

Hydrocarbon Contamination of Egyptian Embalming Resin: ¹⁴C Dating Effects

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KEY WORDS: Egyptian resin, bitumen, radiocarbon.

Abstract

Excessively old radiocarbon dates were found on resin specimens from a group of Egyptian mummies archaeologically dated to the Greco-Roman period (30 BC - AD 395). Organic analysis identified the presence of bitumen (asphalt) in the resin. The available evidence for the substances contained in ancient Egyptian resin is reviewed and the impact that «radiocarbon-dead» bitumen can have on ¹⁴C dating procedures is discussed. Attempts to extract the bitumen component from the resin prior to analysis were not predictably successful.

Introduction

Kellis site at the Dakhleh Oasis in Egypt's Western Desert has been under study for more than two decades. The mummified human remains found in 21 tombs at that site were studied in 1993 (Aufderheide et al, 1999; Aufderheide et al, 2003). Archaeological dating indicated a Greco-Roman Period for this site but radiocarbon dating of mummy tissue yielded several dates substantially older. The cause of the aberrant values proved to be contamination of the mummy tissue's resin content with hydrocarbons from bitumen, several of which had chemical signatures identical with asphalt from Israel's Dead Sea.

Materials and methods

The archaeological features of these mummies have been detailed in Aufderheide et al., 1999 and Aufderheide et al., 2003. Procedures employed to identify bitumen (asphalt) in the embalming resin have been reported in Maurer et al., 2002. Principal analytical steps involved gas chromatography and mass spectrometry. The techniques used for extraction of bitumen and the resulting changes in radiocarbon dating are detailed in a report accepted for publication (Aufderheide et al, in press). They involve simple immersion of the tissue specimen in benzene and acetone prior to radiocarbon analysis by accelerator mass spectrometry (AMS).

Results and discussion

Initially a part of a sample of hair known to be free of bitumen contamination was extracted with benzene and subsequent AMS radiocarbon dating carried out on both the original sample and the portion of the sample extracted with benzene. Essentially identical results were obtained (conventional ¹⁴C dates of 1890 (40) and 1870 (30) BP. The figures in parentheses represent one standard deviation. This established that benzene itself contributed no significant carbon atoms to the extracted specimen. Three samples (liver, muscle and resin) were extracted four times with benzene, two of which were pulverized and extracted with benzene several times. Results (Tab. 1) indicated no significant differences in radiocarbon dates between the unextracted and extracted muscle and resin samples and a reduction of 200 years for the liver sample when preparing the values with a range of two standard deviations.

Mummy No.	Specimen	Before Extraction			After 4 Organic Solvent Extractions			After pulverization & 7 Solvent Extractions		
		Lab. No.	R/A ¹	Conventional ¹⁴ C Age (±) ²	Beta Lab. No.	R/A	Conventional ¹⁴ C Age (±)	Beta Lab. No.	R/A	Conventional ¹⁴ C Age (±)
4	Liver	BI19806	R	2210 (50)	170565	A	2010 (40)	-	-	-
9	Muscle	GX20368	R	2245 (60)	170567	A	2240 (40)	172213	A	2160 (40)
7	Resin	BI20426	A	2580 (50)	170566	A	2660 (40)	172212	A	2660 (40)

Table 1

The probable reason for these results lies in the observation by Maurer et al (2002) that the contaminating materials are mixtures that include nonbotanical material, beeswax, bitumen and others. Some of these substances are insoluble.

The conclusion to be drawn from these studies is that tissue samples suspected to be contaminated by bitumen cannot be reliably freed of such contamination by benzene or other simple hexane extraction.

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