

# Mold and Yeast Mitigation using Pure - Light TiO<sub>2</sub> Coating

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## **Technology of Pure-Light Coating**

The photocatalytic process is well recognized for the removal of organic pollutants in the gaseous phase such as volatile organic compounds (VOCs), having great potential applications to contaminant control in indoor environments [1, 2].

Due to the antibacterial applications of TiO<sub>2</sub> -mediated photo oxidation, this process shows promise for the TiO<sub>2</sub> elimination of microorganisms in areas where the use of chemical cleaning agents or biocides is ineffective or is restricted by regulations, for example in the pharmaceutical and food industries [3]. TiO<sub>2</sub> is nontoxic and has been approved by the American Food and Drug Administration for use in human food, drugs, cosmetics, and food contact materials [4].

In terms of environmental health in the food industry, the antifungal capability of the Pure-Light TiO<sub>2</sub> photocatalysis against mold fungi would be very significant. The purpose of this experiment was to determine the effectiveness of the Pure-Light coating using photocatalytic activation specifically to control mold and yeast on barley sprouts.

## **Test Details**

Using high efficacy LED grow lights, barley sprouts were grown from seed to harvest using the Pure-Light coating on the grow light lenses with a control group grown under identical conditions without the Pure-Light application.

To further determine the effectiveness of the Pure-Light coating, mold was promoted at the time of the seed germination process and throughout the 9 day grow period. To promote mold, the humidity of the grow tents were raised to 62% average and all air circulation was turned off. Mold was evident on the seed hulls within the first 24 of germination for the control group and within 48 hours for the test group. The continued growth of this mold was evident throughout the grow process on both.

Using 1.5 pounds (dry weight) of seed for both the coated and control group, the germination rate for both groups was around 85-90%. Most of the control group seeds appeared soft and wet, while the seeds under the Pure-Light coated lights appeared more dry and firm after 24 hours.

As the barley sprouts grew, the root structure in the control group had much less root structure as compared to the test group. At the time of harvest after 9 days from seed, the test group had about twice the root length of the control group.

At the time of harvest, the test group had roughly twice the sprout height of the control group. Mold was very apparent in both the test and control group, but a significant reduction was seen in the test group.

Testing on both groups was performed at an independent testing lab, Iron Laboratories. Bio-Analysis performed was for the detection of Molds, Pests, and other impurities.

Total combined yeast and mold count measured in colony forming units per gram (cfu/g) was significantly different between the test and control samples.

Analysis of the test sample with Pure-Light - 129,908 cfu/g

Analysis of the control sample without Pure-Light - >626,632 cfu/g

With a reduction in mold/yeast counts of almost 80%, we have determined that the effectiveness of the Pure-Light coating is significant when used to control mold in food products.

**Lab Test Results are shown in Addendum A**

Final Weight (3.8 control vs. 3.5 pounds coated)

Difference due mostly to water not being absorbed due to lack of growth in control group

Control



Coated



## **Conclusion**

The photocatalytic technique appears to be a versatile and efficient disinfection process capable of inactivating a wide range of harmful microorganisms in various media. It is a safe, nontoxic, and relatively inexpensive disinfection method whose adaptability allows it to be used for many purposes.

Mold levels are very significantly reduced under very difficult conditions not normally seen in horticulture. Typical conditions would not promote mold before and during a cultivation period and therefore would never reach levels of mold found in our testing. Under normal conditions, it would be expected from our test results that mold levels would very easily be controlled by use of the Pure-Light coating.

## **References**

1. D. T. Tompkins, W. A. Zeitner, B. J. Lawnicki, and M. A. Anderson, "Evaluation of photocatalysis for gas-phase air cleanin—part 1: process, technical, and sizing considerations," *ASHRAE Transactions*, vol. 111, no. 2, pp. 60–84, 2005.
2. D. F. Ollis, "Photocatalytic purification and remediation of contaminated air and water," *Comptes Rendus de l'Academie des Sciences IIC 3*, vol. 3, no. 6, pp. 405–411, 2000.
3. E. V. Skorb, L. I. Antonouskaya, N. A. Belyasova, D. G. Shchukin, H. Möhwald, and D. V. Sviridov, "Antibacterial activity of thin-film photocatalysts based on metal-modified TiO<sub>2</sub> and TiO<sub>2</sub>:In<sub>2</sub>O<sub>3</sub>nanocomposite," *Applied Catalysis B*, vol. 84, no. 1-2, pp. 94–99, 2008
4. C. Chawengkijwanich and Y. Hayata, "Development of TiO<sub>2</sub> powder-coated food packaging film and its ability to inactivate *Escherichia coli* in vitro and in actual tests," *International Journal of Food Microbiology*, vol. 123, no. 3, pp. 288–292, 2008.

Addendum A to follow

Testing Accreditation #: 77802

Test Certificate #: 87720-001

**Client #: 1000949**  
**Client: Aqua Growers**  
**Sample Name: Treated**  
**Sample Type: Flower**

**Sample ID#: 87720**

Date Received: 11/15/2016

Test Date: 11/15/2016

Valid Through: 02/17/2017



## Bio-Analysis: FE02

Impurities:	Detected
Molds:	Yes
Pests:	No
Anthers:	No
Detritus:	No
Fibers:	No
Hair:	No
Mature Seeds:	No
Premature Seeds:	No
Other Impurities:	No
Moisture	-
Yeast and Mold Count*	129908 cfu/g

Types: N/A

Types: N/A

REFERENCE	AHPA	NSF/ANSI	USP
<i>Material</i>	<i>Dried, unprocessed herbs</i>	<i>Botanical ingredient, non-extract</i>	<i>Dried botanicals</i>
Total combined yeast and mold count (limits) in colony forming units / gram (cfu/g)	100000 cfu/g	100000 cfu/g	1000 cfu/g

AHPA - American Herbal Products Association, Guidance on Microbiology & Mycotoxins, 2012

NSF/ANSI - NSF International Standard / American National Standard NSF/ANSI 173-2012

USP - United States Pharmacopeial Convention, USP-NF 37-32, 2014

## Additional Notes:

Yeast and mold = 129908 cfu/g

Moisture is percent dry weight (wt/wt%); moisture analysis is not part of Iron Laboratories ISO/IEC 17025:2005 Accredited Scope.

\*Yeast and Mold Count uses method FE-37

Iron Laboratories, LLC is an ISO 17025:2005 Testing Laboratory laboratory, accredited by (PJLA) Perry Johnson Laboratory Accreditation, Certificate No. 77802





Testing Accreditation #: 77802

Test Certificate #: 87719-001

Client #: 1000949 Client: Aqua Growers

Sample Name: Untreated Sample  
Type: Flower

Sample ID#: 87719

Date Received: 11/15/2016

Test Date: 11/15/2016

Valid Through: 02/17/2017



## Bio-Analysis: FE02

Impurities: Detected  
Molds: Yes  
Pests: No  
Anthers: No  
Detritus: No  
Fibers: No  
Hair: No  
Mature Seeds: No  
Premature Seeds: No  
Other Impurities: No  
Moisture: -  
Yeast and Mold Count\* TNTC; Greater than 626643 cfu/g

Types: N/A

Types: N/A

REFERENCE	AHPA	NSF/ANSI	USP
<i>Material</i>	<i>Dried, unprocessed herbs</i>	<i>Botanical ingredient, non-extract</i>	<i>Dried botanicals</i>
Total combined yeast and mold count (limits) in colony forming units / gram (cfu/g)	100000 cfu/g	100000 cfu/g	1000 cfu/g

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USP - United States Pharmacopeial Convention, USP-NF 37-32, 2014

## Additional Notes:

Colonies too numerous to count. Counted approximately 325 colonies on half of the plate (325 X 2 = 650 estimated colonies), resulting in greater than 626643 cfu/g.

Moisture is percent dry weight (wt/wt%); moisture analysis is not part of Iron Laboratories ISO/IEC 17025:2005 Accredited Scope.

\*Yeast and Mold Count uses method FE-37

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**Comparison of Barley Seeds Germinated in Grow Tent using LED Lights Not Coated (Control) Compared to Coated LED Lights**

<b>Harvest Results 9 Days</b>	<b>Coated</b>	<b>Control</b>	<b>Control % Increase</b>
<b>Mold/Yeast Count CFU/G</b>	<b>129,908</b>	<b>626,643</b>	<b>482%</b>
<b>Weight (lbs.) See Note Below</b>	<b>3.5</b>	<b>3.8</b>	<b>8%</b>

<b>Germination Process - Nine Days</b>		
<b>1) Soaking Seeds in each One Gal Bucket</b>		
Start Date and Time	11/6/2016	6:00 AM
	Coated	Control
Dry Seed Weight (lbs.)	1.5	1.5
Time Interval (Hours)	12	12
Volume of Water (Gallons)	1	1
<b>2) Spread Soaked Barley Seeds into Propagation Trays</b>		
	11/6/2016	6:00 PM
<b>3) Watering</b>		
Start Date and Time	11/7/2016	6:00AM
	Coated	Control
Time Interval (Hours)	12	12
Times Per Day	2	2
Volume of Water(Cups) Per Water	0 to 1.5	0 to 1.5
<b>4) Harvest</b>		
Start Date and Time	11/15/2016	1:13 PM

<b>Certified Barley Seed Information</b>		<b>PH Adjusters</b>
Variety	Thoroughbred	None Used
Pure Seed	99%	
Germination Rate	90%	
Inert	1%	
Lot #	EP-1113	
Date Tested	7/14	

<b>Water Stats</b>	
<b>Control - RO Water from Grocery Store</b>	
pH	6.30

<b>Propagation Tray Info</b>	
Dimensions (Inches) Inside	20.5 L x 10 W x 2.5
Bottom Tray	

<b>Grow Tent Environment Stats</b>	
Average Temp	78
Average Humidity	62%

<b>LED Light Placement Over Trays</b>
LED 4' Bar Grow Lights were 3 1/2 Inches above Tray Line

Note: Based on visual observation the control tray had standing water while the tray under the coated LED Lights tray had no standing water which contributed to the control tray's weight