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Preserving cultural heritage through radiation-curing resin consolidation: a case study of an indigenous ceramic vessel

Ana Carolina Delgado Vieira [1,2], Pablo A. S. Vasquez [2], Maria José Alves de Oliveira [2], and Fabíola Andréa Silva[1]

[1] *ana.carolina.vieira@usp.br*,
Museu de Arqueologia e Etnologia - Universidade de São Paulo [Museum of Archeology and Ethnology - University of São Paulo] (MAE / USP)
Av. Professor Almeida Prado, 1466
05508-070 São Paulo, SP, Brazil

[2] *pavsalva@usp.br*,
Instituto de Pesquisas Energéticas e Nucleares [Institute of Energy and Nuclear Research] (IPEN / CNEN - SP)
Av. Professor Lineu Prestes, 2242
05508-000 São Paulo, SP, Brazil

1. Introduction

Traditionally, the ceramic vessels made by the Asurini do Xingu indigenous people in the state of Pará, Brazil, are made by women and used for cooking, storing, and serving food. A variety of mineral pigments are used in its painting, such as iron oxide (goethite and hematite) and manganese, resulting in colors such as yellow, red, and black. Fine brushes as feathers or plant fiber stems are used to create geometric patterns, including zigzags, rhombuses, straight, crossed, and curved lines [1]. As soon as the design has dried, the ceramist applies a thin layer of Jatobá resin (*jutaika*) on the outside surface of the vessel. As the ceramic is heated, the resin melts upon contact with the hot surface and can be applied with a stick to the vessel. A shiny finish is provided to the ceramic by the resin. A significant part of the conservation vulnerability of Asurini do Xingu pottery is due to the resin finish. As a result of the loss of resin, the glossy surface detaches, taking with it the previously applied decoration (Fig. 3).

Figure 1: Ceramics showing the loss of resin and paint layers. Photo: Ana Carolina Delgado Vieira, 2023.

Asurini do Xingu pottery art represents the indigenous worldview, which serves as an important medium for communicating with and teaching younger generations. Due to this, it is necessary to identify methods that can contribute to the preservation of this material culture, preventing the deterioration processes described above.

Previous experiences at the Museum of Archaeology and Ethnology (MAE/USP), had unsatisfactory effects with the use of consolidants applied by brushing and injections, employing thermoplastic acrylic resins such as Paraloid B-72 and Primal AC-33. The fragility of the jatobá resin is so significant that it hinders the injection of the consolidant into its fractures, where the displacement of acrylic resins ends up causing detachment in other areas of the varnish that seemed stable. Experiments with brushing the consolidant onto the surface of the jatobá resin were also unsuccessful, as the acrylic consolidant did not penetrate in a way that would anchor the varnish to the ceramic substrate, leaving the consolidant merely deposited on its surface.

As a result of the failure of traditional conservation methods, it is imperative to adopt a new approach. The use of ionizing radiation for obtaining monomers appears to be a promising alternative, since it does not cause chemical or physical changes, nor does it increase the temperature during polymerization [2]. Radiation has been used since the 1960s for wood and stone consolidation [2]. It has been many decades since ARC-Nucléart, in France, published and applied positive experiences with the treatment of fragile materials. Other research studies have examined the use of less toxic and reversible solvents as well [3, 4, 5]. As a result of the radiation curing process, consolidating resins form three-dimensional structures, which improve the mechanical characteristics of weakened artifacts. Additionally, the high penetration power of gamma rays allows for uniform polymerization and a more homogeneous result [2].

In conventional approaches to cultural heritage consolidation, a radiocurable resin is typically impregnated into the object. In this investigation, a resin was selectively applied solely to the external surface of the vessel to serve as a consolidating agent. The purpose of this study is to evaluate the performance of an unsaturated polyester and styrene-based resin in consolidating an Asurini vessel, comparing its physical properties before and after treatment, as well as assessing potential color changes.

2. Methodology

The Asurini do Xingu vessel selected for this study belongs to the Laboratory for Interdisciplinary Studies on Technology and Territory (LINTT - MAE/USP). To document the process and to evaluate the aesthetic changes to the object following the intervention, the vessel was photographed before and after the experiment. Colorimetric determinations were made with a PCE-CSM 8 equipment using the CIEDE2000 color coordinate system and SQC8 Color Management Control System (0°/45° geometry; 58 mm diameter aperture) connected to a computer. The CIEDE2000 color-difference formula is derived from the CIELAB color space. The CIEDE2000 formula demonstrates a heightened level of sophistication and computational complexity when compared to its precursor color-difference equations utilized in the CIELAB color space [6].

$$\Delta E_{00} = \sqrt{\left(\frac{\Delta L'}{k_L S_L}\right)^2 + \left(\frac{\Delta C'}{k_c s_c}\right)^2 + \left(\frac{\Delta H'}{k_H s_H}\right)^2 + R_T \frac{\Delta C'}{k_c s_c}\frac{\Delta H'}{k_H s_H}} \quad (1)$$

Six measurement points were chosen according to the colors of the vessel. In order to evaluate possible changes in the behavior of the resin applied, measurements were taken before, 96 hours after, and eight months after the radiation consolidation procedure.

3. Results and Discussion

As shown in Table I, the vessel's weight increased by 10 grams after consolidation. According to these results, 0.68% of the resin in the vessel was impregnated, resulting in no significant increase in the original

mass of the artifact.

Table I: Mass before and after treatment consolidation with resin.

Mass before (Mb) the treatment (g)	**Mass after (Ma) the treatment (g)**	**Impregnation rate retained in the vessel (%) = 100·(Ma - Mb)/Ma**
1450	1460	0.68

The vessel's final appearance is consistent with the characteristic shine of Asurini do Xingu vessels. With the polymerized resin, the vessel acquired a glossy, unique, homogeneous film, which is very similar to the original Jatobá resin. As a result, the final appearance of the object, particularly in the areas where the original polychromy had been lost, was extremely satisfactory as the resin saturated the color of the clay, mimicking the color of this area of the object as a whole (Figs. 2-3).

Figures 2-3: The area of loss before and after treatment is shown in detail. Photo: Ader Gotardo, 2023.

The colorimetric analysis did not reveal any adverse changes in the visual aspect of the vessel. The losses areas were smoothed and the absence of detrimental changes in the object's appearance suggest that this method could be a viable option for Asurini do Xingu pottery experiencing analogous conservation issues.

4. Conclusions

The consolidation treatment carried out at IPEN was a successful experience. Using this method, the resin was consolidated to the vessel and no longer lost its decoration. Weighing revealed satisfactory impregnation of the resin to the vessel, in accordance to the brushing method. The aesthetic aspect of the treatment was consistent with the original glossy appearance of the Jatobá resin. It may be possible to conduct future studies in collaboration with Asurini do Xingu potters, allowing the artisans to participate directly in the decision-making process for the preservation of these objects.

Future studies may incorporate additional analytical techniques for resin characterization, such as investigating aging properties to monitor potential changes in the polymer's chemical structure caused by exposure to light or fluctuations in temperature and humidity. Further research can also contribute to the development of reversible or less toxic radiocurable consolidants, as well as resins with varying levels of gloss, expanding the options of consolidants compatible with different finishes of Asurini do Xingu vessels.

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