# The Secret Life of an Ancient Egyptian Weaver: Advancements to Identify Dyes and Fibers on an Ancient Egyptian Basket

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## Introduction

Below, is an Ancient Egyptian basket dated to the New Kingdom Era (1550-1292 BCE).
It is on loan to the Johns Hopkins Archaeological Museum from Eton College; its original provenance is unknown.
Its component materials—fibers used to coil basket and dyes to design the basket—are unknown.
Eton College provided a list of potential dyes that could have been used inferred from dyes used by Egyptians during that time period including: madder lake, indigo, safflower seed, pomegranate rind, henna, alkanet, and ochreous earths.
Identifying the components of ancient artifacts presents with many complications such as having limited samples of the artifact and inconclusive and ambiguous data.

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## Summary and Conclusions

The database alone does not allow any conclusions to be made about the basket. Once the fibers are identified, the next step is to make mock samples of the basket. The two identified fibers will be obtained and dyed with the dyes from the database. The dyed palm leaves will be analyzed using ATR-FTIR and XPS. Following that, sampling the basket from the dyed sections will be more permissible. ATR-FTIR should be run on those samples and compared to the model for identification of the dyes.

## Objectives:

This research aims to continue the process of identifying the dyes in the basket by:

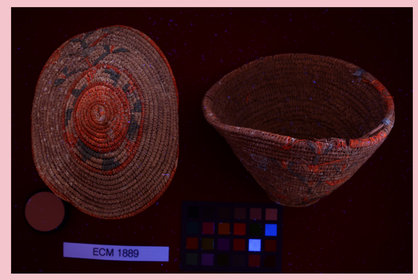
- building a database of proposed dyes from Eton College including their historical background and their spectral, chemical, compositional, and anatomical properties
- identifying plant fibers used to structure the basket


## X-Ray Fluorescence

Prior analysis was performed on the basket by JHU using X-Ray Fluorescence (XRF).
XRF is an elemental analysis technique that uses x-rays to detect elements present on a surface. It is non-destructive.
Four areas were tested: undyed, red dye, blue dye, and yellow dye.

**Findings:**
Major peak: Ca
Minor peaks: Fe, Br, Sr, Rh, Cl, Ni
Trace peaks: K, S, Ti, Mn, Cu
All graphs were generally the same except for an elevated Cl in the yellow area, and a smaller Br peak and elevated Fe peak in the red area.

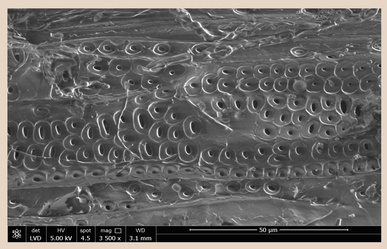
## Ultraviolet Luminescence

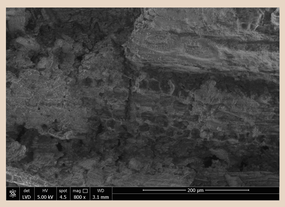


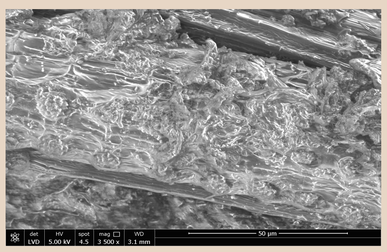

Previous analysis also included varied multispectral imaging techniques, including UVL. The red-orange glow suggests the red dye may be madder lake.

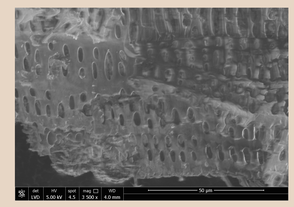
## Scanning Electron Microscopy

During transportation, the basket shed a few fibers that were collected for analysis using the scanning electron microscope (SEM).
After examining the basket under an optical microscope, it was hypothesized the there are at least two types of fibers used to coil the basket: one to form the coils and one that wraps around the coils used to stitch the coils together.
Potential fibers: date palm, doum palm, papyrus, halfa grass, and flax
Below are some of the SEM images taken of the basket. They are currently being analyzed by the British Museum's conservator, Caroline Cartwright for identification.




## Database of Dyes:

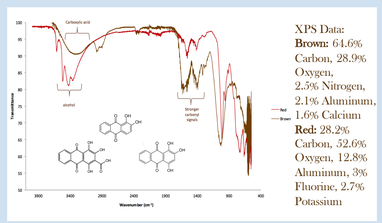
The database compiles information about dyes obtained from Kremer pigments. All of them were analyzed using Attenuated Total Internal Reflectance - Fourier Transform Infrared Spectroscopy (ATR-FTIR), and a few of the dyes were analyzed using X-Ray Photoelectron Spectroscopy (XPS).

ATR-FTIR:
Measures vibrational energy of molecules by passing a beam of infrared light through the molecule.
Vibrational frequencies correspond to the type of organic bonds present.

XPS:
Measures elemental composition in the parts per thousand range to give the empirical formula of the compound
X-Ray beams irradiate the material and measures the number of electrons transmitted from the surface with their corresponding kinetic in a high vacuum
XPS was run on brown madder lake, red madder lake, indigo, and yellow ochre from Andalusia

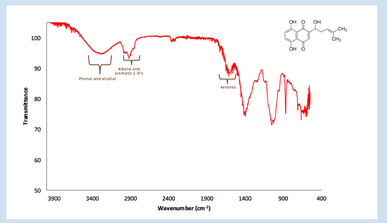
**To the right, and below, are the IR spectra taken using the Thermo Scientific Nicolet iS5 iD5 ATR-FTIR Spectrometer of 10 potential pigments used on the basket.**

### Madder Lake

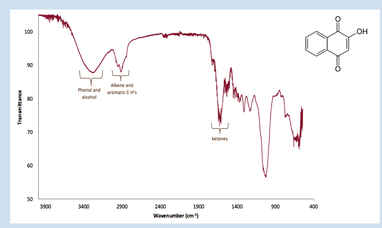



XPS Data:
**Brown:** 64.6% Carbon, 28.9% Oxygen, 2.5% Nitrogen, 2.1% Aluminum, 1.6% Calcium
**Red:** 28.2% Carbon, 52.6% Oxygen, 12.8% Aluminum, 3% Fluorine, 2.7% Potassium

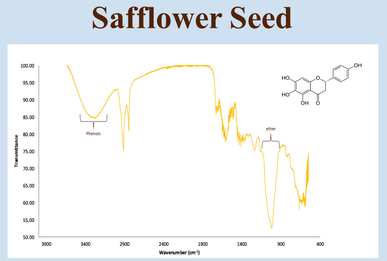
### Alkanet



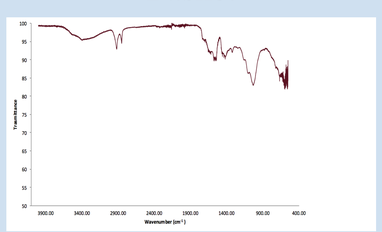

### Henna Red



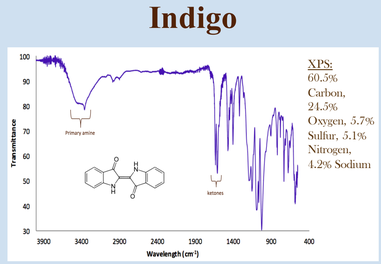

### Safflower Seed




### Basket

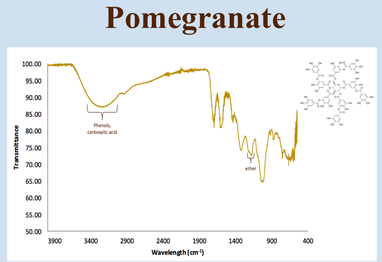



### Indigo

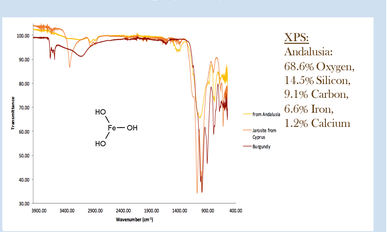



XPS:
60.5% Carbon, 24.5% Oxygen, 5.7% Sulfur, 5.1% Nitrogen, 4.2% Sodium

### Pomegranate




### Ochres




XPS:
Andalusia: 68.6% Oxygen, 14.5% Silicon, 9.1% Carbon, 6.6% Iron, 1.2% Calcium