# Heated Towel Rack Mitigates Bacterial Growth

Evaluation of independent testing results

performed by EMSL Analytical, Inc.


using Heated Towel Racks supplied by Amba Products


This assessment is authored by

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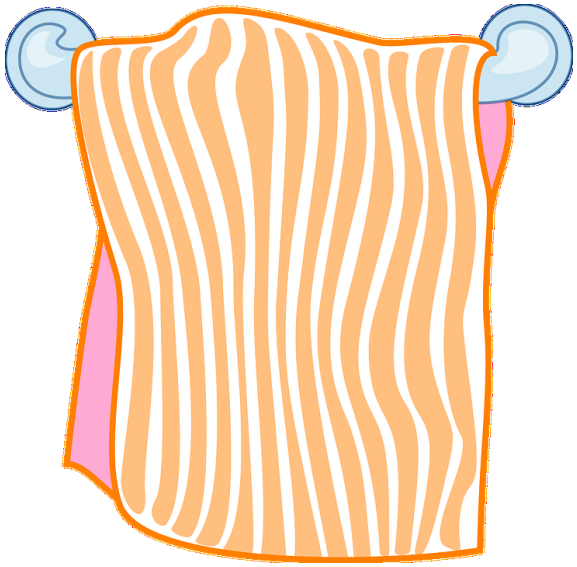


# INTRODUCTION

Every home includes a towel rack to hang-dry wet bath towels. While towel racks are a convenient place to hang a wet towel, they also increase the surface area of the towel that is exposed-to-air, which facilitates drying of the towel. Allowing proper drying of a wet bath towel should reduce musty odor and microbial growth[1]. This also allows users to reuse a towel multiple times before laundering. However, since bath towel racks are typically placed in the bathroom for convenience, towels are often left to dry in the most humid room in the house. In addition, a hang drying towel is exposed to more humid conditions each time another family member showers in that bathroom, increasing the wet-time of the bath towel and decreasing the effectiveness of hang drying. Heated towel racks are available as a solution to more efficiently dry towels in this humid environment. But does a heated towel rack actually help keep daily dampened towels fresh for a longer period of time?

Here, an independent analytical testing laboratory, EMSL Analytical, Inc., was contracted to evaluate the effect of using a heated towel rack (Solo 33" Freestanding Towel Warmer from Amba Products) on bacterial growth and odor on towels dampened daily[2]. To simulate human towel use after a daily shower, testing also included dampening of towels with diluted active cultures of bacteria. Bacterial growth on the towels was monitored over the course of a week and the towels were monitored for the emergence of a musty odor.

# PRODUCT & METHODOLOGY

The Solo 33" Freestanding Towel Warmer (Amba Products, Inc.) was used to evaluate the effect of a heated towel rack on bacterial growth and odor emergence on bath towels dampened once daily over the course of seven days. Negative control experiments were conducted using an identical towel rack that was unplugged and did not generate heat.

**Soiled Dampening Experiment**

Towels were dampened daily with ¼ Liter of water supplemented with 10% TS broth (containing organic nutrients that support bacterial growth) as a controlled laboratory substitute for human drying. This method is defined here as "**soiled dampening**". In this experiment, no experimental bacteria were added to the system, therefore any bacterial growth would result from the growth of natural microbes in the environment.

**Contaminated-Soiled Dampening Experiment**

Towels were dampened daily with ¼ Liter of water supplemented with 10% TS broth containing live bacteria derived from a laboratory culture. This method is defined here as "**contaminated-soiled dampening**". In this experiment, bacteria grown in the laboratory were added to the system, therefore any bacterial growth would result from

a combination of growth of the laboratory-derived bacteria and the growth of natural of microbes in the environment. This experiment acts as a controlled substitute for human drying (which would normally include transfer of natural microbes to the towel). The selection of laboratory bacteria for this study was *Staphylococcus Aureus* (*S. Aureus*), because it is a species of bacteria that is typically present on human skin.

Each experiment consisted of 6 towels (3 towels per rack). Three of the six towels make up the **unheated** control experiment (an unplugged towel rack) and the other three towels make up the **heated** condition (an identical heated towel rack turned on). Each towel was dampened with ¼ Liter of Soiled Dampening solution or Contaminated-Soiled Dampening solution once daily and returned to the towel rack. Racks were kept in a room with the ambient temperature maintained between 68-72°F over the course of the seven-day testing period.

Evaluation of bacterial growth and odor detection were conducted on day-0 after the initial dampening, and at three timepoints after the initial dampening, with the final timepoint at day-7.

Bacterial growth was measured by taking an equivalent 2" x 2" square cut-out from each towel. Bacteria were collected from each towel square in liquid media, and the bacterial count was established by counting growth of bacterial colonies after serial dilution and plating of aliquots on commercial aerobic count plates. Bacterial colony counts from dilutions were used to calculate the number bacteria extracted from the towel square and reported as the # of bacteria (colony forming units) per square inch of towel.

Odor detection was evaluated by an observer. The observer provided an odor designation of Fresh & Pleasant, Pleasant, or Musty for each observation.

# KEY FINDINGS

**Soiled Dampening Experiment Results**

The heated towels demonstrated fewer bacteria per square inch of towel than the unheated towels (After day-0). This indicates that the heated towels mitigated against the growth of bacteria found naturally in the environment. After Day-0, **heated towels had between 0.2 – 33% of the recovered bacteria relative to unheated towels.**

Musty odors were not detected for any towels at any time-point in this experiment.

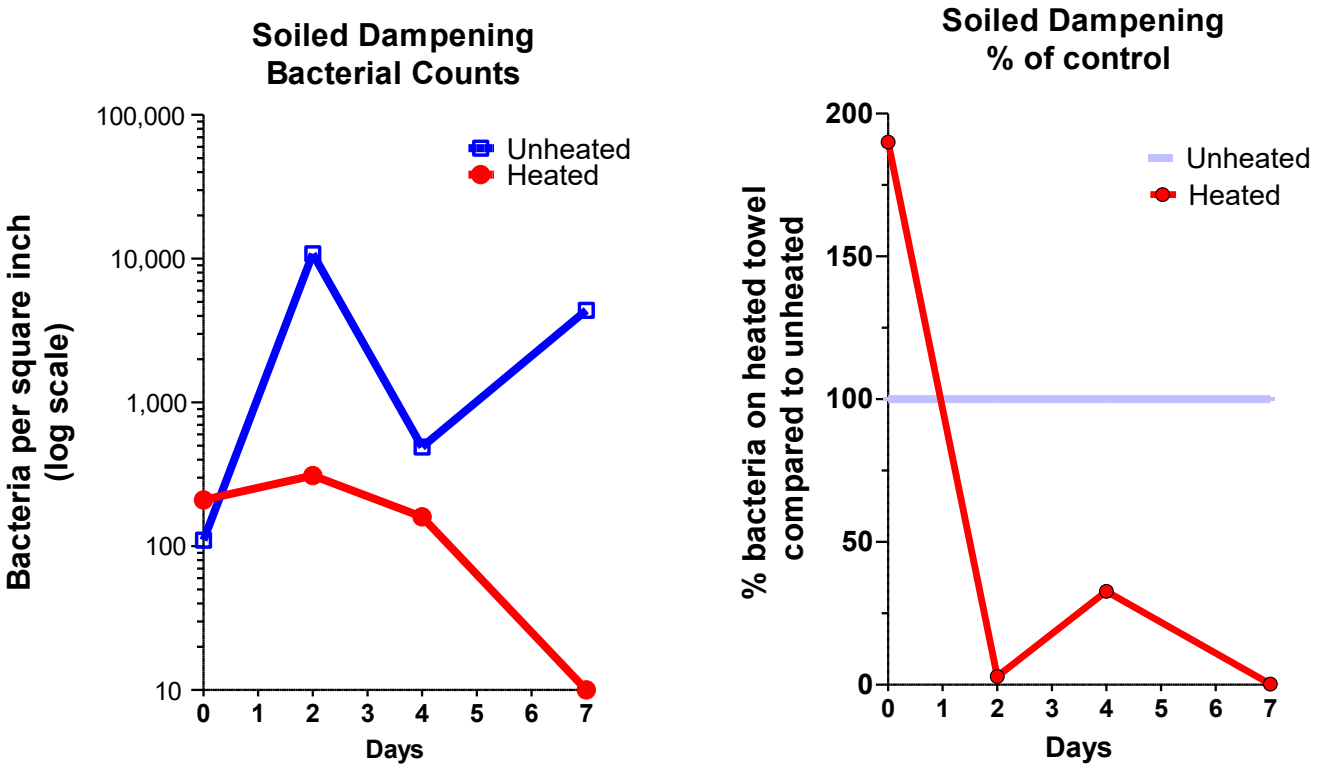



***Figure 1:*** Quantitation of viable bacteria extracted from towels after daily cycles of **soiled** dampening. [Left] Raw numbers of bacteria per square inch extracted from towel cuttings, expressed as the average value from 3 towels. Values are plotted on a log scale. [Right] The quantity of viable bacteria extracted from the heated towels is expressed as a percentage of the control (unheated) towels at the same timepoint.

**Contaminated-Soiled Dampening Experiment Results**

The heated towels demonstrated far fewer bacteria per square inch of towel than the unheated towels at each timepoint evaluated, after day-0. This indicates that the heated towels mitigated against the growth of the experimental bacteria introduced to the towel during the daily dampening. It is notable that the active bacterial load on the towels actually decreased between day 0 and day 3 suggesting that the majority of bacteria introduced at the time of dampening were not viable after exposure to the either towel rack. After Day-3, heated towels had between 0.17 – 03.6% of the recovered bacteria relative to unheated towels, **resulting in a ≥94% reduction of living bacteria on towels that are dried on a heated towel rack compared to similarly treated towels that are not heated**.

A musty odor was only detected on the unheated towels at day-4 and beyond.

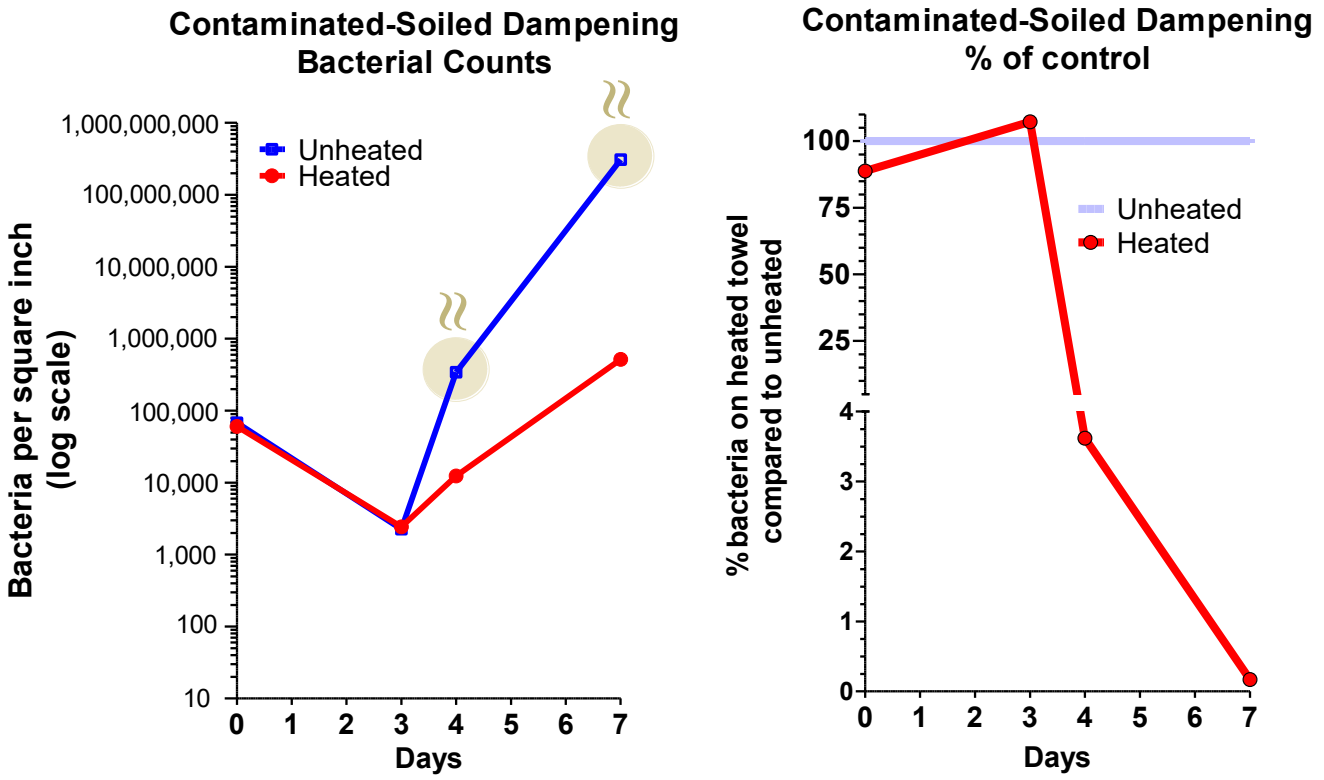



**Figure 2:** Quantitation of viable bacteria extracted from towels after daily cycles of **contaminated-soiled** dampening. [Left] Raw numbers of bacteria per square inch extracted from towel cuttings, expressed as the average value from 3 towels. Values are plotted on a log scale. Conditions that were observed to have a musty odor are highlighted with tan circle and an odor symbol. [Right] The quantity of viable bacteria extracted from the heated towels is expressed as a percentage of the control (unheated) towels at the same timepoint.

# CONCLUSION & DISCUSSION

It is common knowledge that many microbes grow and survive better in a humid environment. A wet towel on the bathroom floor or a forgotten load of towels in the washing machine will get musty, if left for too long. While a musty odor is itself undesirable, it is also an indication that bacteria, mold or fungal microbes are thriving and multiplying. Drying off after a shower with a microbe contaminated towel should be avoided to reduce the spread and propagation of germs. Generally, it is accepted that allowing your towel to dry quicker and more completely would be of benefit in this regard. Certainly, hanging a towel spread out on a horizontal towel bar would be expected to provide for better drying than hanging on a hook because the towel bar allows for more towel surface area to be exposed to the air.

The application of heat to the towel would be a rational added solution, whether that be throwing the towel in the dryer or hanging it outside on a clothesline. Therefore, the application of an electric heated towel warmer or rack makes sense, if it reduces wet-time and improves completeness of drying. By building this feature into a towel drying rack, users can potentially store their used towel in a convenient place in the bathroom near the bath or shower. Since this location is often one of the most humid places in a home, heated drying has the potential to improve drying. While this makes sense in principle, empirical evidence for the benefit of a heated towel warmer is not readily available. Therefore, this study was initiated with the purpose of determining whether a benefit of reduced growth of bacteria on reused towels is achieved with a heated towel rack.

In the study presented, bacterial growth was clearly reduced with the initiation of heating using a commercially available freestanding heated towel rack (Solo 33" Freestanding Towel Warmer from Amba Products). Two separate experiments were performed, each comparing bacterial growth on towels on a heated or unheated towel rack with once daily dampening. The first experiment evaluated soiled dampening, which is dampening with organic additives in the form of diluted bacterial growth media. The second experiment evaluated contaminated-soiled dampening, which was carried out much like the first experiment, but with the addition of diluted active bacterial (*S.Aureus*) cultures.

The **soiled dampening** experiment resulted in a clear decrease of active bacteria under the heated condition. However, the bacteria never exceeded ~10,000 bacteria per square inch of towel and no musty odors were detected. The heated condition resulted in a 97% reduction of bacteria at day-2 and day-7. The day-4 condition resulted in only a 64% reduction of bacteria in the heated condition. While still an improvement, there are some potential details to consider when evaluating that time-point. The less efficient reduction of bacteria relative to the unheated group appears to be a result of a lower bacterial count in the unheated group, and is not correlated to any increase in bacterial growth in the heated condition. The unheated day-4 timepoint appears to be a low-value outlier in relation to the other data points. Additionally, since no experimental bacteria were added to the system for this experiment, bacterial growth is due to natural contamination which would not likely to be uniform across the towel; therefore, we might expect more variability between samples based on the positioning of the excised square of towel for evaluation.

The **contaminated-soiled** dampening experiment also resulted in a clear decrease of active bacteria under the heated condition. All timepoints after day-3 demonstrated more than 94% reduction in recovered bacteria. The musty odor observe with unheated towels after day-4 was prevented in the heated condition The initial bacterial count at day-0 is measured before heating is introduced and therefore is a reflection of the number of viable bacteria introduced to the towel at each dampening cycle. Decreases in the number of bacteria recovered on day-3 suggest that the majority of introduced bacteria were not viable in the either condition.

Under these controlled laboratory conditions there is a major benefit of reduction in bacterial growth. These conditions are meant to be a well-controlled substitute for human use of a towel to dry off after a shower. Indeed, the ability to evenly dampen the towel with bacteria-laden moisture is required to control variability between different cut squares of towel. When used properly, a heated towel rack would be expected to provide a benefit of reduction of bacterial growth in a real-world situation.

There are some considerations to be made on how a real-world situation might be different than the laboratory conditions. These considerations may be useful for heated towel rack users to consider in their real-world applications; and support the design of additional studies to better understand these issues.

First, the current study does not address humidity in the experimental environment. It is likely that the humidity in the laboratory environment would be lower than in the average bathroom. Future studies could be conducted in a controlled humidity environment that would better model the humidity of a bathroom, or to introduce cycles of high humidity. Indeed, when someone else showers in a bathroom the humidity increases even if the hanging towel is not used. I would expect control unheated towels to foster even more growth of bacteria in higher humidity conditions. It is reasonable to expect a benefit from the heated towel rack in a more humid environment, but empirical evidence would allow a better quantification of benefit.

Second, many individuals take multiple showers per day, which increases the wet-time of a single used towel and increases the cycling per day between the wet and dry condition. This may be an even more impactful use case, since towels may not dry completely between uses in the absence of a heated towel rack.

Finally, the available data provided by the EMSL Laboratories report[2] provides values for a single experiment run in triplicate. Repeating this experiment with multiple independent experiments would allow for statistical analysis. This assessment should be considered as an assessment of the values provided with no judgement made on statistical significance.

**Key Takeaways**

- Utilization of a heated towel warming rack did reduce the accumulation of live bacteria on towels over the course of one week of daily dampening cycles.
- With the introduction of a viable bacterial contaminant into the dampening cycle:
  - Live bacteria on the towels were reduced by 94-99.8 % when a heated towel rack was used after a period of 4 days.
  - Musty odor was prevented over the course of 7 days when a heated towel rack was used.

# REFERENCES

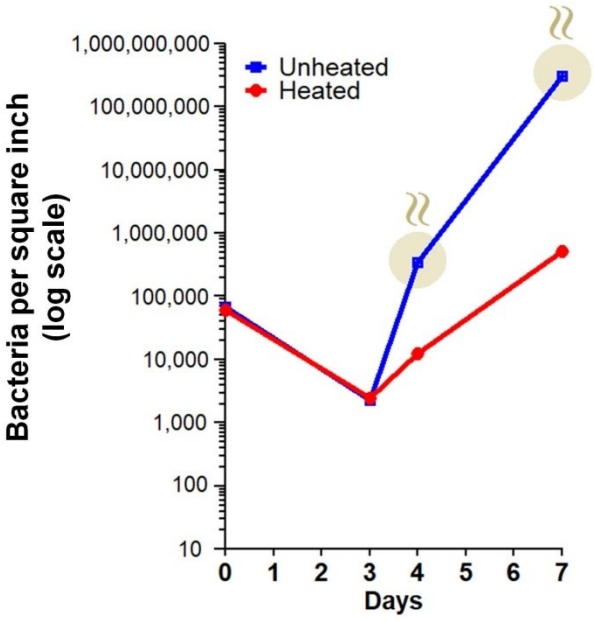

1. How often should you wash your (germ magnet of a) bath towel? (2019). Cleveland Clinic Health Essentials, accessed June 28, 2022. https://health.clevelandclinic.org/how-often-should-you-wash-your-germ-magnet-of-a-bath-towel/

2. Efficacy of a Heated Towel Rack to Reduce Bacterial Growth On Towels Under Daily Wetting Conditions, Final Report, EMSL order # 152202225, created June 3, 2022.

# VISUAL SUMMARY

## Use of a Heated Towel Rack
## Reduced Bacterial Growth by 94 - 99.8%
## and Prevented Musty Odors

Bacterial growth on towels dampened daily




Relative reduction in bacterial growth with a heated towel rack