Journal of Social Research and Behavioral Sciences

Sosyal Araştırmalar ve Davranış Bilimleri Dergisi

ISSN:2149-178X

Volume: 11 Issue: 23 Year: 2025

Original Article

Received/Accepted Dates

14.01.2025/05.02.2025

DOI:10.52096/jsrbs.11.23.10

Acrylic Painted Contemporary and Modern Cleaning Methods in The Conservation and Restoration of The Paintings

Serpil Çetinkaya

İstanbul Üniversitesi, Edebiyat Fakültesi Kültür Varlıklarnı Koruma ve Onarım Bölümü, serpil.cetinkayaermez@istanbul.edu.tr

Doç. Dr. Gülder Emre

İstanbul Üniversitesi, Edebiyat Fakültesi Kültür Varlıklarnı Koruma ve Onarım Bölümü, gulemre@istanbul.edu.tr

Abstract

Within the scope of the study, the artist Berna Erkün's acrylic painting titled "Route-Abstract Landscape" made in 2015 was wet surface cleaned using the current computer software Modular Cleaning Program. In this context, it was tried to underline the contemporary, modern art period that the painting is associated with and the technique and different type of acrylic paint used by the artist. At the same point, new perspectives and methods about surface cleaning, which is an important factor in painting conservation and repair practices, were investigated in the specific case of acrylic paint. As a result of the research, the wet surface cleaning method was preferred for the painting in question, and this cleaning method was applied in 8 different areas determined on the surface of the painting. The effect of the preferred wet surface cleaning on the acrylic painting was examined comparatively with laboratory analyzes before and after. laboratory analyzes and visual examinations applied to the acrylic painting.

These examinations included pH testing, HPLC, SEM-EDX, analysis by color measurement and visual/optical examinations with visible light, raking light and back-illumination, ultraviolet (UV) light, infrared (IR) light and light microscopy. The aim here is to determine the conditions that occur or may occur before and after the application.

The modular cleaning program, which is one of the contemporary methods in the field of painting conservation and restoration, was used for the prescription to be prepared for wet surface cleaning with the analysis and information made specifically for the work in question. As a result, the comparison of all the data, before and after, allowed a general conclusion to be drawn in concrete terms.

Key words: acrylic painting, surface cleaning, restoration, conservation, esael painting

Akrilik Boyalı Çağdaş ve Modern Tabloların Koruma Onarımında Yüzey Temizlik Uygulamaları

Özet

Çalışma kapsamında, sanatçı Berna Erkün'ün 2015 yılında yapmış olduğu "Rota-Soyut Manzara" isimli akrilik boyalı tablosunun güncel bilgisayar yazılımı Modüler Temizleme Programı kullanılarak ıslak yüzey temizliği uygulaması gerçekleştirilmiştir. Bu kapsamda, eserin ilişkilendiği çağdaş, modern sanat dönemi ile sanatçının kullandığı teknik ve farklı boya türü olan akrilik boyanın altı çizilmeye çalışılmıştır. Aynı noktada tablo koruma onarım uygulamalarında önemli bir faktör olan yüzey temizliği hakkında yeni bakış açıları ve yöntemler, akrilik boya özelinde araştırılmıştır. Araştırma sonucunda ıslak yüzey temizliği yöntemi bahsi geçen eser için tercih edilerek, tablonun yüzeyinde belirlenen 8 farklı alanda bu temizlik yöntemi uygulanmıştır. Akrilik boyalı tabloda tercih edilen ıslak yüzey temizliğinin etkisi, öncesinde ve sonrasında laboratuvar analizleri ile karşılaştırmalı olarak incelenmiştir. akrilik boyalı tabloya uygulanan laboratuvar analizleri ve görsel incelemeler bulunmaktadır.

Bu incelemeler; pH testi, HPLC, SEM-EDX, renk ölçümü ile yapılan analizler ve görünür ışıkta, yandan ve arkadan aydınlatma ile morötesi (UV) ışık, kızılötesi (IR) ışık ve ışık mikroskobu ile görsel/optik incelemeler gerçekleştirilmiş olup, bu incelemeler aynı zamanda yüzey temizliği öncesi ve sonrasında da aynı yöntemlerle gerçekleştirilmiştir. Burada amaç, uygulama öncesi ve sonrasında oluşan ya da oluşabilecek durumları tespit etmektir.

Tablo koruma ve onarım alanında çağdaş yöntemlerden olan modüler temizlik programı, bahsi geçen eserin özelinde yapılan analizler ve bilgiler ile ıslak yüzey temizliğinde hazırlanacak reçete için kullanılmıştır. Sonucunda tüm verilerin karşılaştırılması, öncesi ve sonrası olmak üzere, somut olarak genel bir çıkarımın oluşturulmasına olanak tanımıştır.

Anahtar Kelimeler: akrilik resim, yüzey temizliği, koruma, onarım, tablo

Introduction

Surface cleaning is just as important as all other applications in the conservation and repair of contemporary and modern works of art. The technological advancements of the modern world have allowed existing conservation-repair practices to develop and evolve. Consequently, these studies have led to changes in the new materials used by artists in their works, including basic tools like paint, brushes, and surfaces. In addition to the traditional materials, artists now incorporate a variety of everyday materials into their works. It is worth mentioning that in modern and contemporary art, not only the artist's perspective and approach have changed, but so have the characteristics of the works themselves. A similar approach can be observed in the conservation of artworks. The examination of paints used in paintings, in particular, remains an ongoing area of research, with discussions and applications across many frameworks.

Different problems and various types of deterioration caused by these issues can be observed in works created using different acrylic paints. The additional substances and formulas of acrylic paints, all of which are industrial products, are proprietary and kept secret by the companies that produce them. The amount of additives in the paint affects all forms of deterioration. Additionally, depending on the artist's use, the scope of the problems expands. Another factor is the availability of ready-made binders, which affect the paint's structure. Beyond all the additives, artists can apply paint not only with a brush but also by spraying or pouring it directly onto the carrier surface. This diversity in application methods causes variations in the types of deterioration in paintings.

There are many methods used in the surface cleaning of modern and contemporary acrylic-painted paintings. These methods include mechanical methods, wet cleaning methods specifically developed for acrylic-painted works, vacuum cleaning, gel and microemulsion methods, and laser cleaning methods integrated with software programs. This study focuses on the Modular Cleaning Program, an updated computer software that is preferred for the surface cleaning of various artifacts in international conservation applications. The program offers convenience in preparing different surface cleaning recipes. Its primary advantage is that it presents recipes created with multiple formulas as examples, thus eliminating the need to test numerous recipes on the artifact to be cleaned. Specifically, the program contains numerous chemically prepared recipes. It suggests preparing these recipes as concentrates and provides instructions on how to dilute them based on the condition of the artifact. The results and effects observed after use can be recorded in the final section of the program and saved for public access.

The background of the program includes detailed information on all chemicals used thus far in the field of conservation and restoration, as well as the physical and chemical effects of these chemicals on the user, the environment, and the artifact. It also contains multiple pieces of applied information with detailed results. This area, which we can refer to as a library, is updated with each new chemical and includes a wide range of information and experiential results, as it is an application accessible to users worldwide. The program, which offers solutions in the field of acrylic-painted wet surface cleaning, can be easily used on any computer. In this study, the most current version of the program, version 9.5, was used.

1.Examinations Conducted Before Surface Cleaning on Acrylic Paintings by Berna Erkün

Painter Berna Erkün and Her Artistic Career

Born in 1962 in Ankara, Berna Erkün graduated from the Department of Painting at Mimar Sinan Fine Arts University, Özdemir Altan's workshop, in 1986. She then completed her master's degree at the same university in 1989 ((http://minesanat.com/sanatcilar/berna-erkun/). Following her master's degree, the artist began participating in exhibitions in 1989 with the Young Painters Generation group exhibition organized by Gallery Baraz. In addition to group exhibitions, Berna Erkün has held ten solo exhibitions to date. Her works are included in various collections in Turkey and abroad. Beyond her artistic practice, she served as a member of the Board of Directors of the International Plastic Arts Association from 2009 to 2012 (http://www.upsd.org.tr/).

When Berna Erkün's works are analyzed, it is possible to see that the subject she generally focuses on is freedom. When we focus on the basis of the subject and look deeper, we can see that it is not limited to freedom, and that the artist also examines and researches the environmental phenomenon. As a result of this orientation, the artist appears today by increasing the landscape effects in her paintings in a formal sense (Küpçüoğlu, 2012). In the interviews with the artist, Erkün describes her art practice as follows; "...in general, I produce my works with an expressionist style. My undergraduate works were expressionist figurative works (1985-1987), and later (1987-1991 period) I continued with mixed media abstract works. Between 1998 and 2008, I worked in various styles; I can say that I experienced the styles that I was curious about and influenced me. In 2009-2011, I participated in Fine Paper Cutting (Kaat'ı) workshops and between 2012-2015 I participated in Ink painting (Sumi-e) workshops, which is a Far Eastern art. After 2008 is the last period and a period when my works that are close to me began to emerge."

While Berna Erkün states that the general framework of her recent works is nature, she adds the following: "I deal with the theme of nature in my works by juxtaposing transparent surfaces paired with the unity of lines, colors, and textures, both vertically and horizontally." For her works, which she usually produces with various materials on canvas and paper, she defines "......." as a structural analysis that questions re-existence, building a bridge to the time before and after me, considering the landscape when lived experience and the poetry of natural space come side by side (https://www.caresseart.com/?sanatcilar=berna-erkun). The artist, who has been experimenting with different materials since the early years of her career, produces her drawings as sketches using ink on paper, while she uses acrylic paint in her works on canvas or other surfaces. Erkün states that she began using acrylic paint in 1987. The reason for using this paint in her works; "The fact that acrylic paint is suitable for spontaneous works due to its fast drying feature is my first choice. The fact that it is water-based is my second reason in terms of health. Acrylic paint, which I use with different materials in mixed technique, gives better results than oil paint. My works consist of a geometric structure where sometimes transparent and sometimes thick textures come side by side. Sometimes I use thin, transparent layers on top of each other in my works, and sometimes I use thick, dense layers of paint. When working in this way, the fast drying of acrylic paint is important in my works.” (Image-1).

Image-1: Berna Erkün, Yakın Uçtuk; Lodos, Acrylic on Canvas, 2011. (Source: Berna Erkün, 2022).

In an interview, artist Berna Erkün provided insight into the production stages of her works: "In my landscape-oriented paintings, I first create the general lines and the infrastructure of the composition. Then, I establish the color, light-dark balance, movement, and rhythm of the composition in my original style. In the final stages, I use mixed techniques with various spatulas to create spontaneous brush strokes and textures. I also pay attention to the richness of the language of painting by using different lines and textures. I often employ mixed techniques with spatulas to create strokes and textures and consider the diversity of paint

materials and tools for drawing with paint.” The artist still works with acrylic paint and regularly participates in exhibitions.

The painting is first examined visually and optically to gather information about its general condition. The method used at this stage aims to obtain the most general information about the condition of the painting, its state of preservation, and the techniques used by the artist (Emre, 2010:111).

1.1 Examinations on the Painting Before Surface Cleaning

Visible Light (VIS) Examinations

The painting was created with acrylic paint on canvas in 2015. The canvas, which forms the base, is made of linen. A primer layer was applied using synthetic paint on the linen canvas. The composition was developed using acrylic paint on the geometric outlines drawn during the sketching phase of the pattern, which is a landscape painting (Image-2).

The artist explains her painting as follows: "...while applying the acrylic paint in transparent layers on top of each other, I sprayed water on the canvas surface to allow the paint to flow. As in my other patterns, in this one, I emphasized the plastic values that highlight the unity of geometric and organic forms."

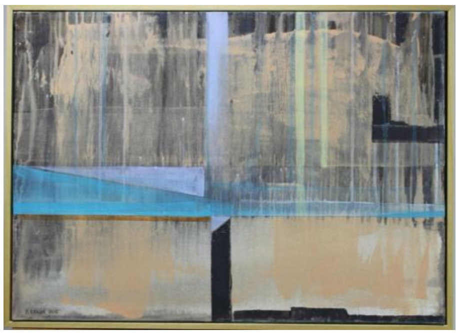


Image-2: Berna Erkün, Kıyı Eskizleri, acrylic on canvas, Istanbul, 2015. (Source: Serpil Çetinkaya 2022).

The acrylic painting by Berna Erkün, measuring 50cm x 70cm without frame and 52cm x 72cm with frame, was examined under visible light. The examination was taken using a Canon EOS 650D camera with a Canon EF-S 18-55mm lens set at an aperture of F7.1, ISO 100, 1/5s and an exposure time of 33mm. Images of the painting were taken from both sides and saved as PNG files using the latest photo editing software.

Based on the information obtained from the front of the painting, it can be determined that the initial drawings were made with pencil. This observation is corroborated by the information provided by the artist about her painting. Furthermore, the back of the painting reveals the artist's inscription: "Berna Erkün, Coastal Sketches, 50x70cm, Acrylic on Canvas, Istanbul 2015," written in her own handwriting. During the interview, the artist confirmed that she wrote this inscription (Image-3-4).

An examination of the back of the painting shows that all four corners of the chassis are interlocked without the use of any connecting materials. Additionally, there are no wedges in the frame, and the painting is placed in a frame wider than the chassis. This information was also verified by the artist. The lower left corner of the painting bears the artist's initials, surname, and the date of the painting.

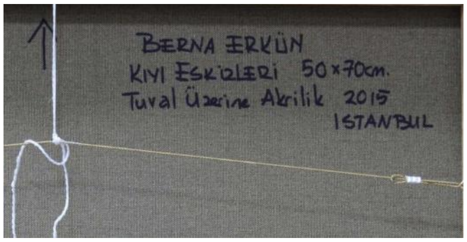


Image-3: Back of the painting (Source: Serpil Çetinkaya 2022).

Image-4: Initial of the artist's name, surname, and date (Source: Serpil Çetinkaya 2022).

The artist used different colors, both layered on top of each other and side by side. While diluting the paint throughout the work to allow it to flow and spill on the surface in upward and downward directions, the artist also applied very thick layers of paint in certain areas. Particularly in the middle and lower right part of the painting, the weave of the canvas textile, which serves as the carrier surface, is visible (Image-5).

Image-5: Use of paint diluted vertically in the painting (Source: Serpil Çetinkaya 2022).

Examination Using Raking Light (RAK)

Examinations conducted with raking light allow for more detailed inspection of surface deformations/deteriorations in the painting. Light sources projected onto the painting from various angles can be used to detect separations in the paint layer, paint blisters, and surface undulations on both the paint and the supporting textile, caused by various factors over time (Lambert, et al., 1986:81). In the raking light examination of Berna Erkün's painting, no issues such as inward or outward blistering, undulations in the canvas textile, or paint blisters were observed (Image-6). However, impasto and thick paint surfaces, which could indicate the artist's unique use of paint, were identified. The artist mentioned that these thick paint strokes were created using a spatula (Image-7).

Image-6: Examination of raking light (Source: Serpil Çetinkaya 2022).

Image-7: Examination of raking light (detail) (Source: Serpil Çetinkaya 2022).

Examination Using Backlighting

Backlighting applied to Berna Erkün's painting, Kıyı Eskizleri*,* has produced visuals that express the artist's stylistic techniques. Backlighting on paintings is used to determine the distribution of the paint layer, any paint losses, cracks, and deteriorations in the textile, such as cuts, tears, and holes (Kayser, 2022: 65). In the examined painting, no such deteriorations were observed, although micro-level paint losses were detected in some areas. The artist has indicated that these areas are due to the use of a spatula (Image-8).

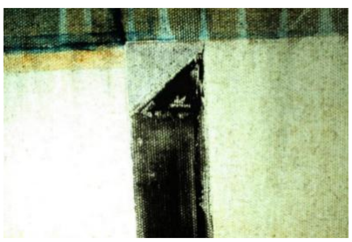


Image-8: Backlight image of the examined painting: textile surface lacking paint due to spatula use (Source: Serpil Çetinkaya 2022).

Examination Using Infrared (IR) Light

In examinations conducted using this method, the rays penetrate the underlying layers, revealing preliminary sketches and designs beneath the paint layer (Mairinger, 2000: 41). For the infrared light examination of the painting, two Philips 250W lights were used. The camera employed for the shots was a Fujifilm digital camera with a Nikon AF-100 lens, designed for infrared photography with a sensitivity range of 380-1000 nm. The resulting images did not provide information on the preliminary sketches detected during visual inspections (Image-9). According to results confirmed by HPLC and SEM-EDX analyses, the pigments in the paint applied after the preliminary sketch prevent the transmission of infrared light. General and detailed shots were taken at different infrared light ranges.

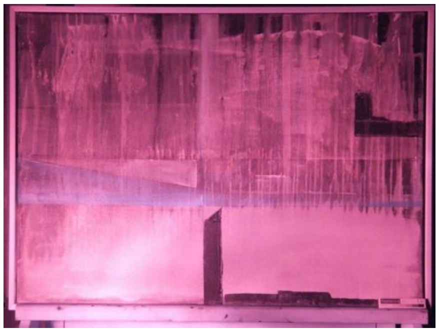


Image-9: Photography using infrared light and digital lens PECA 900 (#18A) (Source: Serpil Çetinkaya 2022).

Examination Using Ultraviolet (UV) Light

Ultraviolet photography is preferred to determine the integrity of old varnish layers, assess them, and identify any retouched areas if present (Cosentino, 2015: 53-62). For the ultraviolet photography of Berna Erkün's painting, a UV light source was used along with a Canon EOS 650D camera equipped with a Canon EF-S 18-55mm lens. The general photograph was taken with a 28mm focal length, F/4 aperture, and ISO 800 setting.

The ultraviolet (UV) photography of the painting revealed that no previous retouching had been applied. Additionally, discussions with the artist confirmed that there is no varnish layer on the painting. The painting was created in the artist's studio in 2015 and subsequently stored in a dark, open area from 2015 to 2019. The storage area was described as being on the ground floor, dark (without light), lacking a ventilation system, and uncontrolled in terms of humidity and dampness. After being removed from storage in 2019, the painting underwent no protective or restorative treatments or examinations. Due to the exposure of both surfaces of the painting to environmental conditions during storage, a significant layer of dust was observed on the paint layer. It was also confirmed that no varnish had been applied to the painting (Image-10-11).

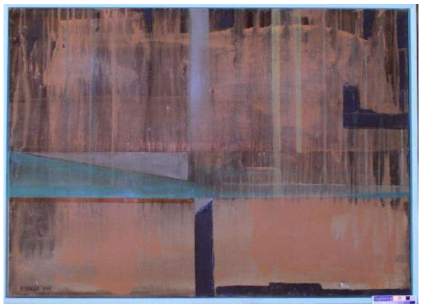


Image-10: Ultraviolet (UV) photography of Berna Erkün's Painting (1.5m, 28mm, F/4, ISO 800) (Source: Serpil Çetinkaya 2022).

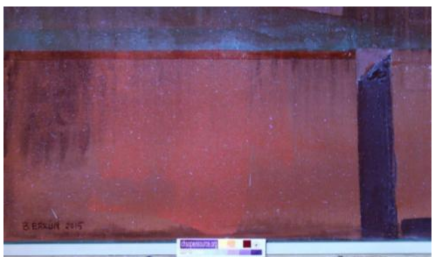
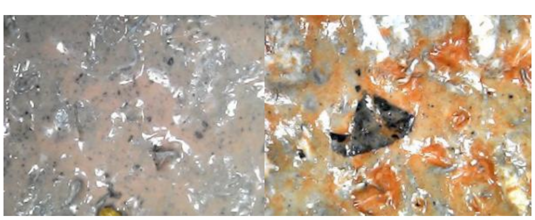


Image-11: Ultraviolet (UV) photography of the painting: surface dust (0.6m, F/5, ISO 200, 40mm) (Source: Serpil Çetinkaya 2022).

Examination Using Light Microscopy

The examination of the acrylic painting using a light microscope was conducted on 8 pre-determined areas (Image-12). A Leica light microscope was used for this examination. It was observed that the paint layer generally has a porous structure. In area 5, the paint film layer appears semi-permeable, likely due to the pigment used. The highest light reflection and permeability across the surface were observed in area 7. In area 4, close-up imaging revealed dirt particles trapped within the paint layer. Similar particles were also detected in areas 1, 2, 5, 6, and 8.



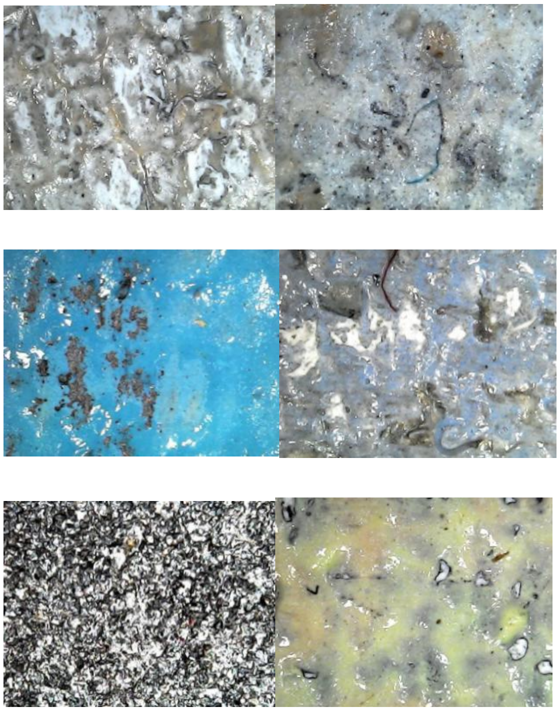


Image-12: Light microscope examination of designated areas of the painting before cleaning (Source: Serpil Çetinkaya 2022).

Color Measurement

CIELAB is a color model developed by the International Commission on Illumination (CIE). It is used to define colors more accurately and consistently. CIELAB has three coordinates. L* represents the range from black to white, where L* is 0 (zero) for black and 100 (one hundred) for white. The colors perceived by the human eye—red, green, blue, and yellow—are represented as a* and b. *The a* axis shows green at negative values and red at positive values, while the b* axis shows blue at negative values and yellow at positive values.

These defined colors are not specific to any device like a computer monitor or printer but are instead related to the CIE standard observer, which is an average of the results of color matching experiments under laboratory conditions (Table-1). The CIELAB color space is three-dimensional and encompasses the entire human color perception or gamut. It is based on the opponent color model of human vision, where red and green form one pair, and blue and yellow form another pair of opponents.

In the color analyses conducted in a laboratory environment, each color present in the sections was tested twice. The change, if any, in color before and after cleaning was calculated using the formula $\Delta E = [(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2]^{1/2}$ (Table-2). In this equation, which shows the difference between two colors measured in the CIELAB color space, a ΔE value of zero indicates no difference between the two colors. Small ΔE values indicate minimal color differences, while larger ΔE values indicate greater color differences (Karadağ, et al., 2010: 178).

	Data Name	Target No.	CMC(l:c)(D65)	Judgement	Pseudo Color(D65)	L*(D65)	a*(D65)	b*(D65)	dL*(D65)	da*(D65)	db*(D65)	dE*ab(D65)	K/S Val(360)	h(D65)	C*(D65)
1	KREM	------	------	------		74,58	12,14	19,77	------	------	------	------	6,46307	58,45	23,20
		------	------	------		74,24	12,12	19,71	------	------	------	------	7,43311	58,42	23,14
2	TURUNU	------	------	------		63,08	16,21	26,80	------	------	------	------	7,81580	58,83	31,32
		------	------	------		62,46	16,36	27,51	------	------	------	------	9,86904	59,27	32,01
3	AÇIK KREM	------	------	------		74,38	2,71	9,46	------	------	------	------	6,43025	74,03	9,84
		------	------	------		74,18	2,65	9,13	------	------	------	------	6,98058	73,83	9,51
4	BEYAZ	------	------	------		81,33	1,45	8,54	------	------	------	------	6,45210	80,35	8,66
		------	------	------		81,25	1,39	8,07	------	------	------	------	6,63168	80,21	8,19
5	TURKUAZ	------	------	------		67,91	-26,28	-12,76	------	------	------	------	6,26003	205,90	29,22
		------	------	------		67,30	-26,74	-13,12	------	------	------	------	7,94071	206,12	29,79
6	MAVİ	------	------	------		71,37	-2,57	-9,58	------	------	------	------	5,65156	254,96	9,92
		------	------	------		71,17	-2,59	-10,05	------	------	------	------	6,12745	255,53	10,38
7	SİYAH	------	------	------		38,81	-0,28	-0,98	------	------	------	------	4,79063	253,85	1,02
		------	------	------		38,42	-0,30	-1,10	------	------	------	------	4,93173	254,91	1,14
8	SİYAH2	------	------	------		37,81	-0,49	-1,44	------	------	------	------	4,81697	251,07	1,52
		------	------	------		37,51	-0,46	-1,59	------	------	------	------	4,90431	253,90	1,66
9	SARI	------	------	------		77,52	-0,79	19,42	------	------	------	------	6,38694	92,34	19,44
		------	------	------		77,13	-0,90	19,38	------	------	------	------	7,69436	92,66	19,40

Table-1: Color reading in color analysis and its numerical correspondence (Source: DATU Laboratory)

	Data Name	L*(D65)	a*(D65)	b*(D65)	K/S Val(360)	h(D65)	C*(D65)
1	KREM	74.58	12.14	19.77	6.46307	58.45	23.2
1	KREM	74.24	12.12	19.71	7.43311	58.42	23.14
2	TURUNU	63.08	16.21	26.8	7.8158	58.83	31.32
2	TURUNU	62.46	16.36	27.51	9.86904	59.27	32.01
3	AÇIK KREM	74.38	2.71	9.46	6.43025	74.03	9.84
3	AÇIK KREM	74.18	2.65	9.13	6.98058	73.83	9.51
4	BEYAZ	81.33	1.45	8.54	6.4521	80.35	8.66
4	BEYAZ	81.25	1.39	8.07	6.63168	80.21	8.19
5	TURKUAZ	67.91	-26.28	-12.76	6.26003	205.9	29.22
5	TURKUAZ	67.3	-26.74	-13.12	7.94071	206.12	29.79
6	MAVİ	71.37	-2.57	-9.58	5.65156	254.96	9.92
6	MAVİ	71.17	-2.59	-10.05	6.12745	255.53	10.38
7	SİYAH	38.81	-0.28	-0.98	4.79063	253.85	1.02
7	SİYAH	38.42	-0.3	-1.1	4.93173	254.91	1.14
8	SİYAH2	37.81	-0.49	-1.44	4.81697	251.07	1.52
8	SİYAH2	37.51	-0.46	-1.59	4.90431	253.9	1.66
9	SARI	77.52	-0.79	19.42	6.38694	92.34	19.44
9	SARI	77.13	-0.9	19.38	7.69436	92.66	19.4

Table-2: *CIE L*AB* Report (Source: DATU laboratory color measurement analysis results)

pH Testing

Eight separate sections of Berna Erkün's painting were subjected to pH measurements. The pH measurements were conducted using a gel method, which minimizes water contact with the paint. In the laboratory, 50 ml of distilled water was heated to 60°C, after which 2 grams of agar agar were added. The temperature was then increased to 75°C, maintained for 2 minutes, and stirred for an additional 2 minutes. Once dissolution was achieved, the agar agar solution was poured into molds. After gelation, the gels were placed on the selected sections of the painting, and pH measurements were taken by inverting the gels and using a pH meter (Image-13). The pH meter was cleaned with distilled water after each measurement. The results obtained are presented in the table below. These results will aid in determining the surface cleaning method (Table-3).

Image-13: pH measurement with agar agar method (Source: Serpil Çetinkaya 2022).

Test Numarası	**Renk**	**pH**
1	Krem	7.3
2	Turuncu	7.1
3	Açık Krem	7.1
4	Beyaz	7.1
5	Turkuaz	7.4
6	Mavi	7,6
7	Siyah	7,4
8	Sarı	7,2

Table-3: Results of the pH test (Source: Serpil Çetinkaya 2022).

High-Performance Liquid Chromatography (HPLC)

A qualitative dye analysis was conducted using high-performance liquid chromatography. Given that the acrylic paint used contains inorganic, synthetic pigments, an EDX analysis was also performed to confirm the HPLC results. The combined results of both analyses are presented below. In the analysis of eight different areas of the acrylic-painted, titanium dioxide was consistently detected in each area. To prevent microbiological contamination in synthetic or cellulosic paints, metals are added. For instance, zinc oxide, lead white, lithopone, or antimony oxide are preferred to inhibit mold formation. The addition of these elements alters the paint's composition. Therefore, the combined results of the two analyses provide a unified conclusion.

In the sample from area 1, titanium dioxide and trace amounts of azoylaryl amidine were detected. Titanium dioxide is one of the most preferred white pigments in acrylic paint. Azoylaryl amidine is a compound found in yellow pigment paints (Figure-1) (Breitbach, et al., 2011:622).

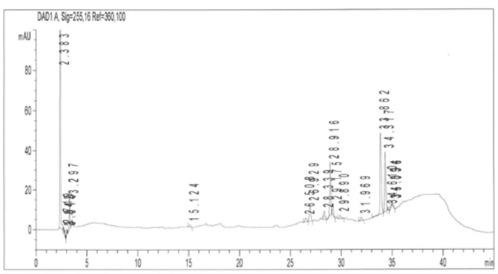


Figure 1: Chromatogram of sample 1 (Source: DATU Laboratory).

In the sample from area 2, titanium dioxide and azoly 2-naphthol (Figure-2) (Breitbach, et al., 2011:622) (azoyl-ß-naphthol) were detected. Naphthol is a crystalline compound derived from naphthalene. 2-Naphthol is frequently used in the production of paints, particularly in red pigmented synthetic paints. In the sample from area 3, titanium dioxide and azoylaryl amidine were identified (Figure-3). In the sample from area 4, only titanium dioxide was identified (Figure-4).

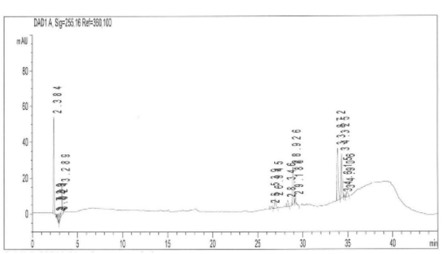


Figure 2: Chromatogram of sample 2 (Source: DATU Laboratory).

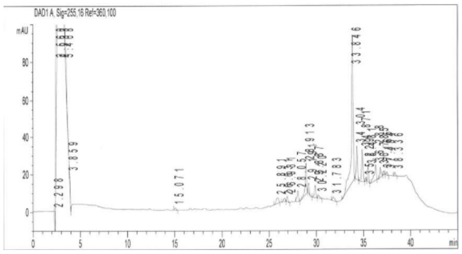


Figure 3: Chromatogram of sample 3 (Source: DATU Laboratory).

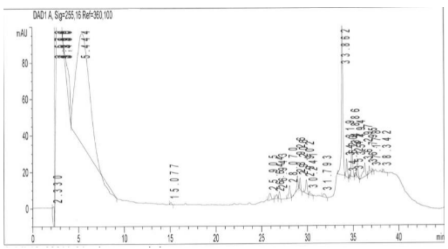


Figure 4: Chromatogram of sample 4 (Source: DATU Laboratory).

In the sample from area 5, titanium dioxide and copper phthalocyanine blue (Breitbach, et al., 2011:622) were found (Figure-5). Copper-based phthalocyanine blue, also known as phthalo blue or copper phthalocyanine, is a synthetic, blue, bright, light-reflective pigment commonly used in phthalocyanine paints. The artist mentioned that they specifically chose this pigment to create bright areas in the painting. The first copper metallic phthalocyanine compound was reportedly obtained by Diesbach and Van Der Weid by heating o-dibromobenzene with copper cyanide in pyridine at 200°C, resulting in a blue, insoluble product. In the sample from area 6, titanium dioxide and copper phthalocyanine blue (Yılmaz, et al., 2017:470) were also found (Figure-6).

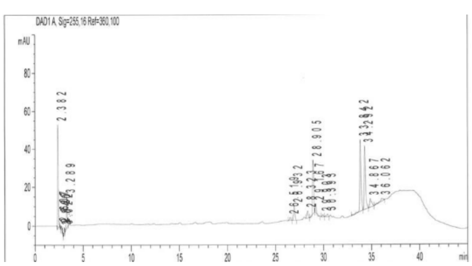


Figure 5: Chromatogram of sample 5 (Source: DATU Laboratory).

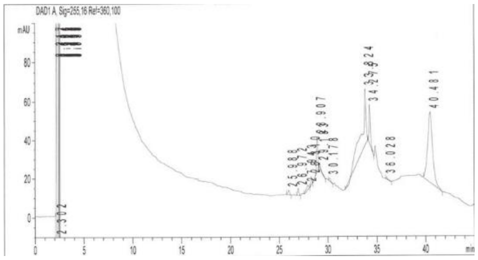


Figure 6: Chromatogram of sample 6 (Source: DATU Laboratory).

In the sample from area 7, "lamp black" and titanium dioxide were identified (Figure-7). Lamp black, also known as carbon black or soot, is a pigment rich in carbon, hence the name carbon black. Chemically, it acts as a black pigment that reinforces the synthetic binder in the paint. It possesses electrically conductive properties and is primarily composed of the carbon element. It is also described as the chemically most stable element. Soot blacks have been used since prehistoric times. They are added as black pigments to liquid and powder paints and are used with titanium white to create gray hues. Lamp black pigment has a range of multiple tones. In the sample from area 8, titanium dioxide and azoylaryl amidine were identified (Figure-8).

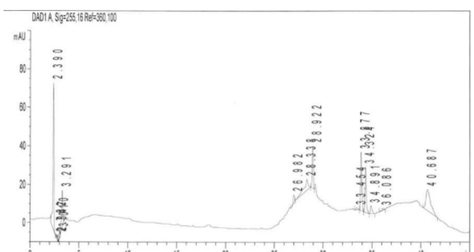


Figure7: Chromatogram of sample 7 (Source: DATU Laboratory).

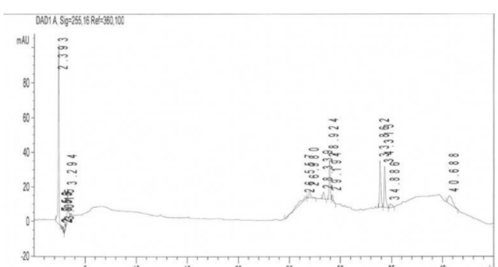


Figure 8: Chromatogram of sample 8 (Source: DATU Laboratory).

Scanning Electron Microscope (SEM) Results

The scanning electron microscope, also known as SEM analysis or SEM technique, is considered an effective method for analyzing organic and inorganic materials on a scale from nanometers to micrometers (μm) (Mohammed, et al., 2018: 1). Using SEM analysis, the surface topography of the painting was examined. Surface activity in samples from eight different areas on the painting was observed to understand conditions due to drying time, storage, and display effects (Image-14).

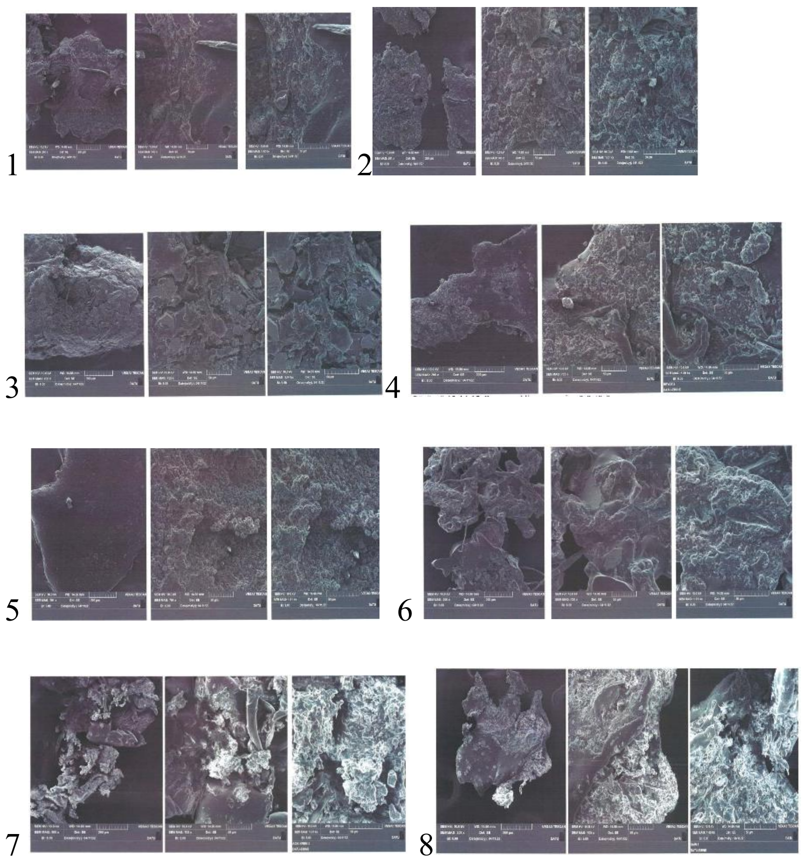


Image 14: SEM image of sample from area (Source: DATU Laboratory).

2. Application of Modular Cleaning Program on the Acrylic Painting by Berna Erkün

A modular cleaning program was used to clean the surface of an acrylic painting by artist Berna Erkün. The painting had been stored under unsuitable conditions for approximately five years. It is currently displayed in the home of a collector. Due to the storage conditions and the static nature of the acrylic paint, the painting attracted all the dust and dirt from its surroundings to its surface and paint layer. Upon examination, a significant layer of dust and dirt was found on the paint surface. Additionally, the absence of a varnish layer allowed the dust and dirt to penetrate directly into the paint. The surface cleaning to be performed will be applied directly to the paint layer of the painting.

Acrylic paint possesses a chemical structure that can vary due to the additives within it and the binders used during application. When the painting was examined using SEM and light microscopy, the paint layer was observed to be very fragmented and rough. Based on these results, a two-pronged cleaning approach was decided upon. Due to the surface structure, mechanical cleaning methods were deemed unsuitable. Similarly, cleaning with saliva or gel was also eliminated for the same reasons. This is because, in gel application, the permeable and porous nature of the surface can make it difficult to remove the cleaning agent from the paint structure.

A more detailed study on this subject was conducted in 2018 by Aditya Kanth, Manager Singh, and Satish C. Pandey, focusing on the use of gellan and agar gels as cleaning methods for acrylic painted surfaces. Their practical research revealed that gellan gels spread more and were harder to control compared to wet cleaning on acrylic painted surfaces. Similar issues were observed with agar gel cleaning. In later stages of their study, different concentrations of gels were tested, yet swelling and glossing of the surface were still observed (Kanth, et al., 2018:455).

On the unvarnished paint surfaces of acrylic paintings, distilled water is often used for surface cleaning. However, this method does not offer a definitive solution for all acrylic works. The Getty Conservation Institute organized two invitation-only colloquia on "Cleaning of Acrylic Painted Surfaces" in Los Angeles (2009) and New York (2011). Observations made by Nicholas Dorman at these colloquia were published as an article in The Western Association for Art Conservation (WAAC) journal in 2012. Dorman reported that cleaning with distilled water was only 13% successful. The samples used in this study were created with acrylic paints from different brands on the same canvas surfaces. Various methods were tested at the colloquium, both robotic and traditional. The "High Efficiency Cleaning Device," developed in collaboration with Dow Chemical, the Getty Conservation Institute, and the Tate Gallery, performed robotic cleaning on surfaces pre-soiled, followed by evaluations using computer-based optical and chemical analyses (Stavroudis, et al., 139-145).

As a result, the obtained data can be clearly and numerically expressed. At the same colloquium, chemist Richard Wolbers, who continued the research, argued that aliphatic hydrocarbons could be developed as a good component for cleaning acrylic paints using wet cleaning methods. While these aliphatic hydrocarbons provide only moderate cleaning effects on acrylic-painted surfaces, they also minimally affect the deterioration or shrinkage of the paint film.

Microemulsion methods are also preferred for surface cleaning applications today. These methods were considered for this study; however, the surface dirt on the painting was found to be only superficial dust. Dirt that had penetrated the paint layer was also detected. Therefore, it was concluded that a non-ionic surface cleaning agent and distilled water with controlled pH would suffice. Due to the aforementioned problems, the wet cleaning method was chosen for the surface cleaning of the acrylic-painted artwork. In the selected wet method, altering pH, conductivity, and ionic effects will be significantly effective in reducing the potential for shrinking, swelling, and deterioration. The cleaning solution will be an effective cleaner while also ensuring it does not damage the paint layer. To minimize the impact of these factors affecting the cleaning process and to control the movement of water, a solution with low conductivity is planned to be used.

The Modular Cleaning Program (MCP) methodology was used for the surface cleaning of the painting. Initially, data related to the painting were entered into the program. Subsequently, the wet cleaning option provided by the software was selected (Image-15).

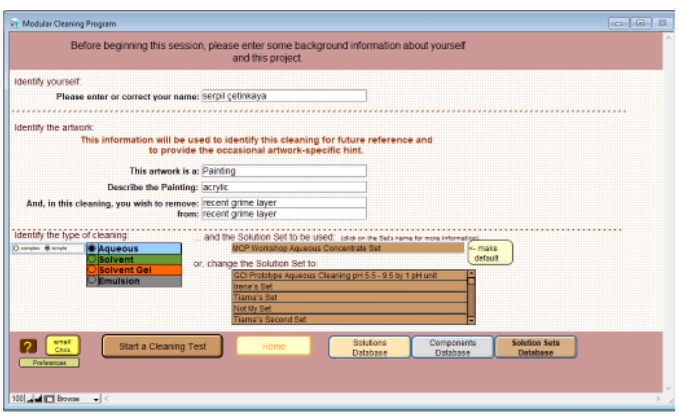


Image 15: Introduction to modular cleaning program- information interface (Source: Serpil Çetinkaya 2022).

After entering the input data into the software, the "MCP Workshop Aqueous Concentrate Set" was selected, and the cleaning set section was accessed. In the second interim page, the solution preparation section, suitable for the wet cleaning system, opened. This section included pH, surface cleaning agent, chelating agent, and pH buffer. Initially, the software selected a variable pH buffer and suggested a solution of pH 6.5, Bis-Tris, and 10% hydrochloric acid (Image-16).The software showed that the pH could be altered, but it could only be adjusted to pH 5.5 (Image-17).

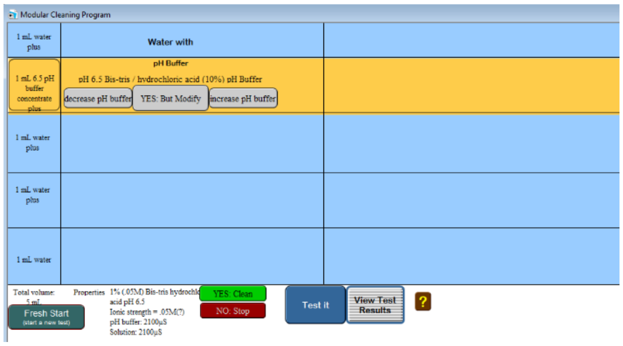


Image 16: pH 6.5, Bis-Tris and hydrochloric acid 10% solution (Source: Serpil Çetinkaya 2022).

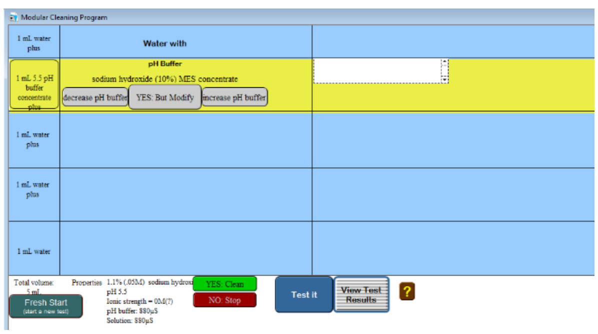


Image 17: pH 5.5, 10% sodium hydroxide solution, MES (Source: Serpil Çetinkaya 2022).

In the prepared solution, a high pH can dissolve any oxidized areas on the painting, while lowering the pH will help preserve these oxidized areas. Considering the sensitivity of the painting and the thin application of the paint layer, it was decided to adjust the pH and the surface cleaner. In the final page that opened, the sample solution was selected from the section labeled “Total Volume,” and the interface for the stock solution was accessed (Image-18).

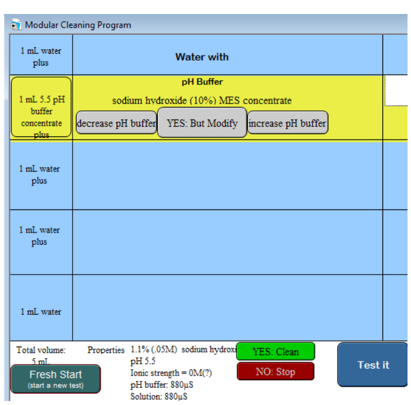


Image 18: Stock solution change (Source: Serpil Çetinkaya 2022).

In the modular cleaning program, various concentrations of solutions are prepared with many variables when making stock solutions. Instead of using the solution prepared with the pH variable provided by the software, "Surfactant" was selected, with pH still being chosen as a variable (Image-19). The surface cleaning agents suggested by the software for wet cleaning were reviewed, and Triton X-100, a non-ionic agent previously used in many artworks, was selected (Image-20).

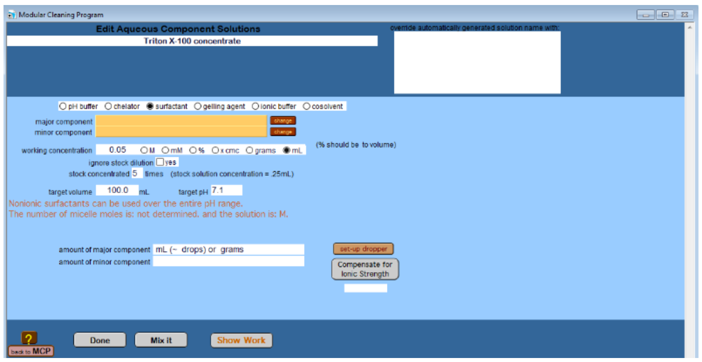


Image 19: Intermediate screen for preparing concentrated stock solution (Source: Serpil Çetinkaya 2022).

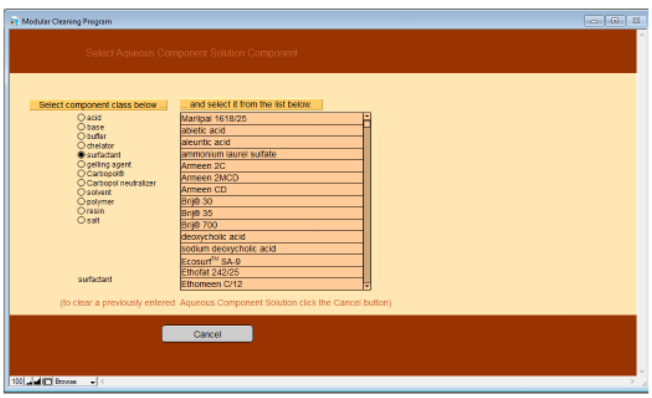


Image 20: Selection of surface cleaning agent for the painting (Source: Serpil Çetinkaya 2022).

Triton X-100, being non-ionic, is unaffected by counter-ion concentrations on the surface. Additionally, for the pH range of the studied painting, Triton X-100 is the most suitable choice. Non-ionic chemicals can be used across the entire pH range. Information related to this pH range was highlighted in red on the screen during the selection of the surface cleaning agent.

When the cleaning solution was tested for the painting at all pH values using the Modular Cleaning Program, it was found that despite the variable pH, the concentrations remained consistent due to the non-ionic nature of Triton X-100. Consequently, the solution recommended for pH 7.1 was prepared and used. The surface cleaning solution provided by the software was utilized in the Painting Conservation and Restoration Laboratory of the Department of Conservation and Restoration of Cultural Properties at Istanbul University's Faculty of Letters. Surface cleaning was performed on eight designated sample areas of the painting. These areas were symbolically marked with numbers on the painting image, as indicated in the colorimeter test (Image-21).

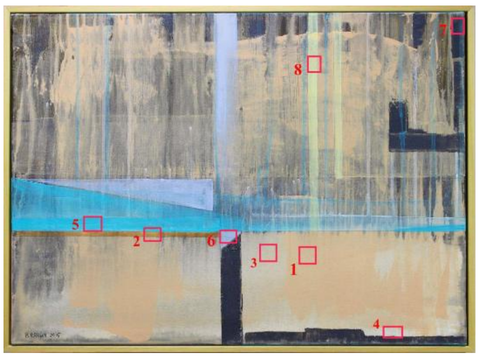


Image 21: Eight sample areas ındicated on the painting surface (Source: Serpil Çetinkaya 2022).

For surface cleaning, cotton was wrapped around a bamboo stick and rolled across the surface for less than one minute. A led-lit, magnifying loop was used during the application. Observations during this method include: water marks, droplets during the rolling of the cotton stick, swelling of the droplets if they occur, and whether the droplet retains its shape on the surface or appears as sharp protrusions on the paint surface. Such reactions during the application indicate the impact of the paint's inherent components and the conductivity distribution of the pigment in the paint. If these effects, as mentioned above, start to appear, the process should be stopped. Otherwise, the inherent components of the paint might be removed or their effects diminished during surface cleaning. Controlled use of the surface cleaner and the choice of a non-ionic chemical prevented these issues during the application (Image-22).

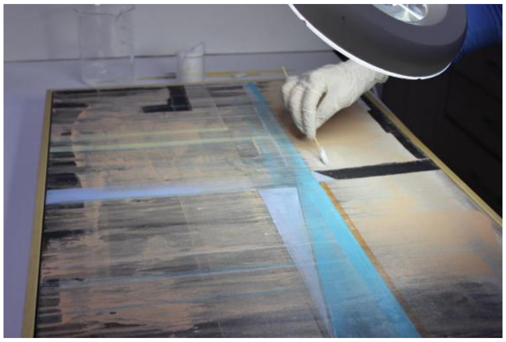


Image 22: Surface cleaning of the acrylic painting: Area-3 (Source: Serpil Çetinkaya 2022).

Due to the different pH measurements taken in the eight areas for surface cleaning, attention was paid to the surface tension, swelling, and what was removed during cleaning—whether pigment, dust, dirt, or the paint film layer. These factors also influenced the duration of the application. Titanium dioxide (TiO_2) was detected in all eight different areas where pigment analysis was conducted. Additionally, alongside the mentioned synthetic pigment (TiO_2), other pigments were observed in each test area.

In areas 5 and 6, along with titanium dioxide, synthetic copper phthalocyanine blue was identified as a pigment. The extended duration of cleaning in these areas compared to others was attributed to the insolubility and resistance of copper phthalocyanine blue in water and many solvents. During the artist's application of this color, invisible dust and dirt particles adhered to the paint layer. These particles can be removed only when the paint is completely stripped. However, the dust and dirt on the surface were removed using the same cleaning method as in other areas. In area 6, dirt was removed from the surface in less than one minute, and no color or paint residue was observed on the cotton-wrapped stick. Instead, the dust and dirt from this area were successfully removed.

In areas 5 and 6, the presence of the same pigments, including titanium dioxide and synthetic copper phthalocyanine blue, was confirmed. The differing color range values measured by the colorimeter are related to the varying amounts of copper phthalocyanine blue in the paints. Additionally, the pH values of these areas differ. Furthermore, the cleaning durations for these areas were longer than for all other areas, attributed to the insolubility and resistance of copper phthalocyanine blue in water and many solvents. During the artist's application of this color, invisible dust and dirt particles adhered to the paint layer, remaining on the surface. These particles can be removed only when the paint is completely stripped. However, the dust and dirt on the surface were removed using the same cleaning method as in other areas. In area 6, dirt was removed from the surface in less than one minute, and no color or paint residue was observed on the cotton-wrapped stick. Instead, the dust and dirt from this area were successfully removed.

In area 7, along with titanium dioxide (TiO_2), "lamp black" pigment was also detected in tests. The color measurement in this area showed it to be closer to black compared to other areas, with a pH of 7.4. During surface cleaning, paint was observed on the cotton-wrapped stick. Following this, the stock solution of the surface cleaner was further diluted with distilled water. Initially, when color appeared on the cotton stick, no swelling, glossing, or surface tension was observed on the surface.

Subsequently, 5 ml of distilled water was added to the concentrated solution for dilution. Upon reapplication, no paint residue was observed on the cotton swab. Wet surface cleaning was performed on eight pre-determined areas of the acrylic-painted. After completing the cleaning process, the cleaned areas were further wiped with cotton-wrapped bamboo sticks using distilled water. Following the entire surface cleaning procedure, the painting was left to dry for 10 days. Afterward, ultraviolet light photography, light microscopy imaging, color analysis, scanning electron microscopy (SEM-EDX), and liquid chromatography (HPLC) analyses were conducted.

After Cleaning Examination of Berna Erkün's Acrylic Painting

It is crucial to visually examine the painting after the surface cleaning method has been applied to detect any potential effects on the surface. Since only surface cleaning was performed, visible light (VIS), ultraviolet light, light microscopy examinations, HPLC, SEM-EDX, and color measurements were conducted.

Visible Light (VIS) Examination

Wet surface cleaning was performed on eight designated areas of the acrylic-painted, followed by imaging under visible light. This imaging revealed no visible changes in the painting. There were no alterations in color balance, surface gloss, or any possible deterioration that could occur during the cleaning process (Image-23).

Image 23: Examination of the painting with visible light(VIS) after surface cleaning (Source: Serpil Çetinkaya 2022).

Examination Using Ultraviolet (UV) Light

During the ultraviolet light examination of the painting by artist Berna Erkün, a UV light source was used along with a Canon EOS 650D camera equipped with a Canon EF-S 18-55mm lens set at 28mm, F/4, and ISO 800. Detailed photographs were taken of the areas where the cleaning application was performed (Image-24). There is no change observed after cleaning.

Image 24: Examination with ultraviolet (UV) light after cleaning (Source: Serpil Çetinkaya 2022).

Examination Using Light Microscopy

After the surface cleaning, the painting was examined using a light microscope. Special attention was given to the layers of dirt and dust on the surface. Additionally, the examined area was checked for any color gloss or loss of color and paint (Image-25).

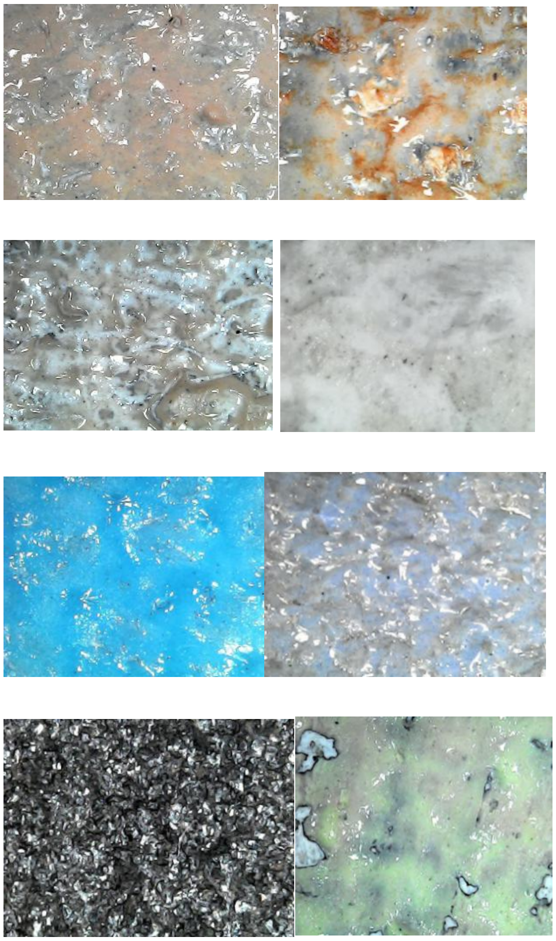


Image 25: Light microscope image (X100) (Source: Serpil Çetinkaya 2022).

Color Measurement

During the surface cleaning application, changes in color, fading, or shifts in the color light wavelength were examined. Below are the results of the color analysis conducted after the wet surface cleaning of the painting. The post-cleaning color analysis revealed no detectable changes in color (Table-4).

	Data Name	L*(D65)	a*(D65)	b*(D65)	K/S Val(360)	C*(D65)	h(D65)
1	krem	72.7	12.03	18.8	6.30184	22.32	57.39
1	krem	72.34	12.02	18.77	7.24063	22.29	57.36
2	turuncu	63.52	10.25	18.86	7.64969	21.46	61.48
2	turuncu	62.88	10.34	19.3	9.72999	21.89	61.82
3	acık krem	75.05	2.28	8.57	6.89344	8.87	75.1
3	acık krem	74.84	2.24	8.25	7.64969	8.55	74.84
4	beyaz	81.33	1.28	8.22	5.9328	8.31	81.11
4	beyaz	81.22	1.24	7.75	6.12745	7.85	80.93
5	turkuaz	66.84	-27.16	-13.18	6.74845	30.19	205.89
5	turkuaz	66.14	-27.71	-13.54	8.75333	30.84	206.04
6	mavi	72.26	-2.38	-10.28	6.4521	10.56	256.96
6	mavi	71.99	-2.38	-10.75	7.16083	11.01	257.52
7	siyah	39.02	-0.29	-1	4.32166	1.04	253.73
7	siyah	38.35	-0.23	-1.04	4.52806	1.07	257.5
8	siyah2	38.24	-0.33	-0.98	4.94554	1.03	251.15
8	siyah2	37.44	-0.26	-0.96	5.27451	0.99	254.82
9	sarı	76.71	-0.42	17.7	6.46307	17.7	91.35
9	sarı	76.35	-0.51	17.63	7.6349	17.64	91.66

Table-4: Laboratory color measurement analysis results from DATU Laboratory.

High-Performance Liquid Chromatography (HPLC)

In the sample from area 1, titanium dioxide and azoaryl amidine were identified (Figure-9). In the sample from area 2, titanium dioxide and azoyl-ß-naphthol (Breitbach, et al., 2011:622) were identified (Figure-10).

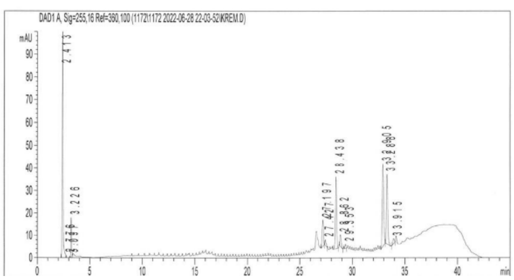


Figure 9: Chromatogram of sample 1 (Source: DATU Laboratory).

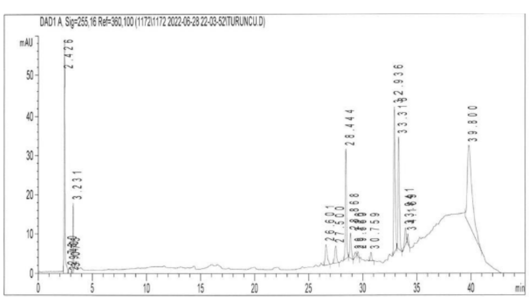


Figure 10: Chromatogram of sample 2 (Source: DATU Laboratory).

In the sample from area 3, titanium dioxide and azoaryl amidine were identified (Figure-11). In the sample from area 4, only titanium dioxide was detected (Figure-12). In the sample from area 5, titanium dioxide and copper phthalocyanine blue were identified (Figure-13).

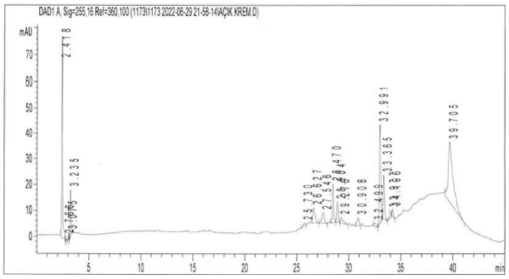


Figure 11: Chromatogram of sample 3 (Source: DATU Laboratory).

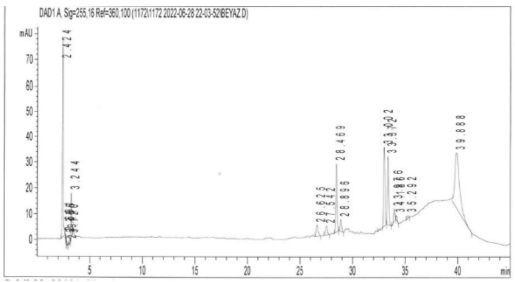


Figure 12: Chromatogram of sample 4 (Source: DATU Laboratory).

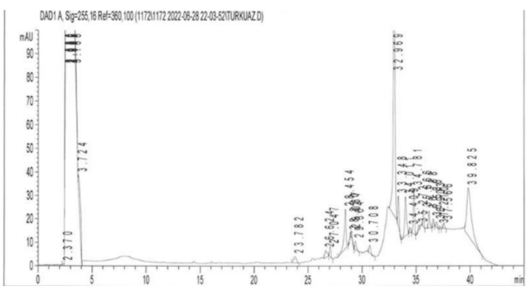


Figure 13: Chromatogram of sample 5 (Source: DATU Laboratory).

In the sample from area 6, titanium dioxide and copper phthalocyanine blue were found (Figure-14). In the sample from area 7, lamp black and titanium dioxide were identified (Figure-15). In the sample from area 8, titanium dioxide and azoaryl amidine were detected (Figure-16). According to the obtained results, no changes or deterioration in colors were identified.

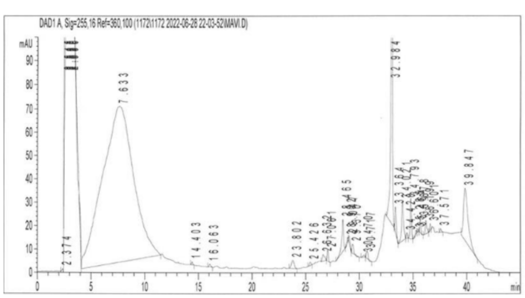


Figure 14: Chromatogram of sample 6 (Source: DATU Laboratory).

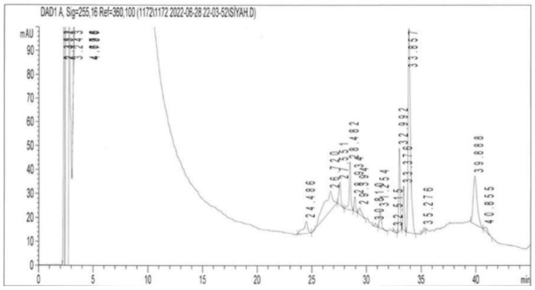


Figure 15: Chromatogram of sample 7 (Source: DATU Laboratory).

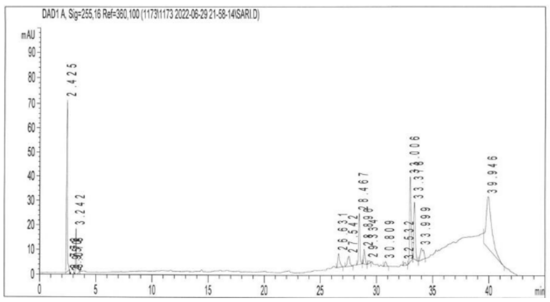
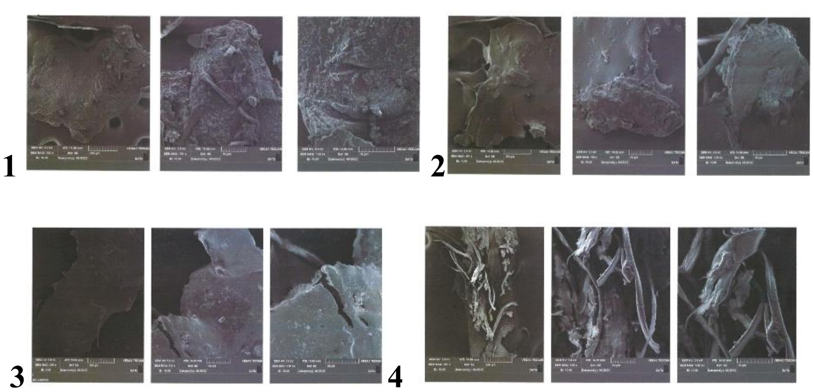


Figure 16: Chromatogram of sample 8 (Source: DATU Laboratory).

Scanning Electron Microscope (SEM) Analysis

After the surface cleaning of the painting, SEM analysis was conducted to examine the surface structure. According to the obtained SEM results, there were no significant changes on the surface of the paint layer after the cleaning.



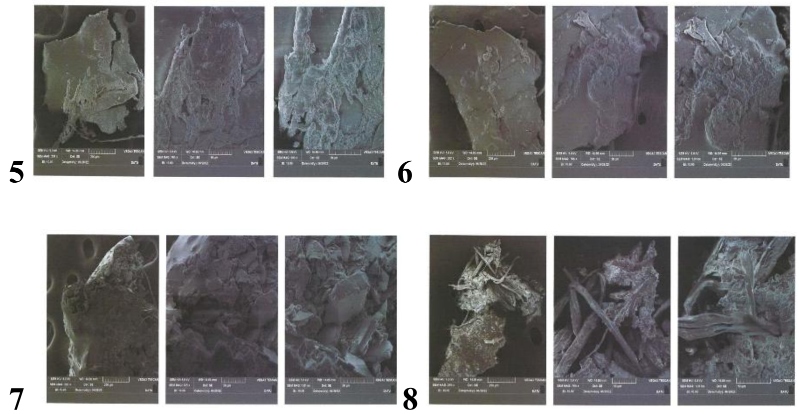


Image 26: SEM Image of 8 samples after wet surface cleaning (Source: DATU Laboratory)

Conclusion

In this study, wet surface cleaning was applied to eight specified areas of an acrylic painting by artist Berna Erkün using a modular cleaning program. Care was taken to ensure that the eight specified areas on the paint layer were in different locations and varied in color and tone. This approach was chosen to observe and compare the potential different outcomes of the planned surface cleaning as accurately as possible.

The modular cleaning program, a computer software used in various disciplines in the field of contemporary international conservation-restoration, was employed for surface cleaning. Information related to the painting is required to use the program. Data for the painting was obtained through its laboratory analyses and visual examinations. These included pH testing, SEM-EDX, HPLC and color analyses, as well as visible light, ultraviolet light, infrared light, backlight, and oblique side light examinations. A light microscope was used where necessary.

In addition to the analysis results, the artist was also consulted to choose the surface cleaning method for the painting by Berna Erkün. Detailed information about the painting, stretcher, and frame was gathered, including the place and date of acquisition, as well as all other materials used, such as paints and brushes.

For acrylic paintings, there are no universally accepted and verified results on the effects of wet spot tests. The applicability of spot tests available today, such as applying drops of distilled water or mixtures prepared with distilled water on the painting surface for some time, also remains uncertain. Therefore, simple spot tests were not preferred.

Initially, visual-optical examinations of the painting were conducted in a laboratory environment. Visible light (VIS) examination provided information about the technique of the painting, identifying thick paint layers, impasto, and brushwork. No surface deterioration was detected during the visible light examination. Backlighting revealed no damage such as tears, holes in the canvas support, or paint layer losses or flaking. The examination with raking light made the details of the impasto technique observed in visible light more apparent. Infrared imaging did not yield any data despite the presence of an underdrawing beneath the paint layer. The presence of an underdrawing was partially inferred from discussions with the artist and partially observed in visible light examinations. The artist mentioned that the underdrawing was done with a pencil during the creation stages of the painting. It is known that accurate information cannot be obtained for areas beneath the paint layer due to the resistance of acrylic paints to infrared light sources. Therefore, infrared (IR) examination was not conducted after the surface cleaning of the painting.

During the ultraviolet (UV) examination conducted before the surface cleaning application, dust-like dirt was detected on the painting's surface. Additionally, no previous retouching applications were observed. Microscopic examination revealed dirt embedded within the paint layer. Information regarding the paint film layer was also obtained. It was observed that in different areas of the painting, the paint did not form a stable film layer and was instead porous.

The painting does not have a varnish layer. Additionally, the artist has expressed a personal preference against applying varnish to the painting even after conservation-restoration treatments. This can be both an advantage and a disadvantage for artworks made of synthetic and thermoplastic materials. Acrylic paintings rapidly attract and absorb dirt and dust during and after the paint application process. This dirt can become embedded in the paint or form a layer on the surface. In the field of conservation-restoration, the varnish applied to acrylic paintings is similar to acrylic paint but differs in being pigment-free and colorless. This presents a disadvantage as it reacts to environmental factors similarly to acrylic paint. However, this situation also prevents dirt from forming a layer directly on the paint. Another issue arises when varnish is applied to the surface before the paint has had sufficient time to dry, causing the varnish to mix with the paint layer and resulting in the paint being removed during surface cleaning. Current research has not provided a valid solution or experience indicating that acrylic varnishes can be removed from the paint layer without damage or disturbing the underlying layers during surface cleaning.

After visual examinations, the pH values of the painting were measured using an agar agar gel. pH values are influential factors in selecting the cleaning method. In particular, fluctuating pH results in water-based paints can lead to surface swelling, blistering, paint detachment, and surface tension when any solution is applied to the painting

For obtaining data related to the paint layer of the acrylic painting, SEM-EDX, color measurement analysis, and HPLC methods were utilized. Color measurements were conducted before and after cleaning for the eight specified areas. No significant change in color was observed. When interpreting these colors, factors such as dirt and dust on the paint layer, especially when surface cleaning is performed, should also be considered.

Eight samples taken from the painting were analyzed using the HPLC method before and after cleaning. Additionally, SEM-EDX analysis was conducted to support the HPLC results due to the synthetic nature of the paints used in the painting. Both analyses detected titanium dioxide in all eight examined areas. Titanium dioxide is a compound used in the production of modern white paints and is also added as a filler to the paint. It has the highest color reflection and opacity. Today, it is used in priming pre-stretched canvases, particularly linen. As the artist indicated, the supporting textile of the painting used in the artwork was purchased pre-primed, and the primer color is white. Based on the verbal information and analyses, the paint applied to the primer is a synthetic white paint containing titanium dioxide. Additionally, samples from areas 1, 3, and 8 contained azoylaryl amidine from the synthetic pigment group azo dyes, while sample 2 contained azoyl 2-naphthol (azoyl-β-naphthol). Azoylaryl amidine is known to have a yellow color range, while azoyl-β-naphthol exhibits a red color range depending on the applied chemical process. Samples taken from areas 5 and 6 revealed the presence of copper phthalocyanin. This synthetic blue pigment, known as phthalocyanine blue, was obtained from samples taken from an area on the painting that is close to blue in color. In the sample taken from area 7, which has the coldest and brightest color on the painting, titanium dioxide and lamp black were detected. Lamp black, also known as soot black or carbon black, is a pigment. It is called carbon black because it contains carbon and is structurally very fine and powdery.

SEM analysis allowed for the comparison of results obtained before and after cleaning, in addition to examining the morphological structure of the pigments present in the painting. The SEM analyses conducted before surface cleaning were also reviewed alongside the color measurement results. Detailed microscopic imaging of the painting revealed that the paint layer was applied very thinly, with the support textile visible in some areas. SEM images also showed that the paint layer did not spread evenly across the surface, appearing porous and fragmented.

Based on information obtained from SEM and microscopic images of the paint layer, mechanical cleaning was deemed unsuitable. It was anticipated that mechanical cleaning methods applied to the surface would damage the paint layer. The water-based nature and synthetic materials of the paint layer significantly influence the choice of surface cleaning methods. Today, it is known that methyl cellulose gels and paper pulps are used for surface cleaning in water-based paintings by balancing the pH. However, this method is recommended for situations where the gel can be left on the thick paint layer and the surface for extended periods. When evaluating other gel methods, it is understood that gels control water release, making them a solution for water-activated surfaces. However, when gels are applied to the surface using cotton-wrapped sticks or brushes, they tend to create more shine and leave residues or deposits on the non-uniform paint layer. Various studies have observed that cellulose ether gels, polyacrylic acid gels, and viscous gels remain on the paint layer after surface cleaning. Due to the structure and application of the gels, this method was deemed unsuitable. Consequently, considering all the features of the painting, wet surface cleaning was concluded to be the appropriate method.

The use of a modular cleaning program was deemed suitable for selecting the wet surface cleaning method to be applied to acrylic paint. The program scales multiple wet solutions at different ratios for the user, chemically explaining these solutions and indicating potential harm to nature, the environment, and the painting. It offers pH balancers, surface cleaning agents, gelling agents, ionic effect balancers, and chelating agents for the preparation of solutions. The user can activate these factors by considering the characteristics of the painting. The program provides all solutions in a concentrated form. All these variables and program features were considered within the scope of the painting to be treated. The program particularly offers sample solutions for wet surface cleaning of acrylic paintings. In the past few years, it has been used on over a hundred acrylic paintings for this specific solution.

Non-ionic cleaning solutions are emphasized today for acrylic painting surfaces. The paint layer of the artwork to be treated is also applied with acrylic paint. Therefore, Triton X-100, one of the non-ionic surface cleaning agents that provides the most effective cleaning results, was planned to be used. The modular cleaning program selected the surface cleaning agent as a variable. The non-ionic nature of Triton X-100 allows it to be used across all pH ranges.

The surface cleaning agent for the concentrated solution in the modular cleaning program was selected based on the pre-determined pH ranges of the painting. The program then provided a sample solution recipe. Using the prepared concentrated solution, surface cleaning was performed on the eight designated sample areas of the painting. It was observed that the cleaning duration varied among areas with different pigments. Considering the SEM-EDX results obtained before cleaning, this was an expected outcome. For example, the cleaning duration was longer in areas 5 and 6 due to the presence of copper phthalocyanine blue. Additionally, area 7, which contained lamp black, required more sensitivity than all other areas.

During the initial application of the cleaning phase, a reaction believed to be due to pH and pigment was observed; a small amount of paint adhered to the cotton swab. The prepared concentrated solution was diluted by adding 5 ml of distilled water. When the newly diluted concentrated solution was applied, no paint traces were observed on the cotton swab, and the cleaning process was shorter for all areas compared to the initial application. After surface cleaning was completed in all areas, distilled water was briefly applied to all areas. This step ensured that no residual surface cleaning agent remained on the surface. The wet cleaning method applied in this study was evaluated through pre- and post-cleaning analyses. As a result, microscopic examinations indicated that the surface cleaning was effective for all areas and did not cause any deterioration. The accuracy of these results was also confirmed through color analysis.

After cleaning examination of the painting using ultraviolet (UV) light showed that dust was removed from the surface. The evaluation focused on potential issues such as color loss, glossiness, color fluctuations, or residues of the surface cleaning agent on the surface. Additionally, HPLC results were compared with the same perspective to assess the cleaning outcomes. No changes were detected in the HPLC analysis results before and after wet surface cleaning. No residues from the selected surface cleaning agent were detected based on these data.

The data obtained from the surface cleaning application using the modular cleaning program were evaluated through laboratory analyses. The applied method did not result in color gloss, color change, paint thinning, or residues from the cleaning process on the painting. Additionally, the dirt layer on the surface, considered to be dust, was removed. The pre-cleaning analyses conducted for the wet surface cleaning application chosen for the painting in this research can be further developed or supplemented with different methods through new advancements.

Acknowledgements:

This study was funded by the Scientific Research Projects Coordination Unit of Istanbul University, Project Number: 38401. The authors owe a debt of gratitude to the Scientific Research Projects Coordination Unit of Istanbul University, Artist Berna Erkün and Artist Assoc.Dr. Ahmet Özel .

Kaynakça

Breitbach, A.M., Rocha,J.C. C&Gaylarde, C. (2011). Influence of Pigment on Biodeterioration of Acrylic Paint Films in Southern Brazil, *Journal of Coatings Technology and Research,*(8), 619-628.

Cosentino, A (2015). Practical Notes On Ultraviolet Technical Photography For Art Examination, *Conservar Património,* (21), 53-62.

Emre, G. (2010). Yağlı boya Tabloların Bozulma Nedenleri ve Laboratuvar Ortamında Çözüm Önerilerinin Araştırılması (Yayımlanmamış Doktora Tezi). İstanbul: İstanbul Üniversitesi Sosyal Bilimler Enstitüsü.

Kanth,A.,Singh,M.& Pandey,S., (2018) Optimizing The Rigidity of Gellan and Agar Gels Cleaning Sensitive Acrylic Emulsion Painted Surfaces, *International Journal of Conservation Science*,volume 9, ıssue 3,451-462.

Karadag, R& Yurdun T. (2010). Dyestuff And Colour Analyses Of The Seljuk Carpets In Konya Ethnography Museum, *Studies in Conservation,* Volume 55: Sup2: Conservation and the Eastern Mediterranean: Contributions to the Istanbul Congress, September, 178-183.

Kayser, S.S. (2022). Hikmet Onat İmzalı Salacak İsimli Yağlı Boya Tabloda Uygulanan Mist-Lining Yöntemi. (Yayımlanmamış Yüksek Lisans Tezi). İstanbul: İstanbul Üniversitesi Sosyal Bilimler Enstitüsü.

Küpçüoğlu, H. (2012) .Yakın Uçtuk Uzaktık, Uzaktık Yakın Geçtik, Sergi Afişi, İstanbul: Mine Sanat Galerisi,

Mairinger, F. (2000). The Infrared Examination of Paintings (Ed.: D.C. Creagh & D.A. Bradley). *Radiation in Art and Archeometry*, Netherlands: Elsevıer Science B.V.(p. 40-55).

Mohammed A. & Abdullah, A. (2018). "Scanning Electron Microscopy (SEM): A Review, Proceedings of International Conference on Hydraulics and Pneumatics" HERVEX November 7-9, Băile Govora, Romania,1-9.

Poilvache-Lambert, T. & Maurits S. (1986*).* Reproduction of paintings. Photography.(Ed: Roger van Schoute and Hélène Verougstraete-Marcq). *Scientific Examination of Easel Paintings*, Pact 13.

Stavroudis, C.& Doherty T. (2013). *The Modular Cleaning Program in Practice: Application to Acrylic Paintings.* Smithsonian Contributions to Museum Conservation, USA: The J. Paul Getty Trust,139-145.

Stavroudis,C., Doherty T.& Wolbers R. (2005). A New Approach to Cleaning I: Using Mixtures of Concentrated Stock Solutions and a Database to Arrive at an Optimal Aqueous Cleaning System, *WAAC Newsletter*, volume 27, number 2, 17-28.

Yılmaz, Y., Youssef, A., & Sönmez, M. (2017). Suda Çözünür Yeni Ftalosiyaninlerin Sentezi ve Fotofizikokimyasal Özelliklerinin İncelenmesi. *Afyon Kocatepe Üniversitesi Fen Ve Mühendislik Bilimleri Dergisi,* 17(2), 469-478.

http://www.upsd.org.tr/ (Erişim Tarihi: 26.12.2024).

http://minesanat.com/sanatcilar/berna-erkun/ (Erişim Tarihi: 26.12.2024).

https://www.caresseart.com/?sanatcilar=berna-erkun (Erişim Tarihi: 26.12.2024).