Paper Dyeing and Ink Corrosion in Mamluk Manuscripts:

A Material Study of 15th-Century Manuscripts

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Presentation overview

- Introduction to the study’s origins and research focus
- Papers and dyed papers used in manuscripts
- Ink corrosion in Mamluk manuscripts
- Scientific analysis
- Infrared imaging methods and digital restoration processes



Introduction





- 62 volumes
- Each ca. 210x310x70 mm
- 14.493 leaves

Kashf al-Bayān an Sifāt al-Hayawān
Abu'l-Feth Muhammad b. Sheikh Bedreddin
(al-Awfī, d. 1534 in Damascus)

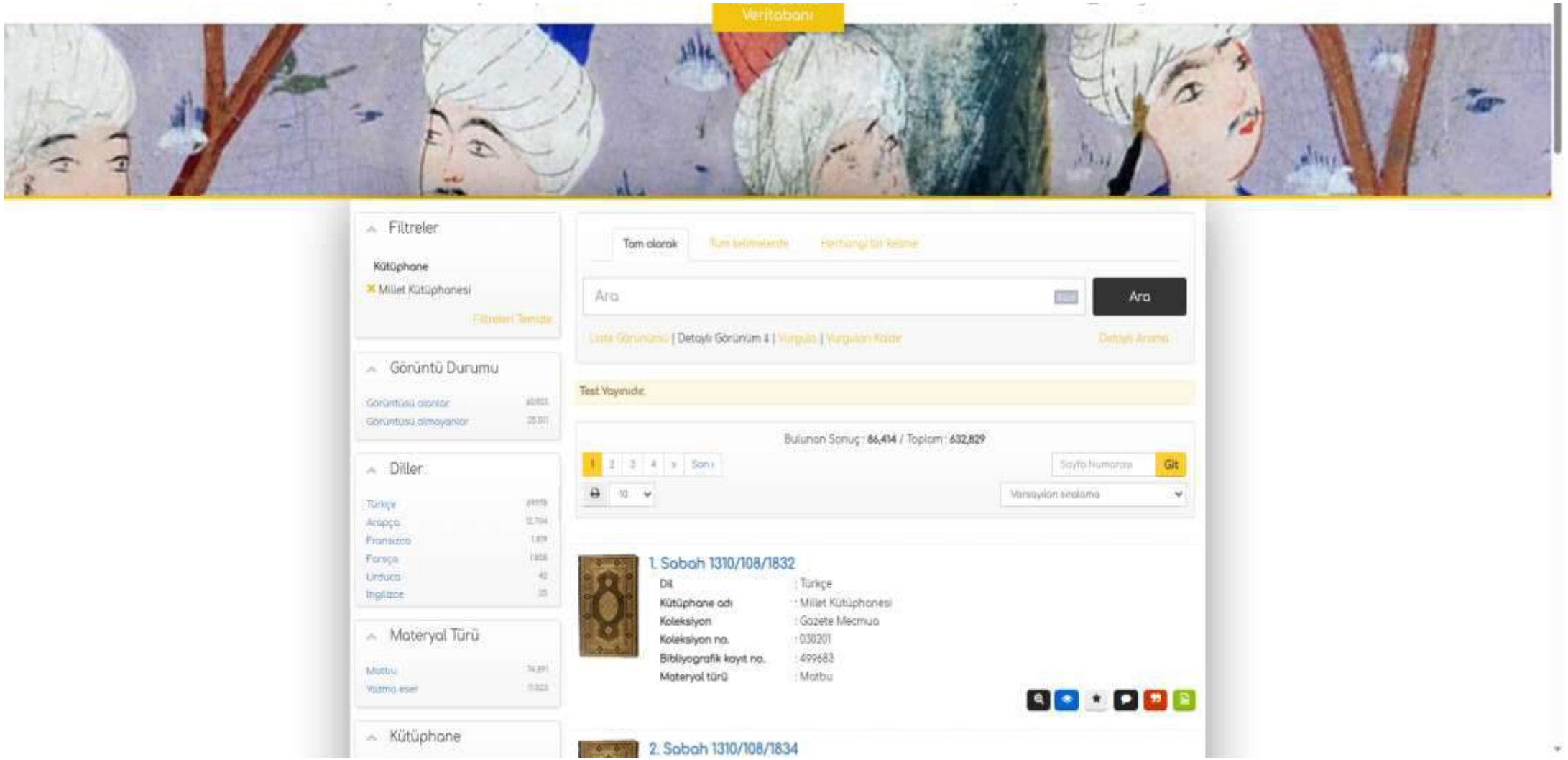
Introduction







TUYEK, Millet ML, Feyzullah Efendi 1720, 1714



https://portal.yek.gov.tr/

Introduction

Place	Number of Mss	Date (H.)
Damietta	1	789
Fustat	1	899
Medina	1	747
Mosul	1	748
Tripoli	1	834
Jerusalem	2	763-835
Nablus	2	823-824
Mecca	3	801-901
Gaza	4	833
Aleppo	6	738-894
Egypt	11	737-846
Cairo	14	714-889
Damascus	16	722-778

Mamluk Manuscripts with dyed papers, 69 examples with known place and date of copying



TUYEK, Suleymaniye ML, Fatih 1381, 763 H. Jerusalem

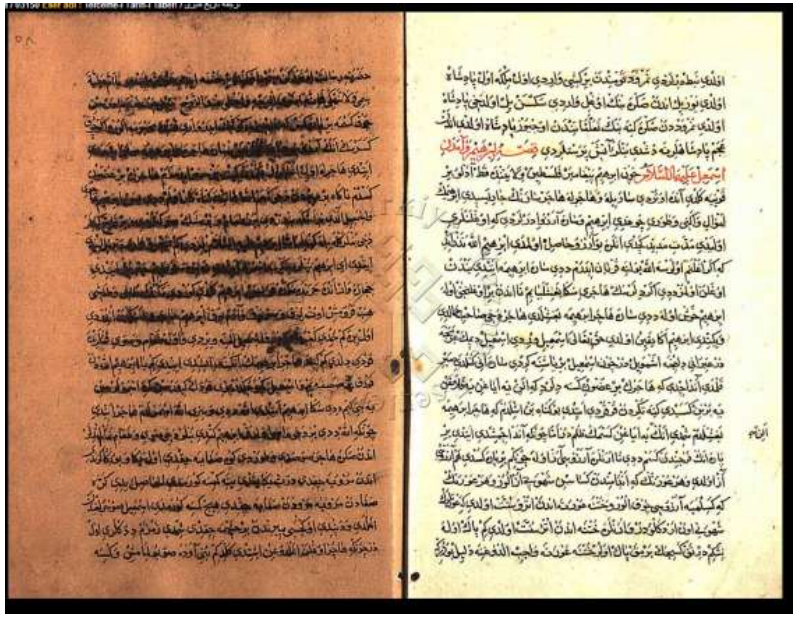


TUYEK, Millet ML, FE 1720, 763 H. Egypt

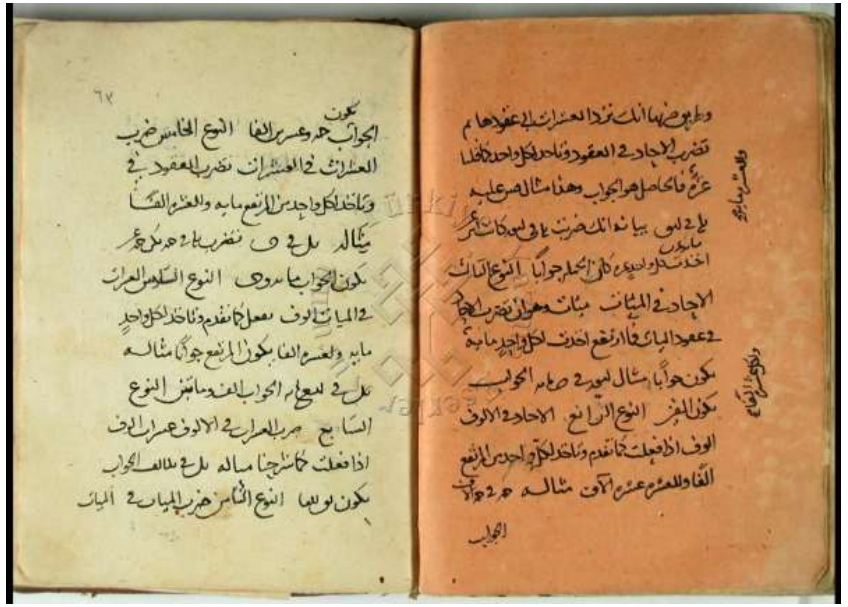
Introduction



TUYEK, Suleymaniye ML, Ayasofya 4032, 778 H. Damascus



TUYEK, Suleymaniye ML, Ayasofya 3150, 851 H., Aleppo



TUYEK, Suleymaniye ML, Ayasofya 3483, 754 H. Damascus



TUYEK, Suleymaniye ML, Ayasofya 979, 768 H. Egypt

Papers and Dyed Papers Used in Manuscripts



TUYEK, Süleymaniye ML, Turhan Valide 48, f. 506b-507a
Ottoman Period, 1460's



TPML, Hazine 2153, f. 11a

Timurid Period, 15th century



TUYEK, Millet ML, Feyzullah Efendi 1720, f. 57b-58a
Mamluk Period, 15th century

Papers

Paper documentation protocol

Protocol for classification : Visual interpretation **1 / 2 / 3 (little, medium, much)**		**Notes**
Manuscript and Page no:		
Properties of a Paper		
Quality of Paper	good / medium / poor	
Surface Characteristics		
Sizing	light / heavy	
Pulp Characteristic		
Translucency	opaque / translucent	
Distributiion of Fibres	clumping /uniform / floccular / water drops / variation of density	
Inclusions	flecks /	
Chain – Line Characteristic		
Clarity	easy / hard to coun	
Character	strait / waving	
Laid – Line Characteristic		
Clarity	easy / hard to coun	
Character	straight / sagging / curve	
Rib Shadows	lightly / hardly seeing	

Papers

Estern / Islamic / Arabic /

Non-watermarked Paper

Chain Lines Grouped in Threes (in 69 manuscripts)

Min-Max thickness: **0,06 – 0,18mm**

Avg. Thickness: **0,12 mm**

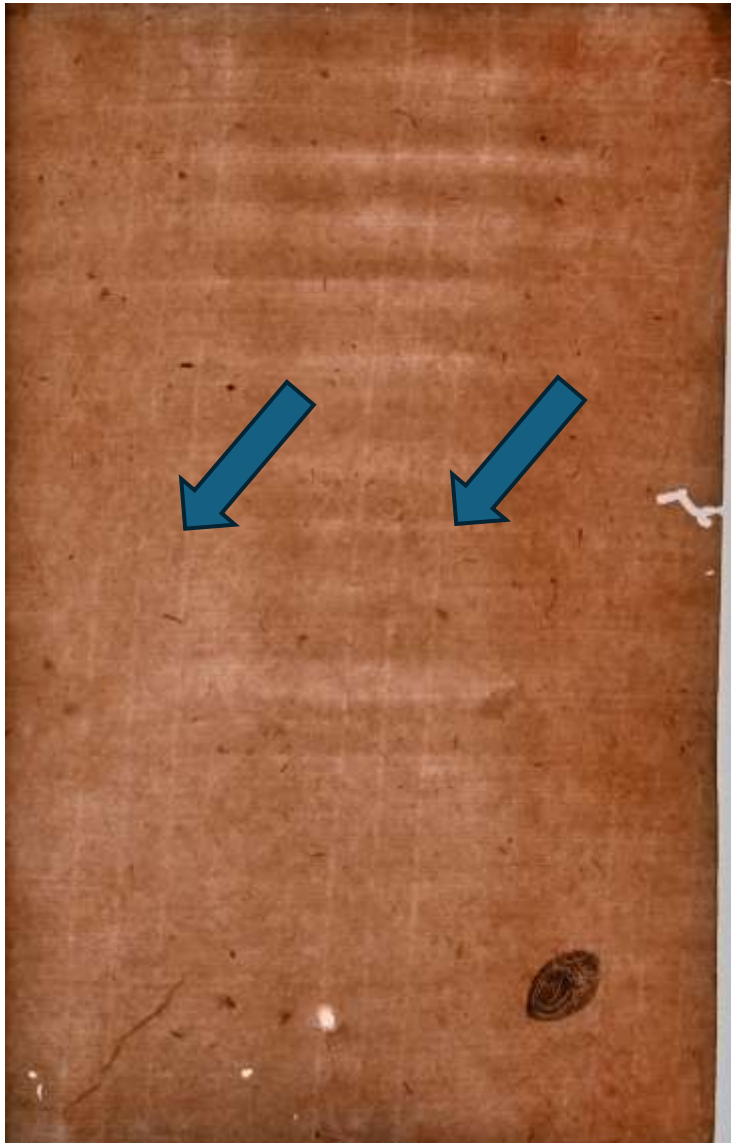
Laid lines in 1 cm: **7 – 12 (avg. 8,9)**

SizAvg. CIE L*a*b*: **88,2 * 1,50 * 12,44**

Pulp : **Homogenius (70 %)**

Chain lines dist. min-max: **11-12-54-13-12-48 mm**

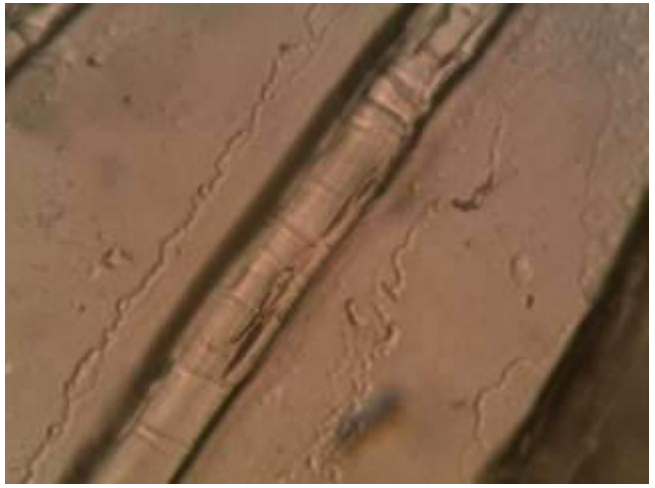
Chain lines direction to spine: **Parallel / Vertical (60 % / 40 %)**

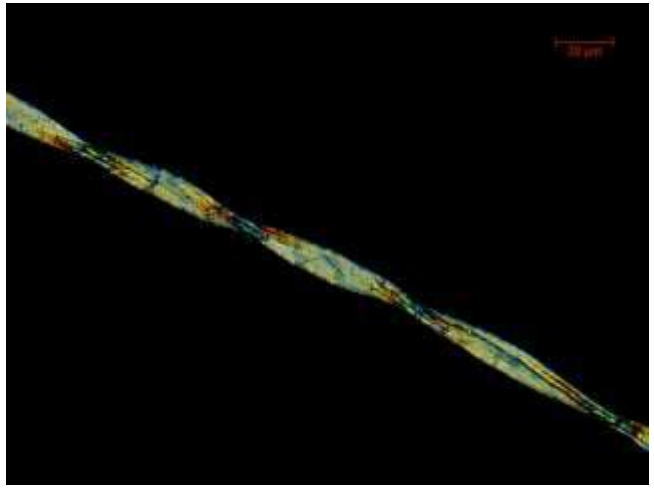


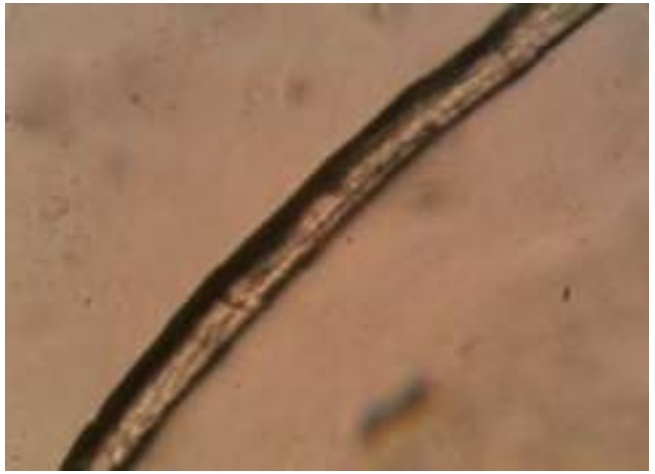
TUYEK, Süleymaniye ML, Ayasofya 2008

Papers











Hemp, linen or flax and cotton fibers, x100

Papers and Dyed Papers Used in Manuscripts



TUYEK, Millet ML, Feyzullah Efendi 1690_1, 15th century
Paper dyed with indigo, surface dying



TUYEK, Beyazıd ML, Beyazıd 5327, 17th century
Paper dyed with colored water extracted from various plants, surface dying

Paper Dyeing Techniques in Islamic Manuscripts
Surface Dyeing: Immersion or Brushing

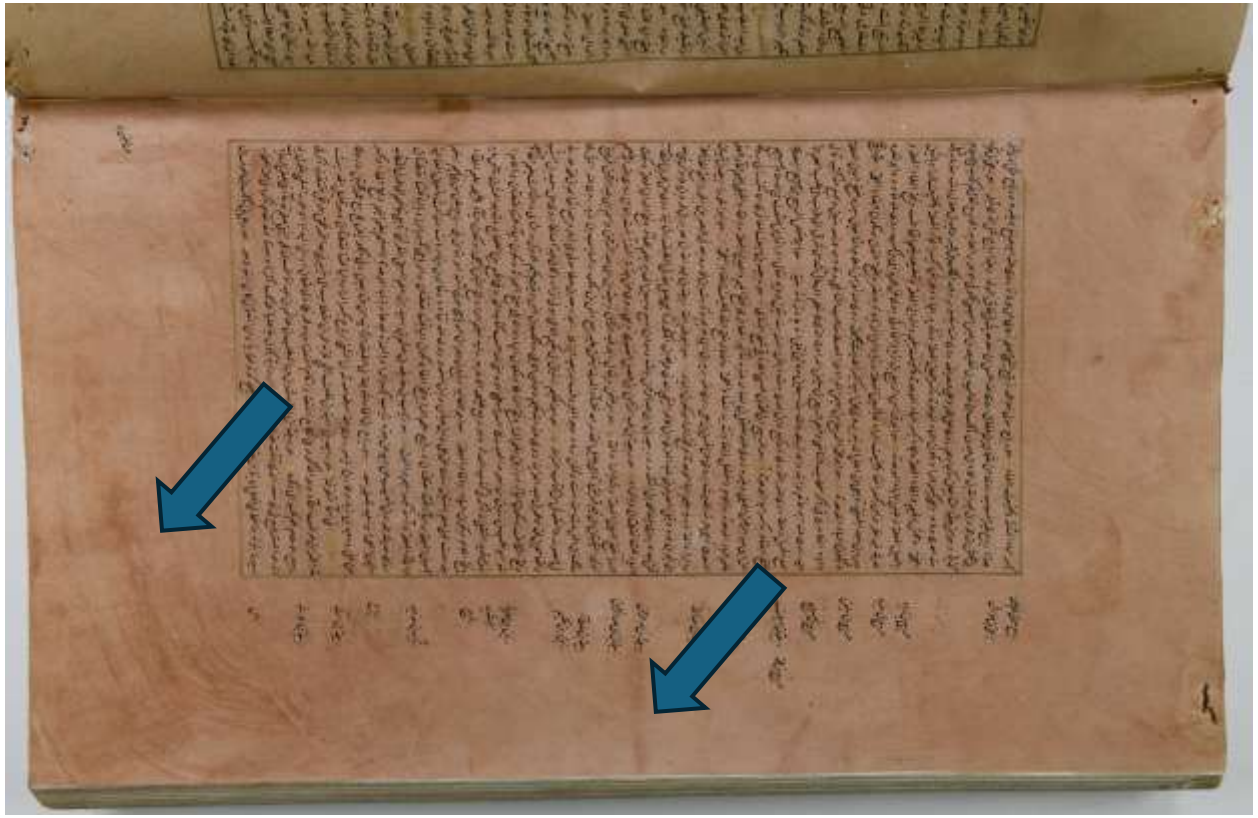
- The dye is applied after the paper has been produced, either by immersing the sheet in a colored solution or by brushing the solution onto the surface.
- Common plant dyes: saffron, turmeric, safflower, lac, sapanwood, henna, pomegranate bark, indigo, sunflower croton.
- Mineral pigments: verdigris, orpiment, blue vitriol.
- Resulting colors: blue (indigo), yellow-brown (pomegranate peel), brown-black (walnut husks), etc.
- Typically extracted by boiling or soaking and fixed with mordants.





Paper Dyeing Techniques in Islamic Manuscripts
Colored Sizing Layer

- The sizing layer applied to the paper surface is colored, so the paper is both sized and dyed in a single process.
- Evidence of this technique: thick colored sizing residue and visible brush marks.



TUYEK, Süleymaniye ML, Turhan Valide 48

Paper Dyeing Techniques in Islamic Manuscripts
Pulp – Coloring Process

- The paper is dyed while still in pulp form, allowing the color to penetrate the fibers completely
- This type is particularly linked to ink corrosion.
- Example: The *Kashf al-Bayān* manuscript, which contains both undyed and dyed papers, including cream and darker shades (nohudi).



Ink corrosion in Mamluk manuscripts



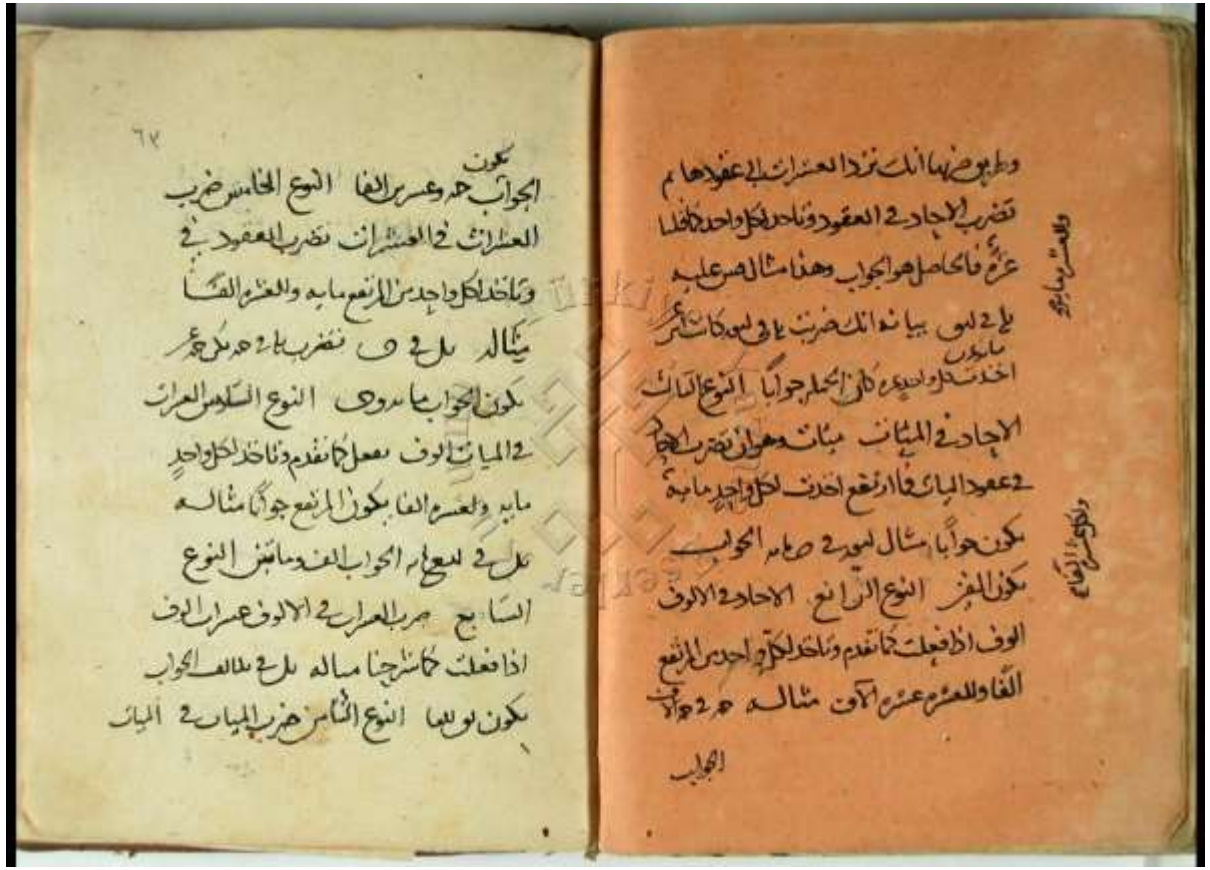
TUYEK, Millet ML, Feyzullah Efendi 1714, 15th century Alexandria



TUYEK, Suleymaniye ML, Ayasofya 979, 768 H. Egypt

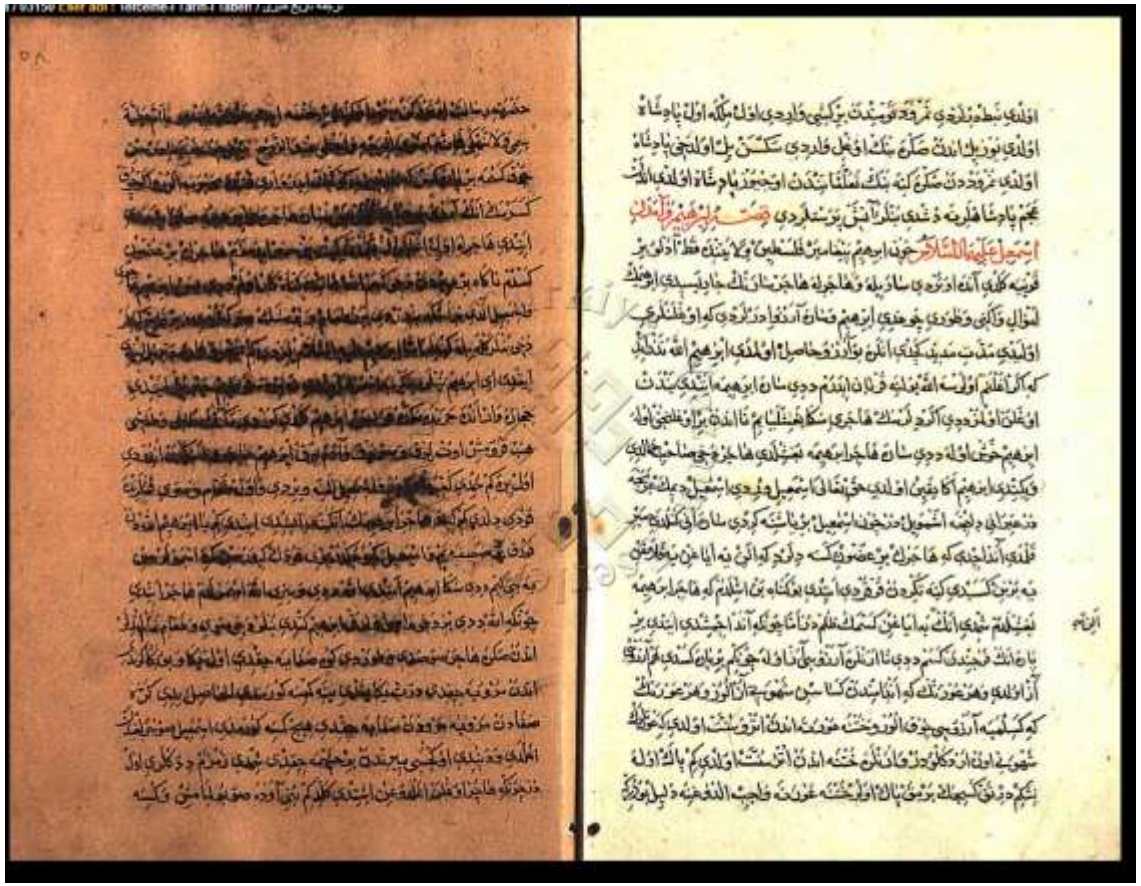
Ink corrosion in Mamluk manuscripts

Carbon ink



TUYEK, Suleymaniye ML, Ayasofya 3483, 754 H. Damascus

Iron-containing ink, iron-gall?



TUYEK, Suleymaniye ML, Ayasofya 3150, 851 H., Aleppo

Ink corrosion in Mamluk manuscripts



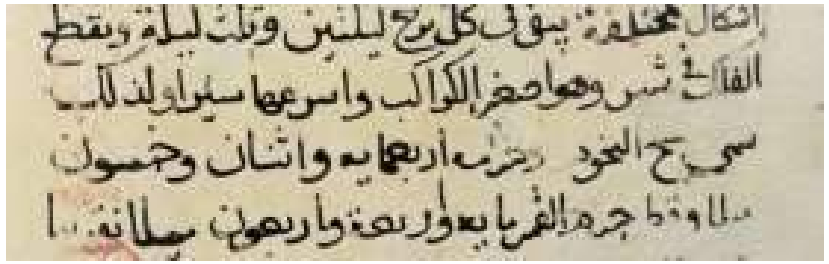
TUYEK , MML, FE 1721

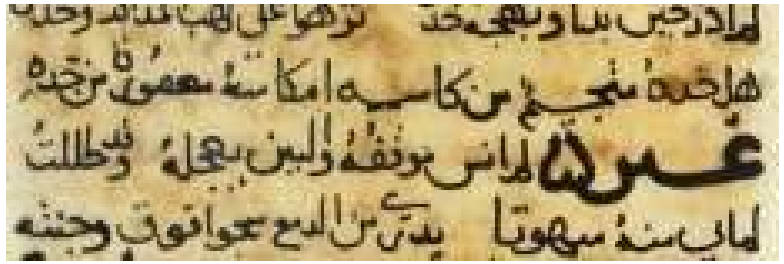


TUYEK , MMl, FE 1716



TUYEK , MML, FE 1709







Ink corrosion in Mamluk manuscripts

Iron-Gall Ink: Composition & Characteristics

Main Ingredients:

1. **Tannin** (from oak galls or other plant sources)
2. **Vitriol** (Iron or Copper Sulfate)
    1. May contain trace metals: copper, aluminum, zinc, manganese
    2. These do *not* contribute to color
3. **Water**
4. **Gum Arabic**
    1. Acts as a **binder**
    2. Helps disperse ink in water

Scientific analysis

Hue	**Fe signal (cps)**	**L***
Light 	138, 54	83,55
Moderate 	185,09	77,13
Dark 	273,55	69,28

Scientific analysis XRF analyses)



Paper Tone	Fe cps (Ink)	Fe cps Difference (Ink - Paper
Dark (66b)	461,29	173,47
Light (67a)	251,34	112,34

TUYEK MYEK, FE 1701

The relationship between ink corrosion and iron content

Ink Corrosion Level	Paper Tone	Fe cps (Ink)	Fe cps Difference (Ink - Paper
Ink corrosion	Light (1a)	314,41	207,89
	Dark (20a)	262,40	68,68
	Medium (47b)	335,25	150,16
	Dark (48a)	650,56	395,16
	Dark (66b)	461,29	173,47
Medium corrosion	Dark (6a)	356,68	83,13
	Medium (30a)	497,13	342,22
	Light (44a)	273,05	130,22
No corrosion	Light (5a)	224,60	86,86
	Light (61a)	251,34	112,34
	Dark (11a)	308,78	57,58

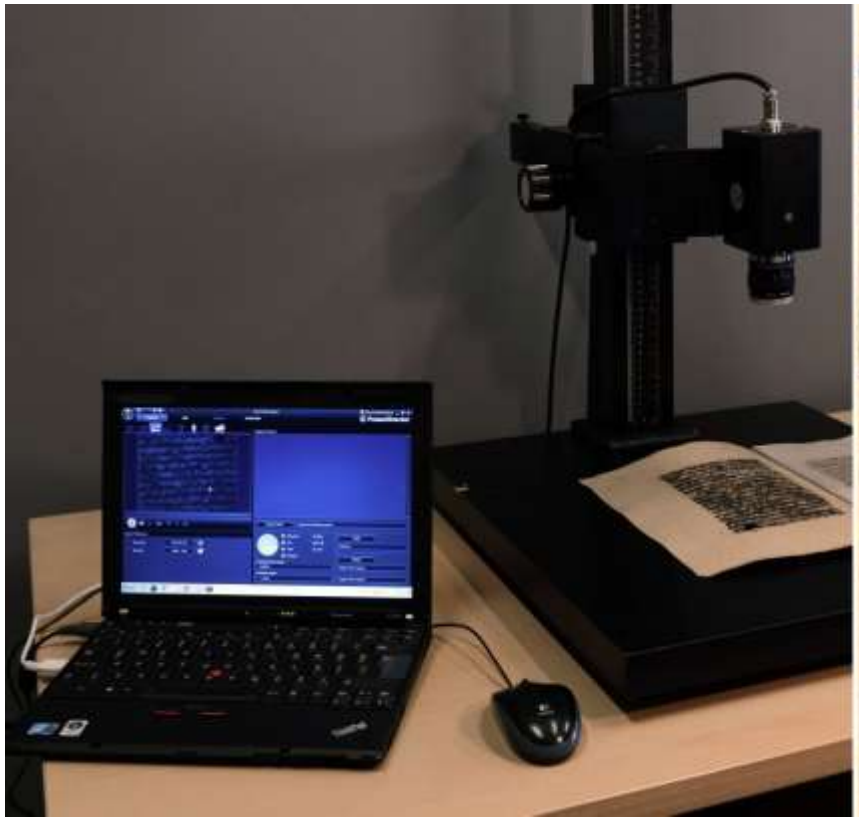
Scientific analysis (HPLC analyses)

Coloring compounds	Biological source	Imagings of plants
Gallic acid and their derivative Ellagic acid and their derivative Chrysophanol	Oak gall (*Quercus ithaburensis*) or Peel of pomegranate (*Punica granatum*)	 Oak gall Peel of pomegranat
Emodin Luteolin Apigenin	Oak gall (*Quercus ithaburensis) or* Peel of pomegranate (*Punica granatum*) Weld *(Reseda luteola)* *+* Rhubarb or dock (*Rheum* or *Rumex* sp.)	 Weld Rhubarb
Flavon Emodin Isorhamnetin Rhamnetin	Oak gall (*Quercus ithaburensis) or* Peel of pomegranate (*Punica granatum*) + Buckthorn (*Rhamnus petiolaris)*	 Buckthorn

Oak gall, gall shellac, peel of pomegranate, weld and buckthorn were all identified as tanning materials and coloring compounds.

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Infrared (IR) imaging methods and digital restoration processes









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Thank you

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