

**Letter**

# Study of the Micro Biological Deterioration Effect on the Vegetable – Tanned Leather Shoes from Mamluk Era with an Application on the Agricultural Museum in Egypt

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**Abstract:** Vegetable tanned leather shoes are considered one of the most important museum artifacts in the both local and international museums, they represent cultural and civilized heritage, we can devise from them very important information about history, Art and important sciences. They are exposed to several problems in their excavated sites or inside museums and their stores; the most important problem is the Biodeterioration which causes the degradation and the loss of these shoes in the end by secreting organic acids like oxalic and citric acids. In this research this problem will be presented with an application on a chosen object from the Agricultural museum in Egypt, Biological scans by sterilized swabs were taken from the surface of the shoes to identify the Fungi grown on the surface of the shoes.

**Keywords:** Vegetable Tanned, Leather Shoes, Mamluk Era, Microbiological Deterioration, Fungi, Agricultural Museum

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## 1. Introduction

### (a) Anatomical and chemical composition of leathers

Leather is considered a flexible membrane which covers the surface of human and animal bodies, the animal leather are covered with fur and hair, it reflected a lot of their properties like: age, sex, environment which they lived and their health cases.

There are two expressions for raw animal leathers: "Row skins" which is called to small animals in age and size like: calves, pigs, sheep and goats, the other is "Row hides" which is called to big animals in age and size like: cows, buffalos, horses and big cattle.

Leather is considered chemically complicated organic material; the Mammalian skins consist of three layers:

- Epidermis;
- Dermis (or Corium);
- Hypodermis. Figure (1).

Proteins are considered complicated organic compounds which enter in the composition of several archaeological

materials; they are the essential compound of archaeological leathers and parchments.

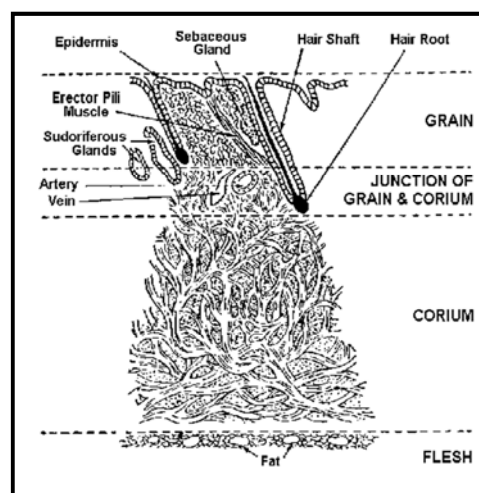


Figure 1. Shows the anatomical structure of leather.

Proteins contain carbon, hydrogen, nitrogen and oxygen elements, all proteins contain approximately sulphur in their composition but nitrogen is the distinctive compound of protein.

From the last studies which were made on a lot of proteins from different sources, it was found that the percentage of essential elements which formed proteins is:

- Carbon 50-55%
- Hydrogen 6-7.3%
- Oxygen 19-24%
- Nitrogen 13-19%
- Sulphur 0-4%.

The proteins molecular weight is very high, it ranges from 13.000 to several millions, the protein molecule consists of  $\alpha$ -amino acid which linked with peptide bonds, in the hydrolysis of proteins, we found the simple organic compounds “ $\alpha$ -amino acids”.

#### (b) Tanning process

##### (1) The aim of tanning process

The essential aim of tanning process is to protect dark places of Collagen (the protein of leathers) from liquids and bacterial attack; we can reach it by the reaction with the side chains of protein to unite with the tanning material.

##### (2) Vegetable tanning

Vegetable tanning “red tanning” depends on the use of tannin substance or tannic acid which unites with the collagen of leather “the chemically united water in collagen replaced with the tannic acid”, the leather fibers after tanning will be strong, cohesive, smooth and water repellent.

##### (3) Tanning chemistry

Tans are a word called to vegetable tanning substances which are responsible for transferring raw leathers to available use leathers. Tans are all natural substances which have physical and chemical properties to be capable of leather manufacturing.

They include water soluble phenolic compounds which have molecular weight between (500-3000). Tans contain complicated elements which depend on four atoms: “carbon, oxygen, hydrogen and nitrogen”, there are two types of tans:

- 1 – Catechols or condensed tans;
- 2 – Pyrogallols or hydrolysable tans.

## 2. Materials and Methods

Microorganisms like: Bacteria, Actionmycetes, Algae and Fungi have a big effect in the deterioration of organic materials like leather if they find the suitable conditions for their growth like: relative humidity increase in the surrounded environment.

Microorganisms cause a severe deterioration for vegetable tanned leathers because of the organic acids they produce which cause the increase of acidity in leather, the hydrolysis of leather and the vegetable tanning lost.

Also the environment in the museum encourages the insects' growth like: Termites, beetles and also silverfish which grow on the leather and the tanning materials causing the lost of them after a short time.

A biological swab were taken from a vegetable tanned leather shoe belonged to Mamluk era (No. 1731) from the Agricultural museum in Dokki – Cairo – Egypt to identify the biological colonies which deteriorated it – Figure (2).



**Figure 2.** Shows the vegetable tanned leather shoes in the Agricultural museum and the shoe. No. 1731.

## 3. Results and Discussion

We found 6 types of fungi as followed in table:



**Figure 3.** Shows *Penicillium notatum* under the microscope.



**Figure 4.** Shows *Aspergillus niger* under the microscope.



**Figure 5.** Shows *Penicillium egyptiacum*.

**Table 1.** Shows fungi types found from the shoe no. 1731 biological scans.

Fungal colony counts /sample	Fungi found in sample (A)
3	<i>Aspergillus terreus</i> Thom Syn. <i>A. Venetus</i> Massee
2	<i>Aspergillus sulphureus</i> (Fresenius) Thom and church
4	<i>Aspergillus niger</i> van Tieghem Syn. <i>A. fuscus</i> , Schumann
2	<i>Penicillium notatum</i> Westling
2	<i>Penicillium egyptiacum</i> van Beyma
1	<i>Penicillium niklewiskii</i> Zaleski

The vegetable tanned shoes from the Mamluk era in the agricultural museum exposed to various deterioration factors especially the biodeterioration like fungi, many scans were taken from the shoe no. 1731 to identify the microorganisms grown, the results are the following fungi (6 types) (*Aspergillus terreus*, *Aspergillus sulphureus*, *Aspergillus niger*, *Penicillium notatum*, *Penicillium egyptiacum*, *Penicillium niklewiskii* – Figure (3-5). The reasons of these fungi growth are the high percentage of relative humidity, the existence of dusts inside the showcases of the museum beside the loss of

tanning materials of the shoes.

## 4. Conclusion

Leather objects are one of the organic materials which are very weak and do not resist the deterioration factors in both burial and exposure environments, the most destructive deterioration factor is the biodeterioration, microorganisms especially fungi produce organic acids like oxalic and citric acids, these acids react with the vegetable tanned leathers and the result is the loss of tanning materials and the weakness of leather so it is very important to control these microorganisms to save this precious cultural heritage to the coming generations.

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