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Microbial Studies to Evaluate Bio-Deterioration of Oil Painting on Masonite board and it's Conservation

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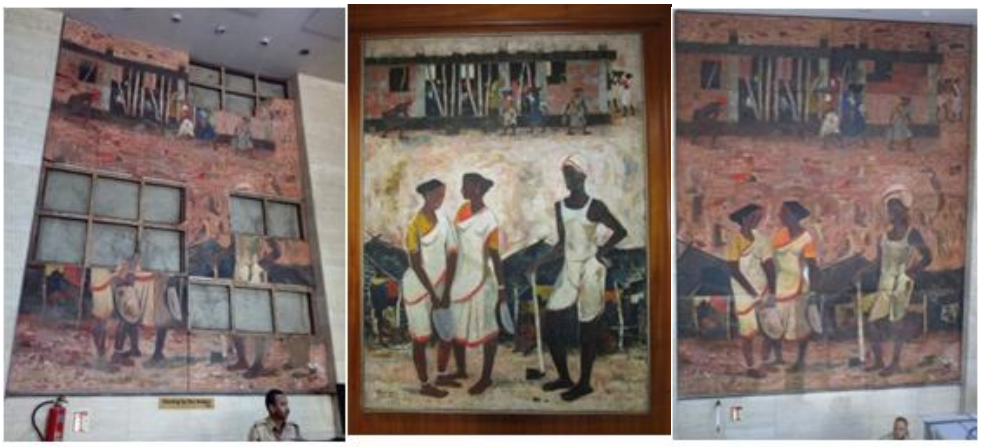
Abstract: ***In this study, we investigated the microbial community (bacteria and fungi) colonizing an oil painting on Masonite board, which showed visible signs of bio-deterioration. For the study, Microbiological samples were taken from deteriorated oil paintings of KK Habbar made on Mesonite board. The results showed that various fungal and bacterial species were isolated from the objects. These isolated micro species were studied to measure their ability in degrading cellulose, gelatin, linseed oil and the varnish dammer. The effects of different concentration of biocides were studied. The results showed that all the tested and single biocide is sufficient to kill a number of fungal and bacterial species effectively.***

Keywords: oil paintings, bio-deterioration, fungi, bacteria, concentration, biocides, conservation, preservation

1. Introduction

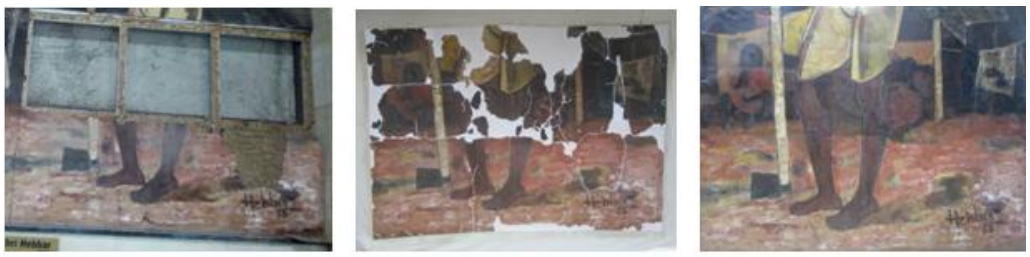
A nation without cultural heritage is like an orphan, has nothing to feed upon. India is deep rooted in the culture of glorious past. India is a vast country, and centuries old. It is difficult to sum up India's heritage in few words. India has been the birth place of many great artists. KK Habber is one of the well known artists of India. In this paper, we are going to discuss about the conservation of oil painting made by artist Shri KK Habber in the year 1963.



(a) (b) (c)

Figure 1: Photographs showing (a) Before, (b) Reference old photo and (c) After Conservation

Krishna Habbar was born in 1911 in Karnataka and received his diploma from Sir J J School of Art in 1938. Habbar felt a strong urge of paint in a genre which draws from traditional Indian art. He exposed him to some of the best worth in western art and finally settled down to study at the academy Julian in Paris. The form begins to take shape in Habber's work on his return from Europe. A skillful draughtsman, his study like Mahim Darga won him National Award in 1956 to be followed by award in annual exhibitions in 1957 and 1958. Habbar has also received the gold medal of Bombay art society in 1947. He was the chairman of the lalit kala academy in 1980 and president of Bombay art society in 1990. The Padamshri was awarded to the veteran artist in 1961 and Padam Bhushan in 1989. He died at the age of 85 in 1996.



(a) (b) (c)

Figure 2: Photographs of panel number-2 showing (a) Before, (b) during and (c) After Conservation

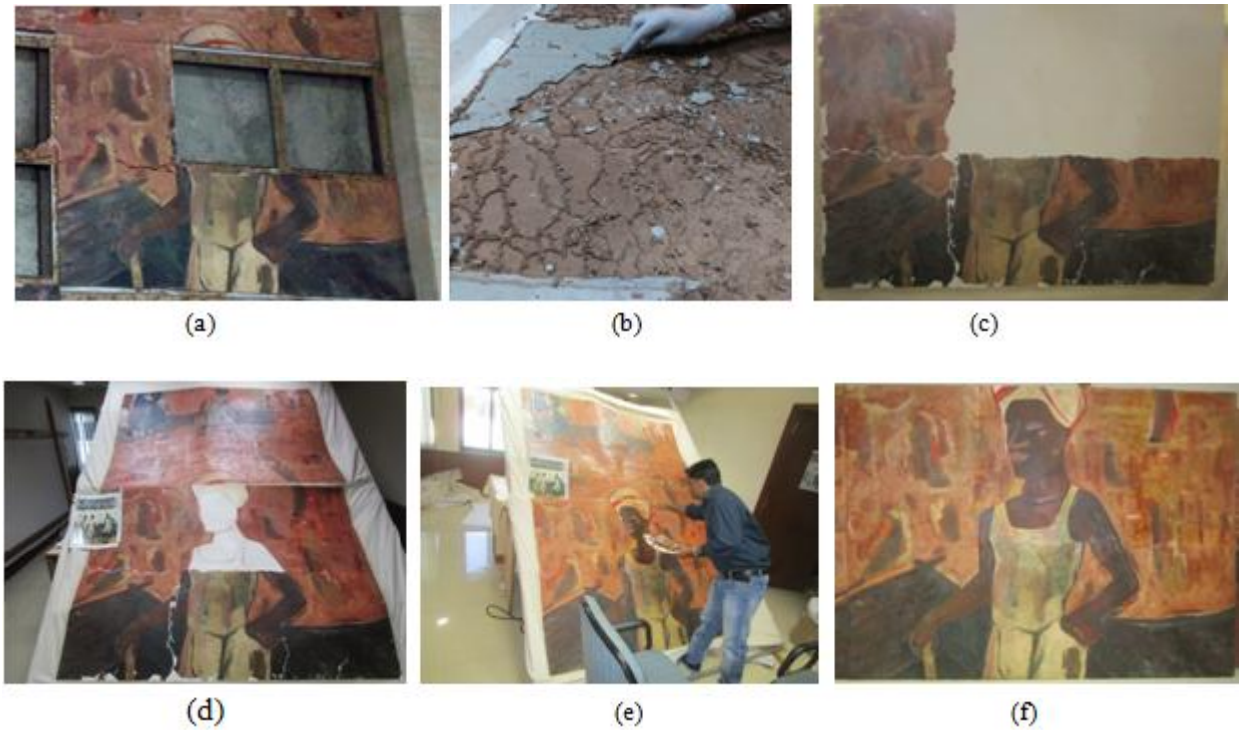


Figure 3: Photographs of panel number-4 showing (a) Before, (b) before lateral view (c, d, e) during and (f) After Conservation

KK Habbar's painting style:

The certain form began to take shape in Habbar's work after his return from Europe. Despite training in the western traditions, Habbar remained rooted to the folk art tradition. The central theme of habbar's art has always been human being, his concern with the human condition made him focus on themes like poverty, hunger and the destruction shapes shaped by war and nuclear explosion. At the same time, he was acutely sensitive to music and dance and having learnt the dance from Kathak. He has produced many paintings in brilliant hues of dancers and performs. In his early work, this is reflected through the depiction of aspect of Indian life such as the local festivals and daily activities of the common man. In later work, this translates into his preoccupation with mans scientific and technological advance and the work often reflect his associated fears. He will be best remembered for his eminently human paintings which draw from Indian colours and forms.

In this paper, we are talking about the oil painting of KK Habbar made on Mesonite board. First of all, we should know about what is mesonite board, it is often used as a painting support. It is a trademarked brand name of a particular type of board. It is made from (in very basic terms) from wood fiber and glue (resin) that is molded into flat board. Masonite board is artificial composite comprised of wood, wax, and numerous resigns. These wood fibers are produced by means of a lengthy course of action that will involve different stages of interfiling and consolidation.

This painting is the collection of LIC of India, Mumbai central office. The oil painting used in this study is shown in Figure-1-3. The size of the painting is 12ft. x15ft. Painting is made up of eight blocks; the size of six blocks is 4ft. x6ft. and the size of two blocks is 3ft. x6ft. Painting is in very fragile condition and it is fixed on wooden strainer through iron nail and rusted screws. Due to rusted nails and screws it is fixed permanently on wooden strainer.

Conservation issues:

The main cause of deterioration is insect/micro-organisms attack. The painting is made on mesonite board. The main cause of insect attack in this painting is the presence of cellulose in mesonite board fibers showing in Fig 3 (b). Mesonite board fibers are usually cellulosic element that is extracted from plats. Cellulose is mainly used to produce paperboard and paper. Some animals, particularly ruminants and termite can digest cellulose.

A verity of insects can damage mesonite board. Some of them actually eat it, while others destroy it when they burrow into the mesonite board to create nest. Some holes or sawdust on the surface of the mesonite board can indicate damage by insect, but in some cases, damage is not visible to the necked eye.

It is a fact that microorganisms also play a vital role in the deterioration of our cultural heritage. The main factor involved in the growth of microorganisms on artifacts is the environmental conditions. Painting contains a wide range of organic and inorganic compounds that may be used by the microorganisms for its growth[1-3]. Most importantly, the materials that are used for the paintings like cellulose of the canvas support materials, the animal glue and linseed oil of the pain layer which are easily degradable. Furthermore, the compounds that may provided nutrients for microorganisms which are further enhanced by dust and dirt and supplementary environmental factors deposited on the exterior of the

painting. The dead or living cells on the painted surface might provide an additional source of nutrients. Microorganisms may use organic biocides to support their growth, and the use of chemicals in conservation practices should be controlled[4-5].

This research paper deals the familiar microorganisms (fungi and bacteria's) associated with the deteriorated valuable oil paintings of KK Habbar made on Mesonite board and the conservation procedure adopted to prevent or slow down the bio-deterioration of this oil painting[6].

2. Materials and Methods

Aim and objective of the conservation

The primary aim of the conservation intervention was that of bringing the work back to a stable preservation state. Furthermore, it was considered that the treatment also fulfilled the additional purpose of restoring the painting to its intended, aesthetically appropriate form[2, 7].

Sampling

The state of deterioration of the oil painting is shown in Figure 1-3. Microbiological samples were collected from the deteriorated paintings and its surroundings as well as also from areas of several parts of the objects which showed particularly dense microbial growths or where they appeared to be associated with decay[1, 8].

Isolation, Identification and purification

The collected samples were plated out on nutrient agar for bacteria and potato dextrose agar (PDA) for fungi. Incubation was achieved at 37^0C for 24 hr for the bacteria and for the isolation of fungi, was kept for 72 hr at room temperature[9].

The identification of fungal isolates was carried out on the basis of their macro and microscopically characteristic sporulation while that of bacteria were carried out by studying physiological and biochemical properties (shown in table-1-3). The frequency occurrence of each species was expressed as the percentage of samples containing a given organism[10].

Microbial species isolates were studies to quantify their capability in degrading support's cellulose, animal glue's gelatin, pigment binder's linseed oil and the varnish dammar by implementing cellulose, gelatin, linseed oil and dammar as carbon sources[11].

Table 1: In-vitro growth of different microbial isolates associated with deteriorated oil painting of various locations using cellulose, gelatin, linseed oil and dammar

microbial isolates	Linear growth on cellulose		Linear growth on gelatin		Linear growth on linseed oil		Linear growth on dammar	
	(mm)	Densities	(mm)	Densities	(mm)	Densities	(mm)	Densities
Alternaria Alternata	48**	+3**	24	+2	18	+1	19	+1
Aspergillus clavatus	22	+2	24	+3	44	+3	67	+2
Aspergillus flavus	19	+1	25	+3	29	+2	82	+3
Aspergillus fumigatus	25	+1	47	+1	56	+3	90	+3
Aspergillus niger	58	+4	41	+2	73	+3	46	+3
Aspergillus terrus	0.00	0.0	30	+1	50	+3	61	+2
Penicillium chrysogenum	10	+1	52	+2	73	+3	66	+3
Penicillium Corylophilum	32	+2	33	+4	65	+3	15	+1
Bacillus acidocalayius	12	+2	9	+3	8	+2	7	+1
Bacillus megaterium	0.0	0.0	29	+1	7	+1	0.0	0.0
Bacillus stearothermophilus	29	+2	12	+3	25	+2	55	+3
Bacillus Subtilis	10	+1	21	+1	25	+1	0.0	0.0
L. S. D. at 5%	3.130		0.868		5.530		3.205	

*Each figure represents average diameter in (mm) of 4 replicates incubated at 27 ±2 °C for 6 days
**+4 = vigorous growth +3 = heavy growth +2 =moderate growth
+1= weak growth 0= no growth

Table 2: Occurrence and frequency of bacteria isolated from various oil painting

Object No.	Bacterial species				Total no. of isolates	Frequency %
	Bacillus megaterium	***Bacillus subtilis***	***Bacillus stearothermophilus***	***Bacillus acidocalayius***		
1	--	--	**1**	**1**	**2**	**5.71**
2	--	--	--	--	--	--
3	**2**	**2**	--	--	**4**	**11.43**
4	**1**	**1**	--	--	**2**	**5.71**

5	**1**	**1**	**1**	**1**	**4**	**11.43**
6	**--**	**1**	**1**	**1**	**3**	**8.57**
7	**--**	**--**	**1**	**--**	**1**	**2.86**
8	**--**	**1**	**--**	**--**	**1**	**2.86**
9	**--**	**--**	**--**	**--**	**--**	**--**
10	**--**	**--**	**--**	**--**	**--**	**--**
11	**--**	**--**	**1**	**3**	**4**	**11.43**
12	**--**	**--**	**2**	**2**	**4**	**11.43**
13	**--**	**--**	**--**	**2**	**2**	**5.71**
14	**1**	**1**	**--**	**--**	**2**	**5.71**
15	**2**	**3**	**--**	**--**	**5**	**14.29**
16	**1**	**--**	**--**	**--**	**1**	**2.86**
17	**--**	**--**	**--**	**--**	**--**	**--**
Total no. of isolates	**8**	**10**	**7**	**10**	**35**	
Frequency	**22.86**	**28.57**	**20**	**28.57**		**100**

Table 3: occurrence and frequency of fungi isolated from various oil painting

Object no.	**Fungal species**								Total no. of isolate s	Frequency %
	Alternari a alternata	***Aspergill us clavatus***	***Aspergil lus flavus***	***Aspergil lus fumigatu s***	***Aspergillu s niger***	***Aspergil lus terrus***	***Penicilliu m chrysogen um***	*Penicilliu m corylophil um*		
1	3	2	5	3	4	--	2	1	20	5.15
2	5	4	6	3	5	1	4	2	30	7.73
3	4	2	4	4	13	--	4	9	40	10.3
4	2	2	32	2	22	14	1	5	80	20.62
5	2	1	4	1	4	--	5	1	18	4.64
6	5	5	4	--	19	--	--	12	45	11.60
7	4	--	--	--	3	--	2	3	12	3.09
8	--	2	5	--	4	--	--	2	13	3.35
9	--	--	--	--	9	--	--	7	16	4.12
10	--	4	4	--	4	--	--	7	19	4.89
11	--	3	--	3	1	--	5	1	13	3.35
12	3	1	3	1	3	--	2	1	14	3.61
13	4	--	2	--	5	--	--	--	11	2.84
14	--	1	4	1	6	--	3	--	15	3.86
15		5		1	6	--	3	3	18	4.64
16	5	--	--	--	2	--	--	3	10	2.58
17	--	--	7	--	5	--	--	2	14	3.61
Total no. of isolates	**37**	**32**	**80**	**19**	**115**	**15**	**31**	**59**	**388**	
Frequency %	**9.53**	**8.25**	**20.62**	**4.90**	**29.64**	**3.87**	**7.99**	**15.21**		

Laboratory studies of biocide efficacy

The effect of biocides on the tested fungi and bacteria was studies using agar plates. A disc from a pure culture of each of the tested fungi was placed on the centre of plates containing different concentrations of the biocide were places in a hole in the centre of inoculated places. Petri plates were incubated at 27 ±2 °C and the two diameters of every plate were measured[12-14].

Methods adopted for conservation and restoration

Conservation and restoration is undertaken in some or almost all case. The main steps involved in conservation and restoration of oil painting are as fallows;

- Photographic documentation
- Cleaning of dust and dirt
- Facing with tissue paper and gauge cloths
- Removal of each panels from wooden strainer one by one
- Mechanical Removal of deteriorated masonite board from back side Removal of deposited termite infected dust and dirt
- Removal of facing.
- Give canvas support from back side of the painting with BEVA
- Filling with canvas cloth and canvas thread at lost part of painting with BEVA
- Cleaning of dust and dirt from front side of painting with sulphur free eraser and saliva cleaning with cotton swab.
- Surface leveling between painting and canvas filling area, coated with frenchalk and kaolin with PVA
- Reintegration of Painting
- Creation of lost panels with the reference of old photograph of painting.
- Give protective coating with paralloid B72
- Screw and fixed on wall one by one panels.

Initially the photographic documentation of the painting was done. For the conservation point of view, superficial cleaning for the removal of dust and dirt was carried out.

The facing was done with tissue paper and gauge cloths. Each panel was separated from wooden strainer one by one and then the photographic documentation of each panel was done. Deteriorated masonite board was removed from the backside with the help of surgical blade. Deposited termite infected dust and dirt was removed mechanically as well chemically. Then, all the small pieces assembled at correct place with painting panels. Facing given to the painting was removed mechanically. The canvas support with BEVA was provided to the back side of the painting and the painting was removed from the dummy stretcher. Lost part of the painting was treated with the canvas cloth and thread using BEVA. Then, dust and dirt deposited in the front side of the painting surface was removed using sulphur free eraser and saliva with cotton swab. Surface was leveled between painting and canvas with frenchalk and kaolin with PVA thrice after drying. Then the reintegration of the painting was done. Lost panels were prepared with the reference of old photographs of the painting, then the painting stretched on aluminum strainer and finally the protective coating was given with Paraloid B72. Before fixing of painting at display area, we had given anti termite, anti microbial treatment and waterproofing coating on the wall where the painting had fixed.

3. Results and Discussion

Table 2 & 3 represents data on the activities of various representatives bacterial and fungal isolates developed on agar media were isolated from different deteriorated oil paintings. The result in table 2 showed that the frequent occurrences of bacterial species ranged from 20% for Bacillus stearothermophilus to 28.57% for Bacillus acidocalayius and Bacillus Subtilis. While in table 1, the microbial linier grow on gelatin were minimum 0.868 and maximum 5.530 on linseed oil. While in table (3), the frequent occurrences of fungal species ranged from 3.87% for Aspergillus terrus to 29.64% for Aspergillus niger. These results agreed with those recorded in the literature on biodeterioration of wall and easel painting. The degree of decomposition of cellulose, gelatin, linseed oil and dammar differed considerably between microorganisms[3, 5, 15-17].

This experiment was undertaken to determine the effect of the tested biocides as agar amendment on the inhibition of microbial growth of the isolated fungi and bacteria. Data indicated that the antimicrobial activity of a biocide against growth of the tested microorganisms was significantly increased as the concentration of the biocide was increased. The result in table 2 and 3 showed that without exception all the screened oil painting was of highly microbial polluted. These results indicated that there are shortages in precautions and in the maintenance of these paintings. High relative humidity, inadequate air movement and darkness provide an almost ideal environment for the cultivation of bacterial and fungal spores, microbiological deterioration and insect attack[18-20].

4. Conclusion

This study demonstrates the common microorganisms associated with valuable oil paintings, their role in deteriorating various layers of the painting as well as the negative effect of some biocides on the tested fungal and bacterial growth. The results showed that a single treatment of the biocides was sufficient to kill a number of fungal species effectively. A regular cleaning and periodical biocidal spraying will help in saving these paintings from bio-deterioration in addition to keep storage and display areas at a constant 50% RH and 20°C, with light levels for display at 50 lux, ultraviolet light at less than 75 µw/lumen and air filtration to 95% of outside levels of pollutants[21-23]. In practice, however, these levels are rarely consistently achieved and realistic alternatives are often chosen, such as the creation of micro-climate frames or conditioned showcases. In warm humid museums, a glass box, if well built, is efficient in creating a safe microclimate and protecting exhibited paintings from microbial deterioration.

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