Study of organic residues in vessels of archaeological origin with physicochemical analytical techniques

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The thesis was conducted and presented at the Dept. of Conservation of Antiquities and Works of Art, Technological Educational Institute of Athens; supervised by Prof. S. C. Boyatzis. Information on the samples and the objects were provided by Ms D. Kotzamani, conservator at the «Laboratory for Metal, Glass and Bone Artifacts Conservation» of Benaki Museum. Part of the experimental work was conducted at the Dept. of Nutrition & Dietetics of Harokopio University of Athens; supervisory assistance on GC-MS sample workup and GC-MS runs was offered by Dr. M. Roumpou and Prof. N. Kalogeropoulos.

Vessels & Samples

A number of copper alloy vessels were selected from the Byzantine Collection of the Benaki Museum in Athens (128 artifacts, purchased from Egyptian markets by the museum’s founder, A. Benakis, during the early 20th century, Kotzamani et al. 2011) As there was no archaeological record of these objects, all information listed in the table below originates from the Doctoral Thesis of Dr Drandaki (Drandaki 2008), curator of the Byzantine Collection at the Benaki museum. (ill.1: Table1: Information about vessels and samples)
Methodology

The scheme above illustrates the experimental procedures for sample workup and analysis. (ill.1: Figure 1: Methodology of sample preparation and analysis procedures)

Results

Top, left: Summary of the results obtained through FTIR spectroscopy (Table 2). Top, right: FTIR spectra obtained after the extraction with acetone (Figure 2). Bottom, left: Bar chart illustrating the detected main components of all samples through GC-MS analysis (Figure 3). Bottom, right: Representative gas chromatogram of the sample #11622 (Figure 4).
GC-MS Results

The identified main components using GC-MS analysis of derivatised samples are:
- glycerol along with C16 and C18 monoacyloglycerols
- a wide variety of even numbered saturated fatty acids ranging from C8 to C26, as well as two odd numbered saturated fatty acids (C9 and C15)
- hydroxy- and dihydroxy- fatty acids: 2-hydroxy-heptanoic (C7(2-OH):0), 9,10-dihydroxy-octadecanoic acid (C18 (9,10-diOH):0), 13,14-dihydroxydocosanoic acid (C22 (13,14-diOH):0)
- a series of linear dicarboxylic acids, both even and odd numbered: C4 to C14.
- β-sitosterol is also present in a number of samples
- a wide variety of two different hydrocarbon types, CvH2v1 and Cv2H2v2-1, with v1 ranging from 28 to 31 and v2 ranging from 43 to 49 in some of the samples
- markers for oxidative degradation of pine resin: dehydroabietic, 7-hydroxy-/7-oxo-dehydroabietic, in sample 11622A (Figure 4: Bar chart illustrating the main components of each sample and their quantity)

Conclusions

The compounds found in the samples were identified as
- Oils collected from plants (Colombini et al. 2005, Evershed 2008, Evershed et al. 2001) of the Brassicaceae family in all samples
- Degradation products of castor oil (Colombini et al. 2005) in samples 11550, 11596,11544
- Fats (Mills et al. 1999) of unknown origin in sample 11544
- Pine resin biomarkers (Serpico et al. 2000) in sample11622A
- The results provide considerable help for the conservator, in order to choose a suitable conservation treatment for the artifacts

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DRANDAKI A., (2008), Bronze vessels of the Late Antiquity: technique, typology, use, terminology according to the collection of the Benaki Museum, PhD dissertation


ABSTRACTS

This poster presents the physicochemical analysis results of the organic residues from copper alloy artifacts dated between 5th and 7th cent. A.D. FT-IR and GC–MS were used to identify the composition of the residues. Biomarkers of pine resins were identified in one sample, while a broad range of oils and fats, along with their degradation products, were identified in all samples and associated with the presence of vegetable oil extracted from plants of the Brassicaceae family.

INDEX

Mots-clés: GC-MS, FTIR, analysis, residual organics, archaeology, bronze, vessels

Keywords: GC-MS, FTIR, analysis, organic residues, archeology, bronze, vessels

AUTHOR

KOUPADI KYRIAKI

Department of Antiquities and Works of Art Conservation, TEI of Athens.
domkoup.k@gmail.com/ koupadikrk@gmail.com)