



# Microbiological efficacy of Genano 5250M air purification device

Author: Satu Salo  
Confidentiality: Confidential

<b>Report's title</b> Microbiological efficacy of Genano 5250M air purification device	
<b>Customer, contact person, address</b> Genano Juhani Tulkki Metsänneidonkuja 6 02130 Espoo, Finland	<b>Order reference</b>
<b>Project name</b> AirCleanerEfficacy2	<b>Project number/Short name</b> VTT-V-128194-20
<b>Summary</b> The efficacy of Genano 5250M air purification device in removing microbes from the air was investigated using a study design where the air in a closed 30 m <sup>3</sup> space was artificially contaminated with microbial aerosol containing bacteria (both vegetative cells and spores), fungi and viruses. During the first hour the Genano 5250M air purification device reduced the bacterial spore levels over three Log-units. Proven by these tests and results the Genano 5250M air decontamination unit provides high efficacy in eliminating airborne viable microbes.	
Espoo 10.11.2020	
<b>Written by</b>  Satu Salo Senior Scientist	<b>Accepted by</b>  Hanna-Leena Alakomi Research Team Leader
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<b>Distribution (customer and VTT)</b> Customer, Juhani Tulkki, Genano and VTT archive	
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## 1. Description and objectives

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The efficacy of Genano 5250M air purification device to reduce the number of microbes in the air was studied in 30 m<sup>3</sup> pilot scale test room set-up. Airborne contamination was arranged in test room and number of microbes was analysed as function of time. Number of viable microbes in air samples was compared from situations when Genano 5250M air purification device was used and when no air purification was used.

Genano 5250M air purification device was provided by the customer (Figure 1). Full speed air flow was selected for test.

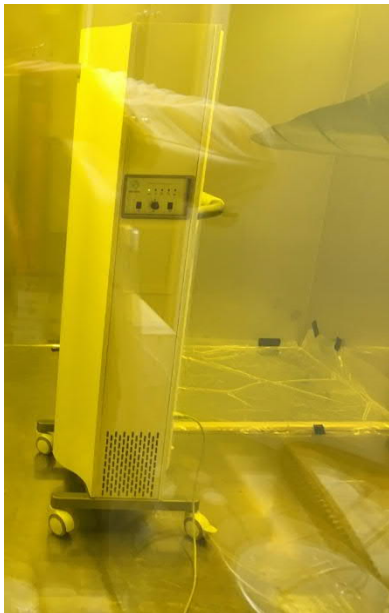


Figure 1. Genano 5250M air purification device in the test room.

## 2. Methods

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The air in the closed test room (30 m<sup>3</sup>) was contaminated with aerosol that contained bacterial spores (*Bacillus atrophaeus*, VTT E-052737), fungal spores (*Aspergillus niger*, VTT D-081297), vegetative bacterial cells (*Staphylococcus epidermidis*, VTT E-97768T) and viruses (bacterial phage MS2 (DSM 13767), a commonly used surrogate for norovirus. MS2 is now being considered as a surrogate for coronaviruses. *B. atrophaeus* spore suspension was performed by culturing strain VTT E-052737 from VTT Culture Collection for 7 d at 30°C in Nutrient Broth including MnSO<sub>4</sub> x H<sub>2</sub>O 10 mg/l. Cells were harvested and suspended in Ringersolution. The suspension was centrifuged and heated for 15 min in a water bath at 80°C. After heating suspension was washed three times using Ringer solution and centrifuged. *A. niger* suspension was performed by collecting cultured colonies with Ringer solution and filtrating it throw glass fibre. MS2 was cultured in Nutrient broth containing *Escherichia coli* and cleaned with chloroform. *S. epidermidis* was used as fresh overnight culture grown in Nutrient broth at 37°C. Microbial inoculum used for contamination of air contained microbes at the following levels: *A. niger* 10<sup>6</sup> CFU (colony forming units)/ml, MS2 10<sup>7</sup> phages/ml, *B. atrophaeus* 10<sup>8</sup> CFU/ml and *S. epidermidis* 10<sup>7</sup> CFU/ml. Aerosol was formed by generating strong microbial inoculum into the air by using Spira medical atomizer operating with 1 bar pressure for five minutes 50 seconds (Figure 2). There was a fan present in the room to efficiently mix the air.

First air sample was taken after generating bioaerosol at time point 0 h. After 0 h sampling Genano 5250M was switched on. Next air samples were taken at time points 15 min, 30 min, 1 h, 2 h and 3 h. Air samples (100 l, collected in 1 min) were collected on a filter (Sartorius, Gelatine Disposables) using MD8 (Sartorius) air sampler. Microbial levels on filters were determined with culture based techniques. Following growth media and conditions were used: moulds - Potato Dextrose Agar (PDA; incubation 25°C, 5 d), bacteria - Plate Count Agar (PCA; incubation 37°C, 2 d) and viruses - *Escherichia coli* containing Nutrient Agar (NA; incubation 37°C, 1 d). Similar samples were collected in a situation when the air purification device was not used. The efficacy of the device was estimated by comparing the results when the device was on or off. Trials were performed in triplicate during 10.9.-24.10.2020 at Tampere VTT test facility.



Figure 2. The nebulizer used to generate the microbial inoculum.

### 3. Results

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Numbers of microbes in air as function of time were compared between situations with air purification on and off. The average numbers of survived microbes (either colony forming units or plaque forming units per 100 l of air) are shown in Figures 3-6. The repeatability in the triplicate measurements was not accurate in number of microbes due to variations in contamination level of the air, but the profiles of microbes behaviour were similar in replicates. Results in figures are based on data from one trial (MS2, *A. niger* and *S. epidermidis*) or from two trials (*B. atrophaeus*). Variation between trials was originated from different microbe inoculation batches and mould blockages in nebulizing unit. The detection limit in this study design was 10 PFU/100 l for viruses, 100 CFU/100 l for mould and bacterial spores and 1000 CFU/100 l of air for bacteria.

One test trial was performed using Genano 5250M air purification unit with minimum speed air flow. Air sampling volume in this trial was 1 m<sup>3</sup>. One log unit reduction of *B. atrophaeus* spores was detected after 15 min, 2 log units reduction after 1 hour and 5 log units reduction after 2 h.

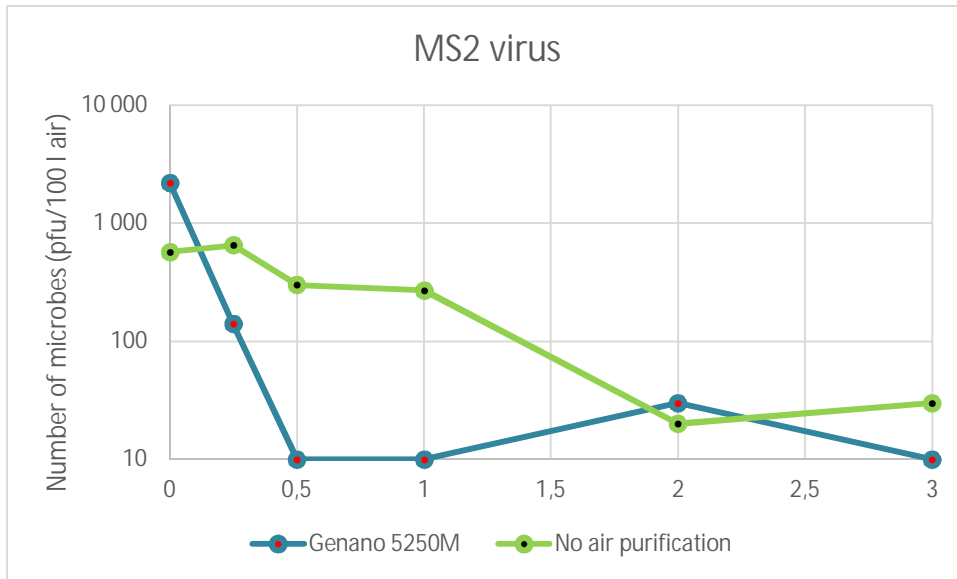


Figure 3. Comparison of MS2 virus number in the air with Genano 5250M on and without air purification.

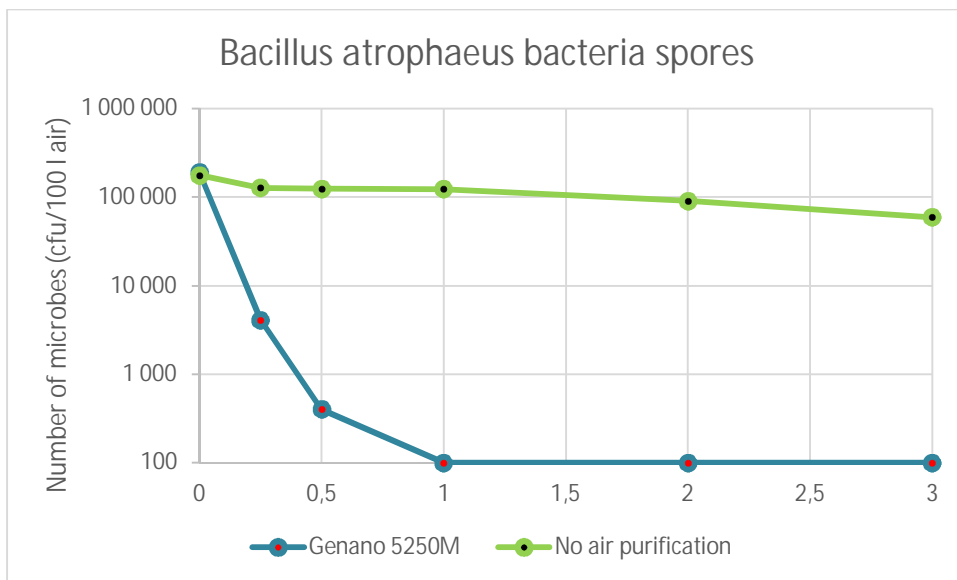


Figure 4. Comparison of *Bacillus atrophaeus* bacteria spore number in the air with Genano 5250M on and without air purification.

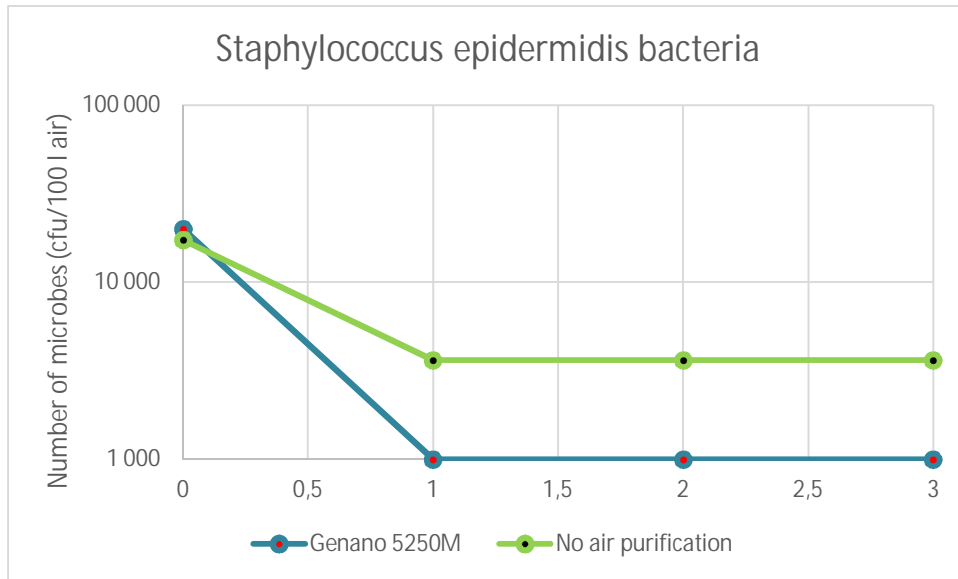


Figure 5. Comparison of *Staphylococcus epidermidis* bacteria number in the air with Genano 5250M on and without air purification.

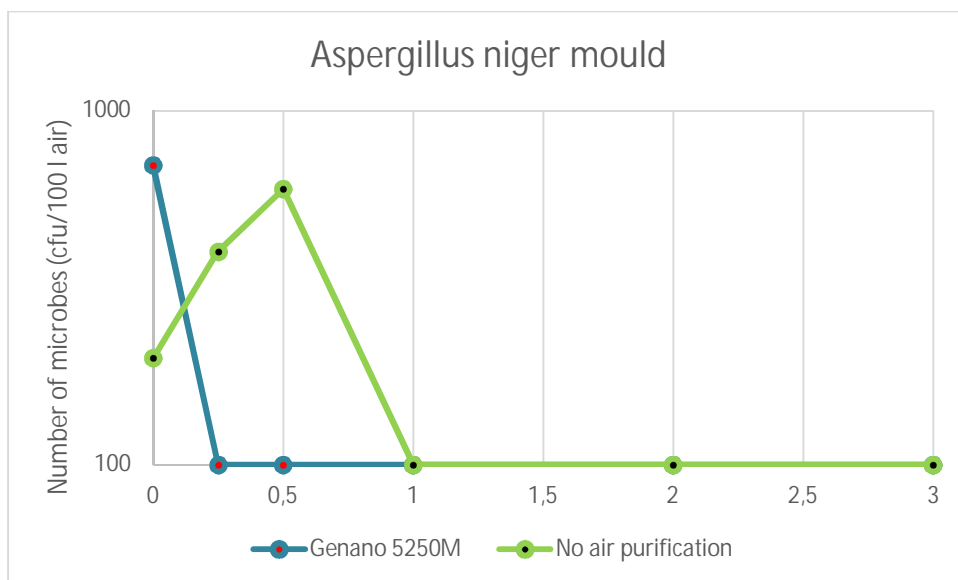


Figure 6. Comparison of *Aspergillus niger* mould spore number in the air with Genano 5250M on and without air purification.

## 4. Conclusions

The efficacy of Genano 5250M air purification device in removing microbes from the air was investigated using a study design where the air in a closed space was artificially contaminated with microbial aerosol containing bacteria (both vegetative cells and spores), fungi and viruses. Microbes were not added during the trial and thus also the natural inactivation of microbes in the air was occurring during the trial. Vegetative cells of *Staphylococcus epidermidis* could not be detected well since the number of *S. epidermidis* decreased quickly close or below detection limit also in the control samples. Bacterial spores on the other hand retained their viability in the air when the device was switched off. During the first hour the device reduced the bacterial spore levels over three Log-units and during the same time fungal spore and phage levels dropped under the limit of detection (10 viruses

and 100 moulds/100 l). The Log reduction after 30 min was over 1.5 for MS2 and over 0.7 Log units for *A.niger*.


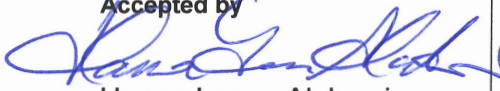
In this study design strong microbial suspension was generated with nebulizer into the air to ensure a high level of microbes in the air. In normal circumstances these high levels of microbes are not encountered in the air. Microbial vegetative cells - unlike spores - usually survive poorly in the air. Also in this study reduction of microbial levels was seen in the samples taken when the device was switched off. In this study set up no new microbes were introduced into the room. In real life both humans and airflow move microbes around and have an effect on how long the microbes stay in the air.

Proven by these tests and results the Genano 5250M air decontamination unit provides high efficacy in eliminating airborne viable microbes.

# **Microbiological efficacy of Genano 350 air purification device**

Author: Satu Salo  
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<b>Report's title</b> Microbiological efficacy of Genano 350 air purification device	
<b>Customer, contact person, address</b> Genano Juhani Tulkki Metsänneidonkuja 6 02130 Espoo, Finland	<b>Order reference</b>
<b>Project name</b> AirCleanerEfficacy2	<b>Project number/Short name</b> VTT-V-128194-20
<b>Summary</b> The efficacy of Genano 350 air purification device in removing microbes from the air was investigated using a study design where the air in a closed 30 m <sup>3</sup> space was artificially contaminated with microbial aerosol containing bacteria (both vegetative cells and spores), fungi and viruses. During the first hour the Genano 350 air purification device reduced the bacterial spore levels over three Log-units. Proven by these tests and results the Genano 350 air decontamination unit provides high efficacy in eliminating airborne viable microbes.	
Espoo 10.11.2020 <b>Written by</b>  Satu Salo Senior Scientist	<b>Accepted by</b>  Hanna-Leena Alakomi Research Team Leader
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## 1. Description and objectives

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The efficacy of Genano 350 air purification device to reduce the number of microbes in the air was studied in 30 m<sup>3</sup> pilot scale test room set-up. Airborne contamination was arranged in test room and number of microbes was analysed as function of time. Number of viable microbes in air samples was compared from situations when Genano 350 air purification device was used and when no air purification was used.

Genano 350 air purification device was provided by the customer (Figure 1). Full speed air flow was selected for test.

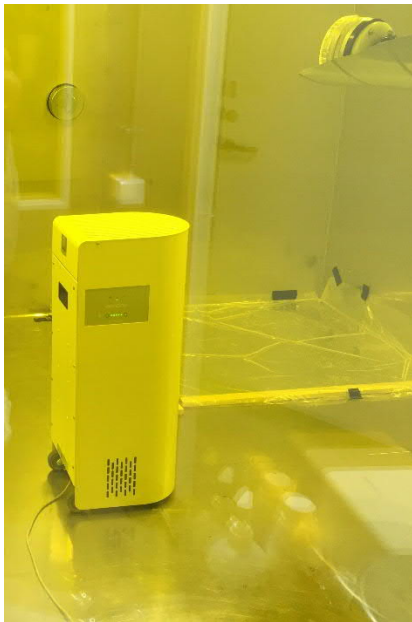


Figure 1. Genano 350 air purification device in the test room.

## 2. Methods

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The air in the closed test room (30 m<sup>3</sup>) was contaminated with aerosol that contained bacterial spores (*Bacillus atrophaeus*, VTT E-052737), fungal spores (*Aspergillus niger*, VTT D-081297), vegetative bacterial cells (*Staphylococcus epidermidis*, VTT E-97768T) and viruses (bacterial phage MS2 (DSM 13767), a commonly used surrogate for norovirus. MS2 is now being considered as a surrogate for coronaviruses. *B. atrophaeus* spore suspension was performed by culturing strain VTT E-052737 from VTT Culture Collection for 7 d at 30°C in Nutrient Broth including MnSO<sub>4</sub> x H<sub>2</sub>O 10 mg/l. Cells were harvested and suspended in Ringersolution. The suspension was centrifuged and heated for 15 min in a water bath at 80°C. After heating suspension was washed three times using Ringer solution and centrifuged. *A. niger* suspension was performed by collecting cultured colonies with Ringer solution and filtrating it throw glass fibre. MS2 was cultured in Nutrient broth containing *Escherichia coli* and cleaned with chloroform. *S. epidermidis* was used as fresh overnight culture grown in Nutrient broth at 37°C. Microbial inoculum used for contamination of air contained microbes at the following levels: *A. niger* 10<sup>6</sup> CFU (colony forming units)/ml, MS2 10<sup>7</sup> phages/ml, *B. atrophaeus* 10<sup>8</sup> CFU/ml and *S. epidermidis* 10<sup>7</sup> CFU/ml. Aerosol was formed by generating strong microbial inoculum into the air by using Spira medical atomizer operating with 1 bar pressure for five minutes 50 seconds (Figure 2). There was a fan present in the room to efficiently mix the air.

First air sample was taken after generating bioaerosol at time point 0 h. After 0 h sampling Genano 350 was switched on. Next air samples were taken at time points 15 min, 30 min, 1 h, 2 h and 3 h. Air samples (100 l, collected in 1 min) were collected on a filter (Sartorius, Gelatine Disposables) using MD8 (Sartorius) air sampler. Microbial levels on filters were determined with culture based techniques. Following growth media and conditions were used: moulds - Potato Dextrose Agar (PDA; incubation 25°C, 5 d), bacteria - Plate Count Agar (PCA; incubation 37°C, 2 d) and viruses - *Escherichia coli* containing Nutrient Agar (NA; incubation 37°C, 1 d). Similar samples were collected in a situation when the air purification device was not used. The efficacy of the device was estimated by comparing the results when the device was on or off. Trials were performed in triplicate during 10.9.-24.10.2020 at Tampere VTT test facility.



Figure 2. The nebulizer used to generate the microbial inoculum.

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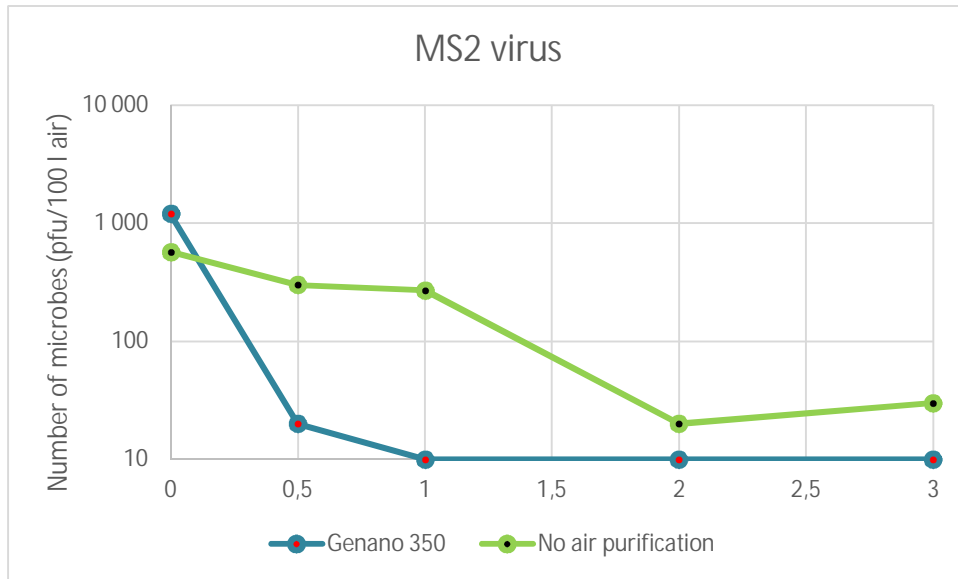


Figure 3. Comparison of MS2 virus number in the air with Genano 350 on and without air purification.

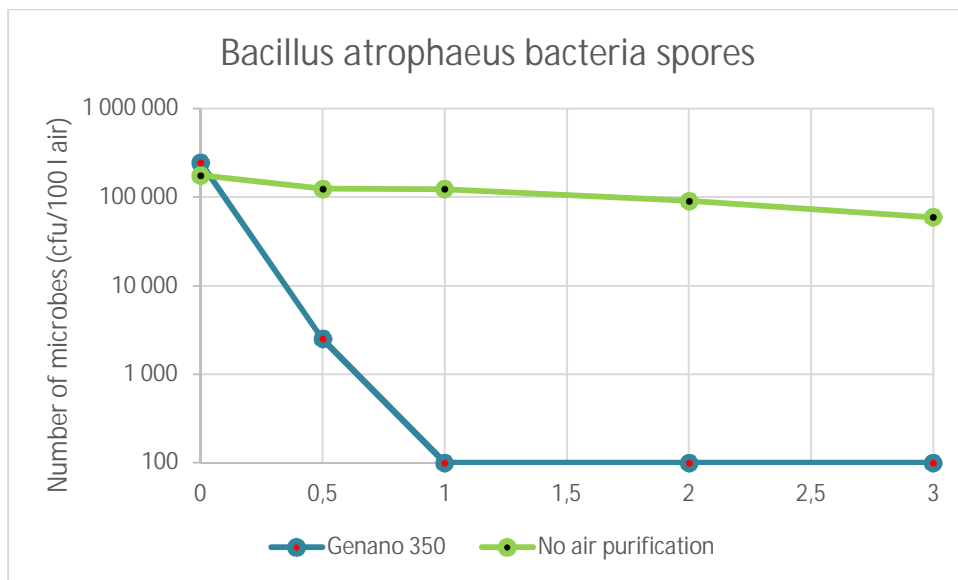


Figure 4. Comparison of *Bacillus atrophaeus* bacteria spore number in the air with Genano 350 on and without air purification.

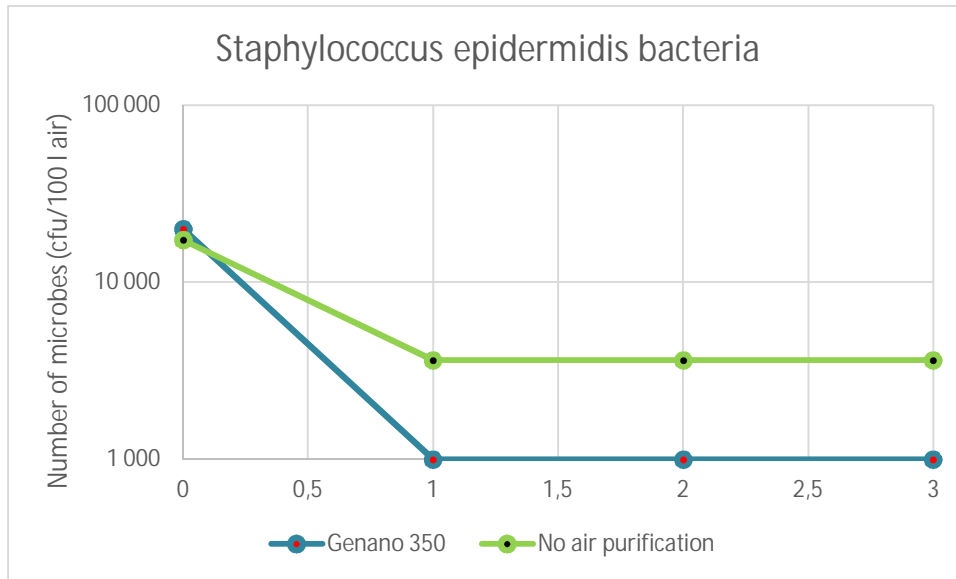


Figure 5. Comparison of *Staphylococcus epidermidis* bacteria number in the air with Genano 350 on and without air purification.

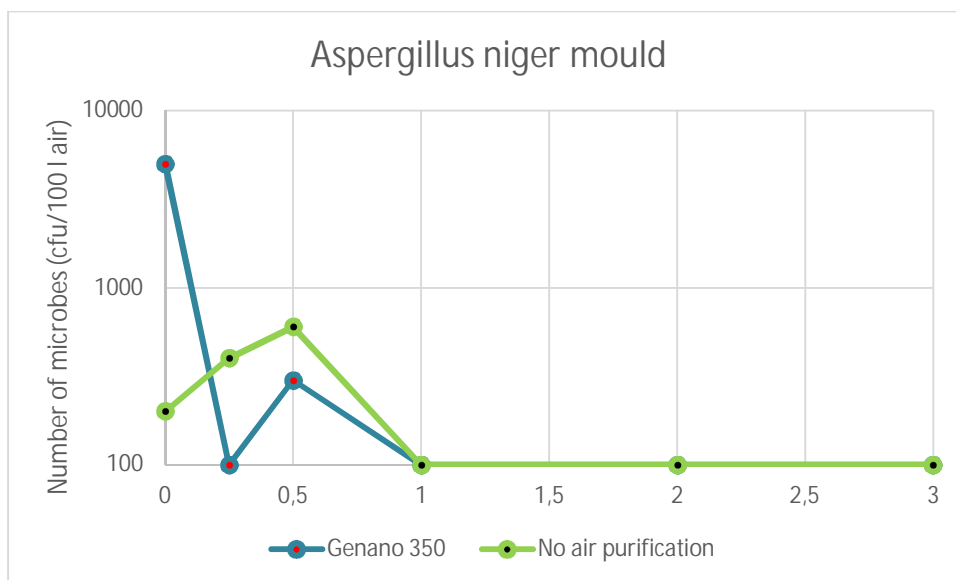


Figure 6. Comparison of *Aspergillus niger* mould spore number in the air with Genano 350 on and without air purification.

## 4. Conclusions

The efficacy of Genano 350 air purification device in removing microbes from the air was investigated using a study design where the air in a closed space was artificially contaminated with microbial aerosol containing bacteria (both vegetative cells and spores), fungi and viruses. Microbes were not added during the trial and thus also the natural inactivation of microbes in the air was occurring during the trial. Vegetative cells of *Staphylococcus epidermidis* could not be detected well since the number of *S. epidermidis* decreased quickly close or below detection limit also in the control samples. Bacterial spores on the other hand retained their viability in the air when the device was switched off. During the first hour the device reduced the bacterial spore levels over three Log-units and during the same time fungal spore and phage levels dropped under the limit of detection (10 viruses

and 100 moulds/100 l). The Log reduction after 30 min was over 1.2 for MS2 and over 0.3 Log units for *A.niger*.

In this study design strong microbial suspension was generated with nebulizer into the air to ensure a high level of microbes in the air. In normal circumstances these high levels of microbes are not encountered in the air. Microbial vegetative cells - unlike spores - usually survive poorly in the air. Also in this study reduction of microbial levels was seen in the samples taken when the device was switched off. In this study set up no new microbes were introduced into the room. In real life both humans and airflow move microbes around and have an effect on how long the microbes stay in the air.

Proven by these tests and results the Genano 350 air decontamination unit provides high efficacy in eliminating airborne viable microbes.