Study for approaching mold problems on photographic materials using antifungal agent and enzyme sheet

Yoko Shiraiwa and Takako Yamaguchi

Introduction

The poster shows two approaches to mold problems concerning photographic materials. The first continuing study uses the antifungal agent, Hokucide® R-150 to prevent mold on water damaged photographs when freezing and drying may be difficult after disasters. The second, Biofree® enzyme filter sheets, is being tested to prevent and suppress mold contamination on photographic materials.

Examination of an Antifungal Agent for Use on Photographs

Antifungal Agent Hokucide® R-150 (Hokko Chemical Industry Co., Ltd, Japan) is an aqueous solution of chloromethylisothiazolinone and methylisothiazolinone. Widely used in the architectural industry as an antibacterial and antifungal agent for construction materials, adhesives, paints, coatings, paper, and silicone oil. Used to control the germination of bacteria, fungi, algae and yeast and a surfactant is usually added to Hokucide® R-150 for even dispersion and reduction of surface tension.

Testing Hokucide® R-150 solutions on photographic materials for long term effect

Hokucide® R-150 solutions used for the test

1.5% Hokucide® R-150 with Fuji Driwel K (1% v/v)
1.0% Hokucide® R-150 with Kodak Photo-Flo (0.5% v/v)
1.5% Hokucide® R-150 with ethanol (5% v/v)
Ethanol was also tested as an alternative to photographic surfactants which are more difficult to obtain.

Method - Accelerated Aging Test

★Wash samples in distilled water, immersed in solutions and dry. Place in a chamber for accelerated aging (at 60°C/140°F, 86%RH for color materials and 70°C/158°F, 86% RH for the rest).
★Reflection density and colorimetric measurements of CIE L*a*b* values were measured using a spectrophotometer before and after immersion, and after 7 days and 14 days of accelerated aging.
★Resolution charts were viewed under optical microscope (100x) at each stages to observe any changes in details.

Samples

1 Colloidal Silver Film
2 Monochrome prints (step tablet) : Albumen print, Gelatin silver POP, Gelatin silver DOP on baryta
3 Macbeth Color Chart (chromogenic color)
4 Resolution Charts of monochrome prints
*For the solution with ethanol, 1 and 3 were tested.

Observations and Results

1 Transmission density changes (ΔTDb) minimal (Table. 1).
2 Reflection density change values for samples similar to the control (Fig. 1), except for POP, which had a slight change in the middle tone area (Fig. 2).
3 For the Photo-Flo solution samples ; slight change of color (ΔE*ab) in magenta:+2.44 (+1.01 for control) and a yellow stain in white: +3.55 (+1.58 for control). Other ΔE*ab values remained between 0.19 and 1.76 after 14 days.
4 No loss of detail observed in resolution charts.

Change in transmission density (ΔTDb) Colloidal Silver Film with initial transmission density

Solutions with Hokucide R-150 (%)	After immersion	After 4 days	After 7days	After 14 days
Distilled water (1.5) control	-0.11	-0.08	-0.16	-0.02
Fuji Driwel K (1.5)	-0.11	-0.13	-0.17	-0.11
Kodak Photo-Flo (1.0)	-0.13	-0.13	-0.16	-0.15
Ethanol (1.5)	—	—	-0.01	-0.10

Table 1.

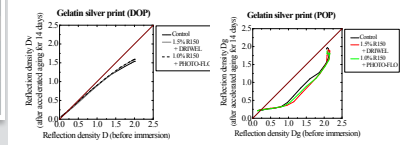


Fig.1

Fig. 2

Antifungal effect by spraying and soaking Hokucide® R-150 solution

Disaster in Japan (2011 Earthquake and Tsunami) resulted in a widespread loss of basic infrastructure with shortage of supplies for several weeks. Important to find a way in which this agent can be used effectively with a limited water supply. The antifungal effect of Hokucide® R-150 of simple spraying as well as soaking was evaluated.

Method

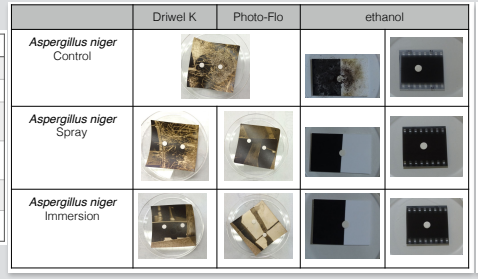
★Prepare groups of prints: control, spray with solution, immerse in solution.
★Place onto prints, spores of fungal strains *Aspergillus niger* and *Eurotium herbariorum* (paper disks).
★Place petri dishes with prints in a chamber at 27°C/80°F and 90-100%RH until fungal growth detected.

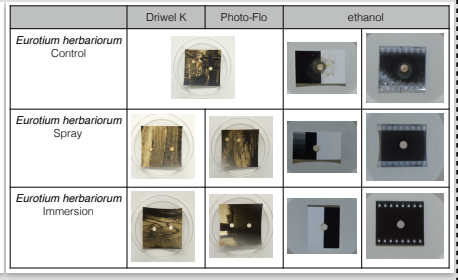
Samples

1. Gelatin silver DOP on baryta
2. Developed black and white negative film (only with ethanol solution)

Results of fungal growth

	fungi	fungal growth after – week
Control	*Aspergillus niger*	1 week
Control	*Eurotium herbariorum*	1 week
Hokucide® R-150 Driwel K and Photo-Flo	*Aspergillus niger*	9 weeks
Hokucide® R-150 Driwel K and Photo-Flo	*Eurotium herbariorum*	14 weeks
Hokucide® R-150 Ethanol	*Aspergillus niger*	Not detected (2016.2.29~)
Hokucide® R-150 Ethanol	*Eurotium herbariorum*	10 weeks





Conclusion

The study suggests a method to be considered in preventing a mold outbreak. The results confirm that Hokucide® R-150 solution with a surfactant (Fuji Driwel K, Kodak Photo-Flo) or ethanol can suppress microbial damage to photographs and furthermore, does not show any significant negative impact on the photographic materials after accelerated aging. To conserve water during emergency situation, spraying the solution proved to be an effective application method. The solution is simple to make, easy to use, and can be sprayed on. Great benefit when treating large numbers of objects during emergency recovery.

Study of using Biofree® enzyme filter sheets to prevent fungal problems

What is it ? How does it work?

Enzyme sheets are widely used as filters in air conditioning systems. Their primary function is to kill airborne microorganisms caught on their surface to protect against secondary contamination. **Against bacteria**, they dissolve the binding sites of a cell membrane by hydrolysis and then burst the cell membrane. Inner osmotic pressure then causes cell death. **Against fungi**, they deactivate the hyphae and maintain a bacteriostatic effect to suppress further fungal growth and contamination. Biofree® is manufactured by Nikki-Universal Co., Ltd. Japan.

Characteristics of enzyme sheets as a sustainable method for preventing and suppressing mold contamination on photographs

- Lytic enzyme, an active ingredient, is immobilized on the filter media by chemical bonding thereby prevents physical separation from the filter media.
- No energy required to activate.
- No frequent changing required.
- Soft and flexible non-woven fabric (rayon), easy to handle and use.
- Safe for the environment and human health.
- Cost effective.
- P.A.T. passed. (ISO 18916:2007)

*The sheet must be in direct contact with the object in order to exhibit its effect, therefore P.A.T. was conducted in 2015.

Effect of enzyme filter sheets on photographic prints contaminated with fungi

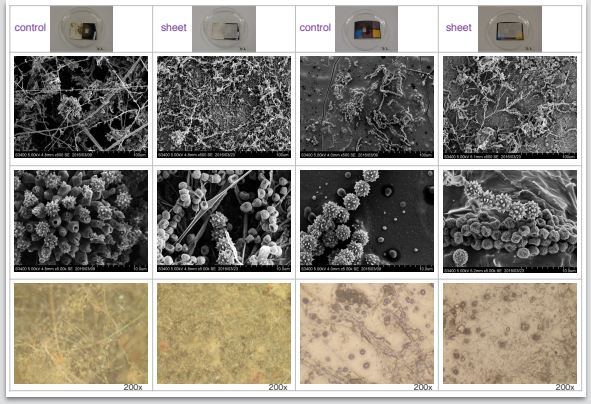
Method A

★Place enzyme sheet onto photographs heavily contaminated with fungi; in this case, *Aspergillus niger* and *Eurotium herbariorum.*
★Cut out a small square from each print as control, cover the rest with the enzyme sheet.
★Place in a chamber at 27°C/80°F and 90-100%RH for 10days.

Method A - Observation and result

Samples observed under a Scanning Electron Microscope.
Compared with control;
•Spores dispersed and scattered, some look crushed.
•Some individual spores shrunken or contracted, changing their shapes and size.
•Some hyphae lost their distinctive shape.
These observations cannot confirm whether fungal activity has been suppressed or not, however dramatic changes in shapes of spores and hyphae noticed.

Samples (*Eurotium herbariorum*)
Gelatin Silver DOP on baryta / Macbeth Color Chart (chromogenic color)



Method B

★ Place two paper disks with spores of fungal strains on each prints. (*Aspergillus niger* and *Eurotium herbariorum*)
★ Leave one disk uncovered as a control and cover the other disk with the enzyme sheet.
★ Place in a chamber at 27°C/80°F and 90-100%RH until fungal growth detected.

Method B- Observation and result

First 7 days mold growth more apparent on the control; after 14 days, mold growth seen on all samples. Due to the high humidity (90-100%RH), the sheet absorbed excessive moisture.

Conclusion and further research

Changes observed on the configuration of fungi spores and hyphae in contact with sheets. Further investigation is necessary to judge effectiveness of the enzyme sheets.
-Monitor long term effects under normal circumstance as opposed to accelerated tests. Elevated humidity causes condensation on this media.
-Test using spore fluid, rather than disks with spores, as the enzyme sheet needs to be in close contact with the object.
-Cultivate the fungal strains which were in contact with the sheets to see how the shapes and growth differ from the ordinary strains.

Yoko Shiraiwa, Paper and Photograph Conservator
Shiraiwa Conservation Studio
www.shiraiwaconservation.com / ys-i@gol.com

Takako Yamaguchi, Conservation Scientist
Tokyo Photographic Art Museum
www.topmuseum.jp / t.yamaguchi@topmuseum.jp