As the solvent begins to evaporate from the top of the poultice, capillary action draws the solvent (and any solubilized soils) up into the poultice again. Evaporation will continue until the poultice, textile, and atmosphere reach a new equilibrium. The poultice must have stronger capillary forces than the substrate to prevent the solvent from spreading into the fabric beyond the poultice rather than being drawn back up into the poultice.

Poultices have several advantages as a means of stain/soil reduction. The poultice material acts as a carrier for the solvent. The carrier can hold the solvent at the surface of the textile for an extended period of time allowing for solvation that might not be accomplished in a shorter time (Smith, Jones, Page, & Dirda, 1984). In addition, the application of the poultice can be controlled carefully to localize treatment to a very small area when total immersion is not possible or desirable. Furthermore, abrasion and mechanical action are minimized.

When choosing the most appropriate poultice material, the conservator should consider several factors. The solvent must be identified first, as some poultice materials cannot absorb or carry certain solvents. The solubility of the stain, soil, or adhesive to be removed will indicate the required solvent; however, the solubility of the fibers, dyes, and finishes in the textile substrate should be tested to ensure that the chosen solvent will not damage any of these features. Furthermore, the poultice should be compatible with the textile selected, keeping in mind the working properties of the poultice and the nature of the textile. Above all, the purpose of the poultice should be clearly defined: Is the goal to draw out a stain or adhesive residue or to act as a carrier for an enzyme treatment?

The following criteria provide guidelines for selecting appropriate poultice materials:

1 The poultice should not cause harm or significant change to the textile or textile finish (e.g. shrinkage, distortion, staining, color change).
2 The poultice should be completely and easily removable, leaving no residue in the textile.
3 The poultice should act as an absorbent medium for the desired solvent over an extended period of time, but allow enough solvent to escape into the substrate for solvation to occur.
4 The poultice should form good contact with the textile to facilitate capillary action (through a barrier if necessary).
5 The poultice should be non-hazardous to the conservator.
6 The poultice should be easy to handle and have good working properties.

General Application Techniques and Considerations

In practice, the amount of solvent in the poultice determines how quickly and how much of a solvent diffuses into the textile. The ratio of solvent to poultice must be controlled carefully: too much solvent entering the textile can cause the stain or adhesive to spread, whereas too little solvent does not achieve the solubilization that allows the soil to be drawn into the poultice. According to Smith et al. (1984),

> a dry poultice works better and results in less lateral movement of the solvent than does a more liquid poultice. A poultice that is too dry will not adhere to the paper well enough to draw the adhesive out (p. 109).

Thomson (1994) echoes this statement by warning that the solvent concentration must be selected carefully to achieve the desired effect of solubilizing soils, then drawing them up into the poultice. It is clear that solvent concentration is a critical factor in the successful use of poultices. Every stain or adhesive reacts differently and has different solubility requirements; therefore a fixed solvent concentration cannot be applied universally to all poultices. Various poultice materials also "hold" the solvent to different degrees, so the amount of solvent that works in one poultice may be too much or too little for another poultice.

Another factor that affects the diffusion of solvent into the textile is the viscosity of the solvent. Viscosity is the "measure of a liquid's mobility" (p. 46) and depends on internal molecular forces and temperature (Ashley-Smith & Wilks, 1983). Liquids with a high viscosity are less mobile as they often have large molecules and strong molecular bonds that hinder flow. As the temperature rises, molecular motion increases, which reduces viscosity. Solvents with low viscosity can be difficult to control and to retain in a poultice, allowing too much solvent to enter the textile too quickly. This lack of control can lead to spreading or bleeding of a highly soluble stain.

Relative humidity affects the equilibrium of the system and the rate of solvent evaporation. Using the poultice in an open or closed system can control this factor. In a closed system, the poultice is applied to the textile and then covered with an impermeable layer, such as Mylar polyester film, which traps the evaporating moisture and creates a microclimate with elevated humidity. An open system allows unrestricted evaporation. Adjusting the relative humidity surrounding the poultice in this way enables the conservator to control the length of time that the textile substrate is exposed to the liquid solvent as well as to solvent vapor.

A Review of Poultice Materials Used in Conservation

Clays

One of the major classes of poultice materials is the clay family. Various natural and synthetic clays have been used in many applications. The properties of clays make them good absorbents for certain solvents, with some clays forming pastes and others forming gels when mixed with the solvent.

Sepiolite: Sepiolite is one of the absorbent natural clays that have been used as a poultice material. It is an aluminum hydrated phyllosilicate with a crystalline structure, "consisting of three-dimensional chains with large numbers of pores and channels" (Heuman & Garland, 1987, p. 30). Sepiolite comes as a fine powder that makes a paste when solvent is added (Thomson, 1994).

Documented use of sepiolite has been found in relation to textile conservation problems. Thomson (1994) investigated three poultice materials (sepiolite, Laponite®, and paper) for removing shellac from linen, using Industrial Methylated Spirits for a solvent. Her research compared the effectiveness as well as advantages and disadvantages of each poultice material. The results of her study indicated that sepiolite performed better than the other materials, but that a barrier was required between the poultice and the substrate in order to minimize deposition of sepiolite into the fibers. Heuman and Garland (1987) used a sepiolite poultice to remove cellulose nitrate adhesive from a silk Chinese textile. They selected sepiolite as it would accept the required solvent (acetone), and because its weight kept the poultice and blotter barrier in close contact with the textile.

Attapulgite: Attapulgite has been used to a limited extent in conservation poultices. Attapulgous clay is a natural, magnesium hydrated phyllosilicate with a structure similar to that of sepiolite. Like sepiolite, attapulgite has an enormous capacity for absorption of liquids: 1000 g of attapulgite can absorb 1500 g of water with no apparent change in volume (Heuman & Garland, 1987).

Laponite: Laponite® is a synthetic clay that comes in the form of a fine powder. It is a magnesium silicate that forms a clear stable sol or thixotropic gel when mixed with water (Chapman, 1986). Laponite® products are designed to imitate the tri-octahedral sheet structure of hectorite $[Si_8Mg_{5.34}Li_{(0.66)}(Ca,Na)_{0.66}]$, a natural clay mineral (Lee, Rogers, Oakley, & Navarro, 1997). Because Laponite® gel is created by ionic bonding, nonpolar solvents do not work well with Laponite®. A review of the literature indicates that water has been the main solvent in Laponite® poultices although small amounts of ethanol can be introduced to the water-based gel once it has been mixed.

Conservators in numerous disciplines have used Laponite® as a poultice material in a variety of applications. Ceramics conservators, for example, have used the synthetic clay to draw stains out of ceramic bodies (Lee et al., 1997). A recent study on the cleaning of feathers using Laponite RD® found that the gel can be a suitable alternative to other methods of localized treatments (da Silveira, 1997). Laponite® poultices often have been used when immersion cleaning, contact cleaning, or a suction device are not appropriate. As with sepiolite, however, a barrier should be used between the Laponite® poultice and the artifact substrate to prevent deposition of clay particles in surface crevices and grooves.

In textile conservation, Laponite® poultices have been used primarily for adhesive reduction and stain removal. Thomson (1994) included Laponite® in her investigations of poultice materials for removing Shellac adhesive residues. She found that Laponite® was not as effective as sepiolite or paper poultices. The use of a barrier, either lens tissue or filter paper, seemed to render the poultice even less effective (Thomson). Other textile conservators have used Laponite® in combination with enzymes for adhesive reduction. Chapman (1986) chose Laponite (as a medium for Bacterial Amylase Novo (BAN) to remove starch paste from Indian cotton textiles. After preliminary experimentation, she used Laponite RD® in a thick gel to hold the enzyme on the pasted areas of the textiles. The results of the adhesive removal were reported to be successful with no adverse effects on the textile.

Removal of hide glue from silk has been investigated using a Laponite® poultice (Spicer, 1992). In one case, the textiles were printed silks that required the cleaning treatment to be controlled carefully within localized areas of adhesive. A Laponite® gel poultice provided the necessary control and achieved a satisfactory level of adhesive removal in preliminary trials. Once the poultice was removed and the area was allowed to dry completely, however, tidelines were noted in areas of soiling as well as stiffened edges of the adhesive spots (Spicer). Thus, Laponite® poultices were discontinued and an alternate technique was employed to reduce adhesive residues.

Cellulose Products

Conservators have used several cellulose products and derivatives as poultice materials. Paper-based poultices often consist of torn up pieces of filter paper (Thomson, 1994), and sometimes of cotton or linen linters. The consistency of the poultice can be adjusted by altering the size of the paper pieces and the ratio of solvent to pulp. In the conservation of terracotta sculpture, small pads of cotton batting have been used with hot water in a poultice treatment (Larson, 1980). This type of poultice was intended to soften a stain that could then be swabbed or brushed away (Larson).

Methyl cellulose. Methyl cellulose also has been used as a poultice material among its many other applications. This material is prepared from "wood pulp or chemical cotton by treatment with alkali and methylation of the alkali cellulose with methyl chloride" (Merck Index, 1989, p. 5963). Methyl cellulose comes in the form of dry white granules and dissolves in cold water to form a stable solution (Merck Index). In textile and paper conservation, methyl cellulose has been used as a gelled medium for holding an enzyme during adhesive removal. Smith (n.d.) prepared a methyl cellulose poultice for the application of alpha-amylase to hardened wheat paste on a linen neckband fragment (Coptic). Similarly, Blüher, Banik, Maurer and Thobois (1996) performed local removal of starch adhesive from prints in albums by an enzyme poultice. The poultice consisted of amylases in a methyl cellulose gel. In both of these cases, the conservators found that they could exercise control over the behavior of the poultice by adjusting the gel viscosity, enzyme concentration and working temperature.

Arbocel®. The focus of the remainder of this paper is Arbocel®, a cellulose product that is manufactured in Germany for a wide assortment of industrial applications. Arbocel® is composed of natural fibers derived from leafwood cellulose. The manufacturer, J. Rettenmaier & Söhne, offers a large selection of Arbocel® products in different grades that vary by fiber length, fiber diameter, and bulk density. Fiber length ranges from 18μm to 2000 μm, and average fiber diameters are between 15 μm and 45 μm. The fibers are processed mechanically by grinding, and purity varies by grade from 50% to 99.5 % cellulose content. According to the manufacturer, no additives such as pigments or optical brighteners are introduced. A phloroglucinol test, as described in Browning (1977), was negative for the presence of lignin. The natural cellulose fibers can absorb 2 to 7 times their own weight in liquid, a desirable property for poultice materials.

ARBOCEL® TRIALS

Objectives

The purpose of the experimental part of this research was to investigate the working properties and poultice behavior of Arbocel® cellulose products for potential textile conservation applications. Several main objectives were pursued during the course of the research. These objectives were to:

1. identify differences in working properties and water transport between Arbocel® cellulose products BC1000 and BWW40;
2. determine general application techniques for Arbocel® poultices;
3. recognize textile conservation problems where Arbocel® poultices may be appropriate.

Preliminary work indicated that it would be impossible to formulate a prescribed method of preparing and applying Arbocel® poultices that would work in all situations. The behavior and effectiveness of any poultice is dependent upon many factors, as discussed earlier. In particular, the fabric substrate and stain or adhesive to be removed tend to dictate poultice composition and procedure. With this in mind, the objectives were aimed at developing a base of practical working knowledge of Arbocel® as a poultice material.

Materials and Methods

The first objective focuses on differences between two grades of Arbocel®. Samples of Arbocel® BC1000 and BWW40 were provided by the manufacturer, and vary according to fiber length and bulk density (Table 1). (These two grades were selected at the discretion of a manufacturer's representative according to our description of intended use and desired properties.) Differences in such physical properties as fiber length and bulk density were expected to cause differences in the water transport mechanisms of the two fibers when in a poultice system.

Table 1. Physical properties of Arbocel® BC1000 and BWW40 (adapted from product pamphlet by J. Rettenmaier & Söhne).

Properties	**Arbocel BWW 40**	**Arbocel BC 1000**
Color	white	white
Ave. fiber length	200 µm	700 µm
Ave. fiber diameter	20 µm	20 µm
Cellulose content	99.5 %*	99.5 %*
pH value	6 ± 1	6 ± 1
Bulk density	110 - 145 g/L	30 - 45 g/L

** The manufacturer identified the remaining 0.5 % as consisting of ether soluble resins, water soluble mineral salts, and oxide ash.*

One concern when using poultices is the degree of control that can be exercised over the solvent by adjusting the solvent-to-carrier ratio and the application techniques. How wet or dry should the cellulose be to achieve maximum poultice results? Can the solvent be contained within the area of the stain/adhesive? Due to the numerous variables that affect the diffusion of a liquid into a textile, it was not expected that a fixed ratio of solvent to cellulose would be discovered. It was hoped that differences between BWW 40 and BC1000 might be notable. Methods of controlling the direction and circumference of solvent flow also were explored.

In order to test solvent control in Arbocel® poultices, several parameters were established that would help to highlight this issue. Water was selected as the primary solvent to be investigated since water transport mechanisms in textiles have been more thoroughly examined and explained by previous researchers. Water also is more viscous and less volatile than solvents such as ethanol and acetone. The slower movement of water would be easier to observe. Next, a staining substance had to be selected that would be simple to apply and that would be highly sensitive to water so that any loss of control over the solvent quickly would become apparent. A black water soluble ink was selected so that bleeding or spreading of the stain would be readily visible.

During preliminary trials, it was noted that the same poultice mixture had very different results when applied to different fabrics. Thus, conducting all of the poultice treatments on one type of fabric would not give useful results that could be transferred to any other fabric. The decision was made to create similar ink stains on a variety of fabrics and observe how the poultices worked in conjunction with different substrates. In this way, qualitative information about the type of adjustments to the poultices needed for various fabrics could be gathered.

Two cotton and two silk fabrics were chosen from a box of study pieces of unknown age and provenance. Table 2 provides information about these fabrics. While these fabrics do not represent all fiber contents and fabric structures, their different textures, finishes and relative absorbencies affected the behavior of both the ink and the poultices.

Table 2. Description of sample fabrics used in poultice trials.

Property	**Brown/white stripe**	**brown print**	**ivory**	**olive**
fiber content	cotton	cotton	silk	silk
yarn structure	warp and weft z-spun singles	warp and weft: z-spun singles	warp: s-spun singles; weft: 2-ply, Z-twist yarn	warp: singles, no discernible twist; weft: coarser singles, no discernible twist
fabric structure	alternating stripes of 1x1 plain weave and 2x1 basket weave variation	1x1 plain weave	1x1 plain weave	1x1 plain weave, rib variation (bengaline)
fabric count	78 warp x 64 weft	72 warp x 56 weft	232warp x 104weft	104 warp x 34 weft

Ink stains were created on the sample fabrics dropwise, expelling one drop per stain (0.026 ml to 0.030 ml). The ink came from Shaeffer jet black fountain pen refill cartridges and is highly sensitive to water. Two of the sample fabrics wicked the ink drops out into large, irregularly shaped spots while the other two fabrics simply absorbed the ink in a small spot where the drop was applied. In the first two fabrics, the same amount of ink is spread out more thinly across a larger area while the ink spots in the second two fabrics appear very concentrated. Each of the ink stains was measured prior to poultice treatment so that any bleeding could be determined.

Preliminary trials indicated a solvent-to-poultice ratio of 1 g cellulose to 2 ml water would be most effective. This ratio allowed some of the ink to solubilize without causing it to bleed into the surrounding area - a very fine line! Poultices of both BC 1000 and BWW 40 were prepared and applied to ink stains on each of the four sample fabrics. The stains were treated with three successive, identical poultices to determine whether repeated applications would maximize poultice action. Each poultice was left on the fabric in an open system for three hours, with observations recorded after 1/2 hour and three hour intervals. The poultices felt dry to the touch after 3 hours.

For removal, the poultices were carefully lifted with a spatula, and any residue was eliminated with a low suction vacuum and fine nozzle attachment. Photographs were taken after each poultice application to record changes in size or appearance of the ink stains, and any surface changes to the fabrics. After each poultice application the stains were left overnight to ensure that the ink was dry between poultices, even though they felt dry to the touch when the poultices were removed. During all poultice treatments, the stained sample fabrics were laid on white cotton flannel so that any ink migration from the back of the stain would be visible on the flannel. This arrangement might indicate whether Arbocel® poultices could be controlled enough on multi-layered textiles to draw the stain upward from the top layer only. Evaluation of the poultice treatments was based on visual comparison (naked eye and under steromicroscope), photographic evidence, and changes in stain dimensions.

Observations on Applying Arbocel® Poultices

From preliminary trials as well as the "experimental" work, differences were noted in the working properties of the two grades of Arbocel®. Observations are shown in Table 3. The longer fibers of BC 1000 cling together more than the short fibers of BWW 40, forming larger clumps of cellulose when both dry and wet. The size of the cellulose clumps affects the ease of application of the poultice. The smaller "crumbs" of BWW 40 do not hold together well in a unit, but do pack closely on the surface of the textile substrate. On the other hand, the long fibers of BC 1000 tend to hold together in a compact unit once compressed.

Table 3. Observations on working properties of Arbocel® BWW 40 and BC 1000.

Property	BWW 40	BC 1000
Texture when dry	Fine powder	Fine powder, but fibers tend to cling together in small clumps
Texture when "wet" with solvent	Small, hard crumbs; feels wetter than BC 1000 with same amount of solvent	Larger, softer crumbs than BWW 40
Packing ability	Small particles pack closely but do not hold together well	Pack well and can hold together in a single compact unit
Contact with textile	Small surface area of each crumb decreases contact	Larger crumbs can be flattened to increase packing and contact
Removal from textile	Dried poultice crumbles easily, many small crumbs and fibers to be removed	Dried poultice can be lifted intact, minimal additional removal of remaining fibers required
Preferred application technique	Place ring of dry powder around stain first, then gently pack wetted poultice into center (within edges of stain), add thin layer of dry material to top of poultice	Same as for BWW 40

Figure 2. Application of an Arbocel® poultice.

Despite the differences between the two Arbocel® grades, one application technique was found to work best for both BWW 40 and BC 1000. In order to contain any "loose" solvent, a 3mm to 6mm wide ring of dry Arbocel® powder was first laid around the perimeter of the ink stain. The poultices were prepared with a ratio of 1g Arbocel® to 2 mL water, and the damp poultice material was applied onto the stain with slight packing to ensure good contact. Care was taken not to exceed the boundaries of the stain with the wet poultice. The dry ring was pressed up against the wet poultice to form a smooth transition. Small spatulas were the preferred tools for applying the poultice (Figure 2), although tweezers/forceps were also useful with the larger clusters of BC 1000. Trials with lens tissue, blotter paper, and cotton fabric barriers were unsuccessful as good contact between the poultice and the textile could not be achieved.

A 1:2 ratio of solvent-to-poultice was determined in the preliminary trials to be the level at which there was sufficient solvent to just solubilize and draw up the stain but not so much as to make the stain spread. In order to achieve even wetting of the cellulose powder, the poultice was mixed well with a small spatula and left to sit for a few minutes so that the water could be wicked throughout the poultice. The average thickness of the poultices when applied was approximately 4 mm.

In some cases a thin layer of dry Arbocel® powder was added to the top to increase the capillary action in the poultice. This additional layer of dry material seemed to help in drawing the ink further into the poultice. Furthermore, this top dry layer worked well when not packed firmly over the wet center but left somewhat loose. In theory, more rapid evaporation is facilitated through individual fiber ends by leaving the dry cellulose fibers unpacked at the interface with the air. As evaporation progresses, capillary forces pull the solvent and solubilized stain towards this interface. In several of the poultices, the ink stain became faintly visible at the top of the poultice. When the poultices were removed and examined in cross-section, it was observed that the solubilized ink had migrated into the poultice to varying degrees, but in some instances almost 3 mm.

Evaluation of Arbocel® Poultices

In general, the Arbocel® poultices were successful in reducing the ink stains and did not cause the ink to bleed. The most obvious results were obtained on the ivory silk substrate (Figures 3 &4). The concentrated black ink stains on the brown and white striped cotton were not visibly reduced although the poultices removed from this fabric showed the largest amounts of extracted ink. Repeated poultices further reduced the stains on all fabrics, but with diminished results each time. The edges of all stains remained darkest and most distinct, perhaps indicating that the ink traveled outwards to these

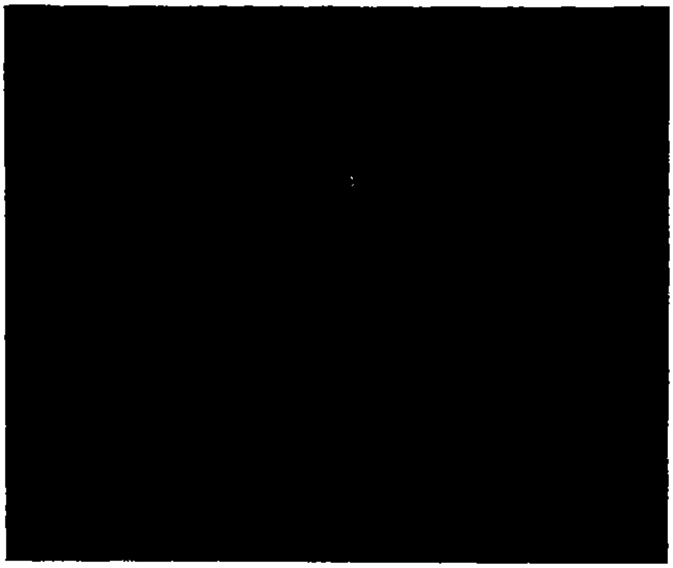

Figure 3. Ink stain on ivory silk sample fabric before poultice application.

Figure 4. Ink stain on ivory silk sample fabric after poultice application

edges, then upwards into the poultice at that point. The edges of the stains also marked the interface between wet and dry poultice materials.

Under stereoscopic magnification, there was no evidence that fibers or yarns on the substrates had been damaged by repeated poultice application. A few stray Arbocel® cellulose fibers remained on each sample, but most could be removed with light sweeping with a soft-bristle brush and low suction. These fibers were not visible without the aid of a microscope. Since the poultice residue consists of cotton fibers, they do not pose the same danger as clay particles that are abrasive and may cause mechanical damage.

Small differences between the two grades of Arbocel®, BC 1000 and BWW 40, were noted. (It should be remembered that these observations are subjective and any differences have not been proven to be statistically significant). The longer fibers of BC 1000 seemed to make this product easier to handle and remove. The short fibers of BWW 40 created small crumbs that were difficult to manage, but that may work well when the stain to be poulticed is very small. Solvent retention seemed to be greater in the BC 1000 poultices. Poultices of BC 1000 appeared to be more effective in capturing ink from the stains. In theory, the longer fibers in the BC 1000 product form a more continuous capillary network that results in stronger forces drawing the water and ink into the poultice.

CONCLUSIONS

The Arbocel® trials indicate that various forms of this product are promising for use as a poultice material for textiles. Highly water-sensitive ink stains on four sample fabrics were reduced without causing the ink to spread outwards or to migrate to a flannel backing fabric. There were no adverse effects on the silk and cotton sample fabrics, such as staining, shrinkage, distortion, surface abrasion, or permanent deposition of Arbocel® fibers.

Preliminary trials allowed such factors as solvent-to-poultice ratio and application methods to be worked out for a specific stain. In the case of a real artifact and treatment, careful testing of the stain, soil or adhesive to be removed will provide the conservator with a good understanding of its nature and solubility. Familiarity with the working properties of Arbocel® can be gained through similar trials. Research into more grades of the Arbocel® products may uncover other working properties and suitable applications for textile conservation treatments.

References

Ashley-Smith, J., & Wilks, H. (1983). Science for Conservators. Book 2: Cleaning. London: Crafts Council.

Barrer, R. M. (1948). Fluid flow in porous media. Discussions of the Faraday Society, no. 3, 61-72.

Blüher, A., Banik, G., Maurer, K-H. & Thobois, E. (1996). The application of enzyme-containing methyl cellulose gel for the removal of starch-based adhesives in albums. In Preprints, Vol. II, of the ICOM Committee for Conservation 11th triennial meeting in Edinburgh, 494-499.

Browning, B.L. (1977). Analysis of paper (2nd edition). New York: Marcel Dekker.

Budavari, S. (Ed.). (1989). The Merck Index: An encyclopedia of chemicals, drugs, and biologicals (11th edition). Rahway, NJ: Merck & Co.

Carman, P. C. (1948). Some physical aspects of water flow in porous media. Discussions of the Faraday Society, no. 3, 72-77.

Chapman, V. (1986). Amylase in a viscous medium - Textile applications. The Conservator, no. 10, 7-11.

Crank, J. (1960). Rate of change of moisture content. In J. W. S. Hearle & R. H. Peters (Eds.), Moisture in textiles (pp. 83-93). New York: Textile Book Publishers.

Francis, K. (1992). Observations on the drying behavior of textiles. AIC Postprints, of the 20th Annual meeting in Buffalo, NY.

Hawley, G. G. (Ed.). (1981). The condensed chemical dictionary (10th edition). New York: Van Nostrand Reinhold.

Hearle, J. W. S. (1960). Fibres and liquid water. In J. W. S. Hearle & R. H. Peters (Eds.), Moisture in textiles (pp. 178-188). New York: Textile Book Publishers.

Heuman, J., & Garland, K. (1987). A poultice technique for the removal of cellulose nitrate adhesive from textiles. The Conservator, no. 11, 30-33.

Hollies, N.R.S., Kaessinger, M.M., & Bogaty, H. (1956). Water transport mechanisms in textile materials. Part I: The role of yarn roughness in capillary-type penetration. Textile Research Journal, ??, 829-835.

Kissa, E. (1981). Mechanisms of soil release. Textile Research Journal, ??, 508-513.

Larson, J. (1980). The conservation of terracotta sculpture. The Conservator, no. 4, 38-45.

Lee, L-M., Rogers, P., Oakley, V., & Navarro, J. (1997). Investigations into the use of Laponite as a poulticing material in ceramics conservation. V & A Conservation Journal, no. 22, 9-11.

Scherer, P. C. (1954). Cellulose: Sources, constitution, and chemical properties. In H. R. Mauersberger (Ed.), Matthews' textile fibers (pp. 53-101). New York: John Wiley & Sons.

da Silveira, L. (1997). A note on the poultice cleaning of feathers using Laponite RD gel. Studies in Conservation, 42, 11-16.

Smith, L. M. (n.d.). Use of enzymes in textile cleaning. (no publication information).

Smith, M. A., Jones, N. M. M. (II), Page, S. L., & Dirda, M. P. (1984). Pressure-sensitive tape and techniques for its removal from paper. Journal of the AIC, 23, 101-113.

Spicer, G. (1992). A sticky business: The removal of hide glue from silk. In Silk, preprints of the Harpers Ferry Regional Textile Group symposium. National Museum of American History.

Thomson, K. (1994). Sepiolite poulticing - An alternative for the cleaning of textiles. Conservation News, no. 53, 49-51.

Tsang, J.S. & Erhardt, D. (1992). Current research on the effects of solvents and gelled and aqueous cleaning systems on oil paint films. Journal of the AIC, 31, 87-94.

Suppliers

Arbocel® - J. Rettenmaier & Söhne GMBH + CO
Manufacturers of Fibres
D-7092 Ellwangen-Holzmühle
tel. 07967/152-0
fax 07967/6111

Phloroglucinol solution - TALAS
568 Broadway
New York, New York 10012
tel. (212) 219-0770
fax (212) 219-0735

Acknowledgements

The author would like to thank the following people and institutions for their guidance, suggestions, and assistance: Deirdre Windsor, Linda Hillyer, Kathy Francis, Jan Vuori & Season Tse, Kate Garland, the Northeast Document Conservation Center, J. Rettenmaier & Sohnes, and especially the entire staff of the Textile Conservation Center in Lowell for their friendship and support.