CHROMATIC ASSESSMENT OF NEWLY MANUFACTURED LEATHER AND PARCHMENT FOR MUSEUM PURPOSES

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Cultural heritage represents a national treasure evolving from the culture and spirituality of people. Therefore, it must be continuously recovered, protected and developed by all generations as priceless heritage. Referring to the Romanian cultural heritage items that are placed in restoration, at present, some works have been done for partial or complete replacing of degraded materials, both as the result of ageing under atmospheric and biologic agents. The aim of this study is testing different samples of new leather and parchment under UV radiation in the 220-380nm domain, in order to simulate the accelerated destruction in photo-oxidative conditions. The following materials have been studied: book binding leather obtained from calf hide, tanned by different systems (vegetable or vegetable and chromium) and parchment obtained from different kinds of animals. The evolution of the chromatic characteristics (luminosity, shade and chroma) at different exposure time was quantified by the diffuse reflectance technique in visible domain range and CIE – Lab software. Based on the chromatic stability after UV exposure, the most stable types of leather and parchment have been selected for further applications in the restoration process of historical manuscripts and books' covers.

Keywords: chromatic investigations, parchment, leather

INTRODUCTION

A very important category from the museum cultural heritage is represented by leather and parchment objects, which lead to precious historical information. Such kind of objects are book bindings, manuscripts, charters, belts, arm covers, maps, sword sheaths, etc.

In order to perform this study, some of the most representative Romanian cultural heritage objects (Fig. 1 and 2), which are made out of leather and parchment, were taken into consideration: a Romanic Greek Evangelic book, an old printing by the Metropolitan Theodosie, from 1693, a Bucharest Bible from 1688, an old printing by Serban Cantacuzino, an Evangelic from 1697, an old printing by Antim Ivireanu, a Penticostarion from 1742, a document on parchment by Simion Moghila, from 1601 and a document on parchment by Mihail Racovita, from 1731.

The restoration of cultural heritage objects from leather or parchment involves, in many cases, the replacement of the irremediable destroyed parts with new ones. The manufacturing process of new pieces of leather and parchment for museum purpose assumes the fulfilment of some specific characteristics, adequate for each cultural heritage object. Two of the most important features of new collagen-based materials (leather and parchment) are represented by the structural compatibility and durability. In order to obtain the structural compatibility, the manufacturing process of new leather and parchment must be very similar to the old one, in which natural auxiliary materials, vegetable extracts and special handmade operations were used.

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Figure 1. Document on parchment by Simion Moghila 1601

Figure 2. Old printing by Serban Cantacuzino, Evanghelic from 1697

Regarding the assessment of leather and parchment durability, it is obtained by simulating some artificial ageing processes, followed by a series of chemical, physical-mechanical and instrumental analyses.

The aim of our paper is to present an objective instrumental procedure meant to evaluate the durability characteristics of newly manufactured leather and parchment for further use in the interest of museums.

MATERIALS AND METHOD

In order to produce new leather and parchment items for museum purpose, we tested different types of technologies and chemical auxiliary materials, especially selected to fulfill the specific characteristics required for such materials. The main characteristics that leather and parchment must have for museum restoration purpose are the following: structural compatibility with the restoration cultural heritage object, physical-mechanical strength and color preservation on artificial ageing.

Among all newly manufactured leather and parchment samples, only a few were selected by means of physical-mechanical and chemical tests. From this point of view, the most resistant types of leather and parchment were:

- leathers tanned with: chestnut (1Ch), chestnut and chromium (2Ch/Cr), oak (1O), oak and chromium (2O/Cr), mimosa (1M), mimosa and chromium (2M/Cr), quebracho (1Q), quebracho and chromium (2Q/Cr);
- parchment obtained from lambskin, unhaired with enzymes (PL1), sulphide and lime (PL2), unhaired with lime (PL3); parchment obtained from calfskin, unhaired with lime (PC1) and parchment obtained from goatskin, unhaired with lime (PC2).

In order to assess the durability of leather and parchment, different types of experiments have been proposed for simulating the environmental conditions, which contribute to oxidative, hydrolytic or thermal degradation (STEP Leather Project, 1991-1994; ENVIRONMENT Leather Project; Chahine; 1995; SMT Programme; IDAP Project, 2001).

In our previous works (Sendrea *et al*., 2017; Miu *et al*., 2002a; Miu *et al*., 2002b; Meghea *et al*., 2002), different kinds of artificial ageing have been performed by simulating the thermal degradation in cyclic exposure times (at 70 °C, 168 hours - cycle I, 336 hours - cycle II and 504 hours - cycle III) followed by physical, mechanical, chemical, instrumental analyses (DTA, DSC, UV-VIS-NIR, IR). Another type of artificial ageing that was performed implied artificial light conditions using a Xenotest device.

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In order to establish a reliable method of evaluation of new leather and parchment materials manufactured for museum purposes, we have also tested the thermal-photo oxidative degradation under UV radiation in the 220-380 nm domain, in a special room, at 50 – 70 °C, in oxidative conditions.

The color change of samples was assessed by measuring the chromatic characteristics like luminosity, shade and chroma by the diffuse reflectance technique in the UV-VIS-NIR range (spectrometer V 570, JASCO). The main chromatic characteristics were processed with CIE-Lab software. This technique can also allow the evaluation and selection of different kinds of treatments for leather and parchment maintenance.

RESULTS AND DISCUSSION

Tables 1 and 3 show the chromatic characteristics obtained for the initial samples of leather and parchment and for the same samples, but after 250 hours of exposure in photo-oxidative conditions. In tables 2 and 4, the chromatic characteristics are again presented, but this time, they are expressed as the differences between the final and the initial state.

The chromatic modification of leather and parchment`s surface under thermal, UV or artificial light conditions represents the result of a predominantly oxidative (ENVIRONMENT Leather Project; Meghea *et al*., 2002) degradation of proteins by generation of ketone groups (Miu *et al*., 2002b) and simulates in a satisfactory way the natural ageing process of collagen-based materials. The artificial ageing in thermal photo-oxidative conditions leads to the modification of the main chromatic and organoleptic characteristics (softness, touch) of the early-mentioned materials.

By combining the chromatic characteristics measured by diffuse reflectance technique, CIE-Lab software, and organoleptic assessment of leather and parchment exposed at UV radiation (Herascu *et al*., 2008; Plavan *et al*., 2010), it was possible to select the suitable samples for restoration purpose as follows: 2Ch/Cr, 1O, 1Q - leather samples, and PC2 - parchment sample, as the most resistant and appropriate materials for restoration propose.

Table 1. Chromatic characteristics for leather samples exposed to UV radiation

Sample symbol and type of tannage	Chromatic characteristics					
	L*		C*		h_{ab}	
	initial	250h	initial	250h	initial	250h
1Ch	38.96	42.96	16.19	20.69	64.38	71.69
2Ch/Cr	31.97	43.13	10.35	11.35	52.10	61.02
1O	45.04	38.96	15.68	16.20	70.64	64.38
2O/Cr	29.83	32.74	6.41	8.06	45.88	60.36
1M	55.78	46.77	16.00	25.10	65.86	61.18
2M/Cr	49.92	45.44	15.20	20.58	58.26	60.10
1Q	55.82	49.97	21.82	23.46	64.70	61.00
2Q/Cr	45.72	40.37	20.80	19.19	58.10	56.00

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Table 2. Modification of chromatic characteristics of leather samples exposed at UV radiation (%)

Sample	Modification of chromatic characteristics				
	Initial sample	After UV exposure	L*	C*	h_{ab}
1Ch			+10.3	+27.7	+11.1
2Ch/Cr			+6.8	+9.7	+17.1
1O			-13.8	+3.3	-8.8
2O/Cr			+9.7	+25.7	+31.6
1M			-16.2	+56.9	+7.1
2M/Cr			-9.1	+35.5	+3.2
1Q			-10.4	+7.5	-5.7
2Q/Cr			-11.7	-7.8	-3.6

Table 3. Chromatic characteristics for parchment samples exposed at UV radiation

Sample	Chromatic characteristics					
	L*		C*		h_{ab}	
	initial	250h	initial	250h	initial	250h
PL1	72.90	72.37	26.01	31.50	88.21	83.58
PL2	68.46	82.06	14.70	25.74	81.08	86.93
PL3	76.61	83.17	3.90	10.90	77.22	87.38
PC1	82.40	88.81	7.30	9.76	75.73	87.48
PC2	80.26	88.86	14.24	17.92	80.18	89.84

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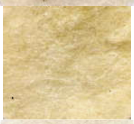
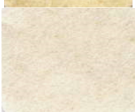
Table 4. Modification of chromatic characteristics of parchment samples exposed at UV radiation (%)

Sample	Modification of chromatic characteristics				
	Initial sample	After UV exposure	L*	C*	h_{ab}
PL1			+10.3	+27.7	+11.1
PL2			+6.8	+9.7	+17.1
PL3			+9.7	+25.7	+31.6
PC1			-13.8	+3.3	-8.8
PC2			-16.2	+56.9	+7.1

CONCLUSIONS

After testing many methods, the quantitative chromatic characterization of leather and parchment samples under simulated conditions of accelerated thermal photo-oxidative degradation represents the most valuable one for selecting the adequate type of leather or parchment materials for museum restoration use.

In addition, it was demonstrated that the thermal photo-oxidative deterioration simulates the natural ageing process of leather and parchment through protein deterioration, creation of ketone groups and modification of the color characteristics.

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