List of the microbiological tests conducted with BIOVITAE devices

Brief introduction to the world of microorganisms

The world of microorganisms represents the invisible part of life: a world populated by countless organisms who constantly interact with all creatures of our planet.

All surfaces and media are densely populated of microorganisms. Plants and animals host a considerable amount of them, and just think they live in our body in a quantity ten times greater than the number of cells that compose it.

And their ability to interact with living beings reaches amazing levels. For example, there are some wasps that use a virus injected into the brain of their preys to paralyze them while larvae devour them from the inside, while some bacteria can decide the sex of the arthropods, and the massive presence of a specific bacterial species manages to ensure thinness or obesity in laboratory mice.

In the common imagination, the concepts of cleaning and sterilization are considerate the same thing, and people believe that to be healthy and reach an effective level of hygiene, it is necessary to eliminate all microbes indiscriminately.

But the truth is that most microorganisms are neutral and follow the dominant group: if pathogens dominate, then the whole environment gets sick; but if, on the other hand, commensal microbes predominate, the whole environment remains healthy.

Therefore, with the indiscriminate elimination of all microbes through aggressive disinfection practices, there is the risk of creating free spaces that can be re-colonized by harmful species which, in an environment lacking antagonists, are able to proliferate without control, thus breaking the existing microbial equilibrium and becoming a potential cause of disease.

The mechanisms of action of BIOVITAE devices

Microbial contamination of surfaces contributes significantly to the transmission of infections, especially in hospitals or environments with a high rate of promiscuity [1, 2, 3, 4, 5].

BIOVITAE technology and the products derived from it are specially designed to safeguard the environmental microbial balance, acting above all for the elimination of pathogens and maximally preserving commensals.

And the principle of continuous sanitation promoted through BIOVITAE technology can help balance the environmental microbial load through the following actions:

- **Promotion of competitive antagonism.** It is a mode of action that maximizes the effectiveness against pathogenic (bad) microorganisms, favoring instead the maintenance of the colonies of (good) probiotic bacteria and (predator) bacteriophage viruses.

- **Prevention of the risk of re-contamination.** Thanks to its continuous sanitizing action which, even in the presence of living beings, prevents re-contamination, that is the risk that a potentially pathogenic microbial population can restore itself within environments previously treated with chemical disinfectants.

- **Contrast to the phenomenon of bacterial resistome.** When microorganisms reach surfaces, they tend to aggregate in polymicrobial biofilms, within which genetic material is exchanged even between different species. This genetic material, called a resistome, contains all combinations of mutations capable of making microorganisms antibiotic-resistant.

Disclaimer

All tests listed below were performed according to the following regulatory standards for the execution of microbiological tests in controlled environments:

- NF EN 14476 + A2 July 2019
- UNI EN ISO 4833-2:2013
- UNI EN ISO15214
- UNI EN ISO 21528-2:2017
- UNI EN ISO 6888-2:2004
- UNI EN ISO 16777:2018
- UNI EN ISO 22196:2011

LIST OF IN-VITRO TESTS

Yellow Fever Virus (Celio Military Hospital, Italy)

The Yellow Fever Virus can be found in tropical and subtropical regions of Africa and South America, and it has no cure. It is a virus of the Flavivirus genre and of the Flaviviridae family. The term "yellow" refers to the jaundice that affects some patients.

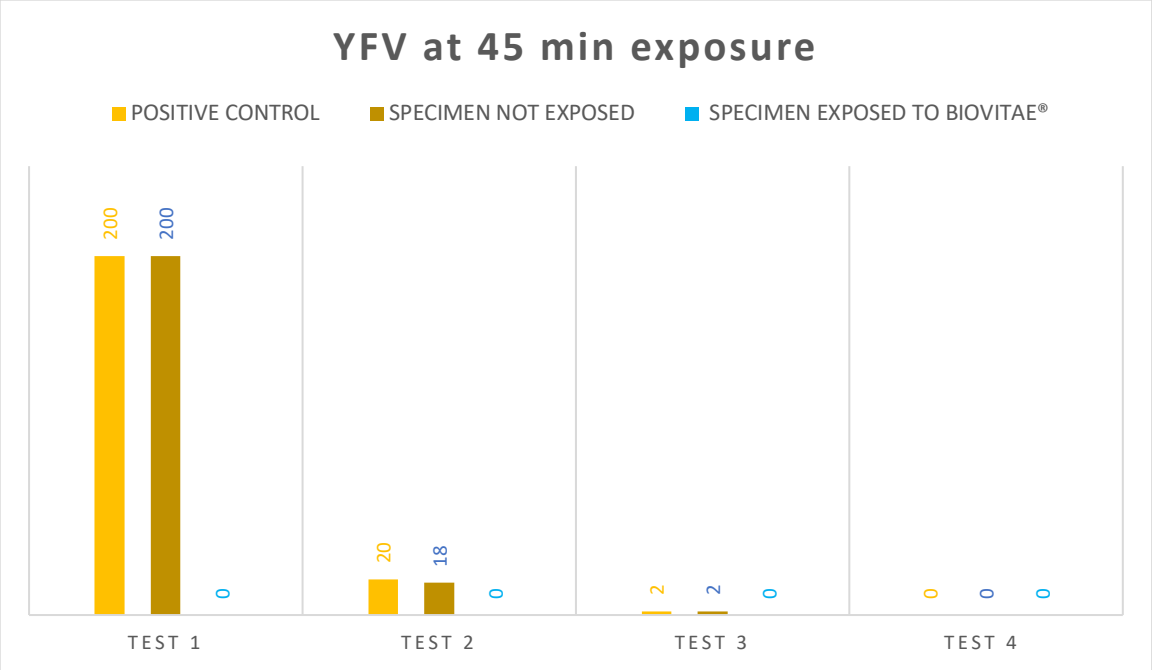

Table 1 - TEST 1 LEG 1 *

The BIOVITAE technology test on YFV (Yellow Fever Virus) was made at the Scientific Department of the Celio Military Hospital, Rome, Italy, which is part of the European Biodefence Laboratory Network (EBLN). Data are expressed in PFU/ml, and tests are performed in quadruplicate. Data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 45 minutes, the BIOVITAE technology achieved a 100% abatement of the original viral load.

* Tests were conducted with viruses in liquid suspension.

SARS-CoV-2 (Celio Military Hospital, Italy)

Coronaviruses (CoV) are a large family of respiratory viruses that can cause mild to moderate illnesses, ranging from the common cold to respiratory syndromes such as MERS (Middle East Respiratory Syndrome) and SARS (Severe Acute Respiratory Syndrome). They are named for the crown-like spikes on their surface, “corona” being the Latin for “crown”.

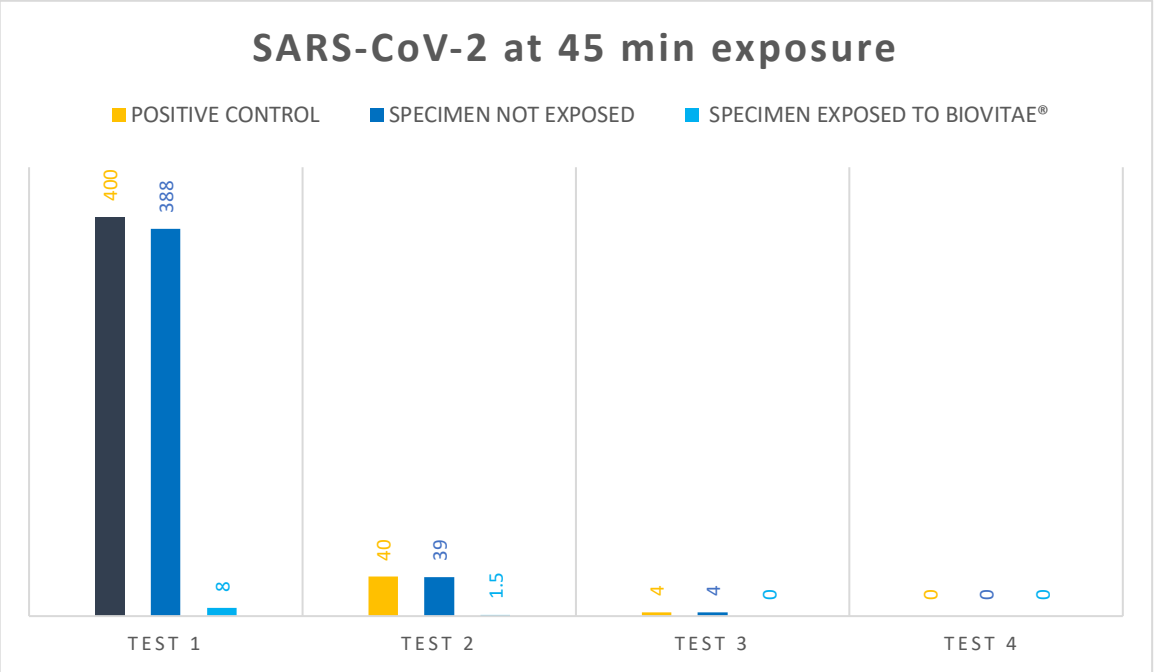

Table 2 - TEST 1 LEG 1*

The BIOVITAE technology test on SARS-CoV-2 (Severe Acute Respiratory Syndrome) was made at the Scientific Department of the Celio Military Hospital, Rome, Italy, which is part of the European Biodefence Laboratory Network (EBLN). Data are expressed in PFU/ml, and tests are performed in quadruplicate. Data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 45 minutes, the BIOVITAE technology achieved a 98% abatement of the original viral load.

* Tests were conducted with viruses in liquid suspension.

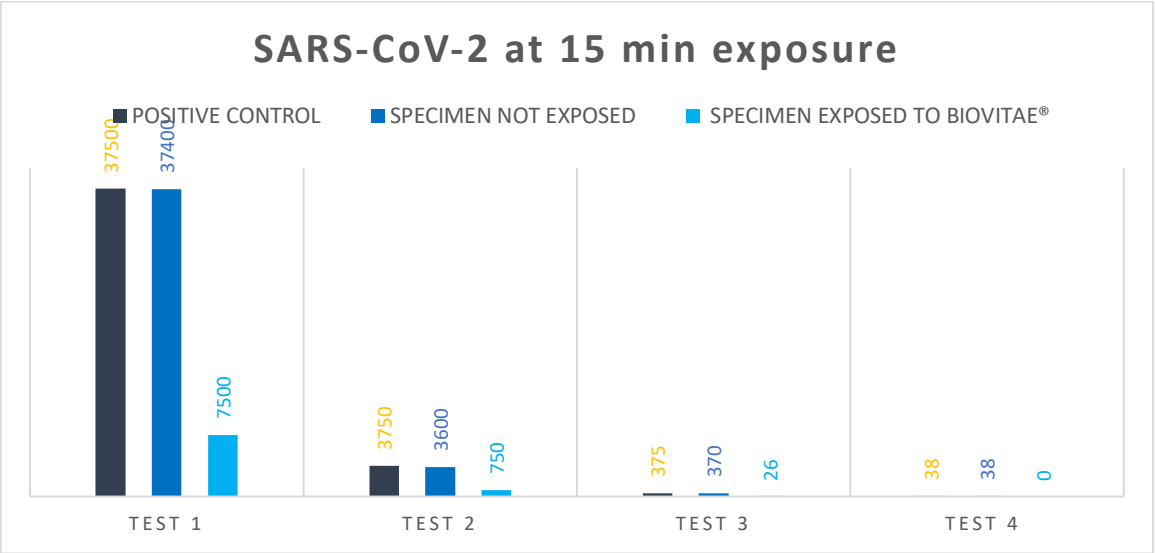

Table 3 - TEST 2 LEG 1*

The BIOVITAE technology test on SARS-CoV-2 (Severe Acute Respiratory Syndrome) was made at the Scientific Department of the Celio Military Hospital, Rome, Italy, which is part of the European Biodefence Laboratory Network (EBLN). Data are expressed in PFU/ml, and tests are performed in quadruplicate. Data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 15 minutes, the BIOVITAE technology achieved an abatement of the original viral load ranging from 80% to 100%.

* Tests were conducted with viruses in liquid suspension.

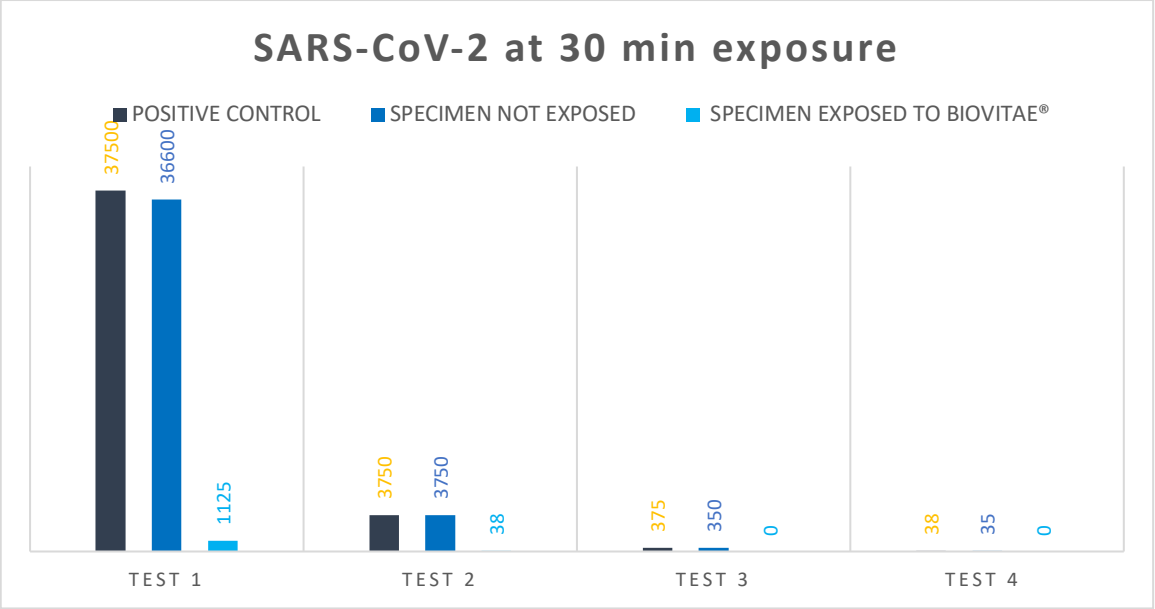

Table 4 - TEST 2 LEG 1*

The BIOVITAE technology test on SARS-CoV-2 (Severe Acute Respiratory Syndrome) was made at the Scientific Department of the Celio Military Hospital, Rome, Italy, which is part of the European Biodefence Laboratory Network (EBLN). Data are expressed in PFU/ml, and tests are performed in quadruplicate. Data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 30 minutes, the BIOVITAE technology achieved an abatement of the original viral load ranging from 97% to 100%.

* Tests were conducted with viruses in liquid suspension.

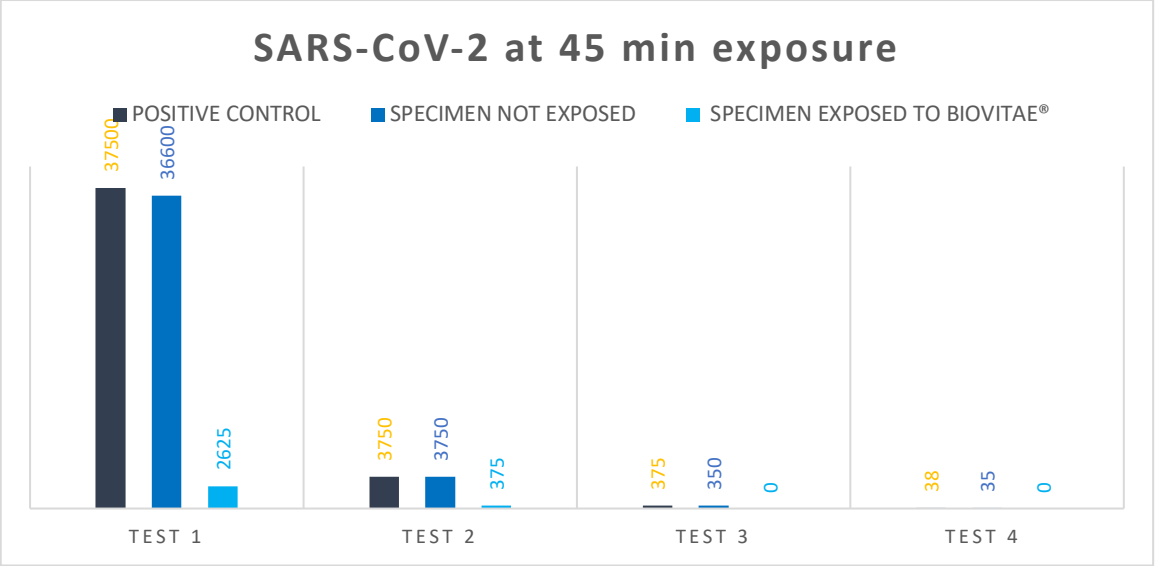

Table 5 - TEST 2 LEG 1*

The BIOVITAE technology test on SARS-CoV-2 (Severe Acute Respiratory Syndrome) was made at the Scientific Department of the Celio Military Hospital, Rome, Italy, which is part of the European Biodefence Laboratory Network (EBLN). Data are expressed in PFU/ml, and tests are performed in quadruplicate. Data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 45 minutes, the BIOVITAE technology achieved an abatement of the original viral load ranging from 90% to 100%.

* Tests were conducted with viruses in liquid suspension.

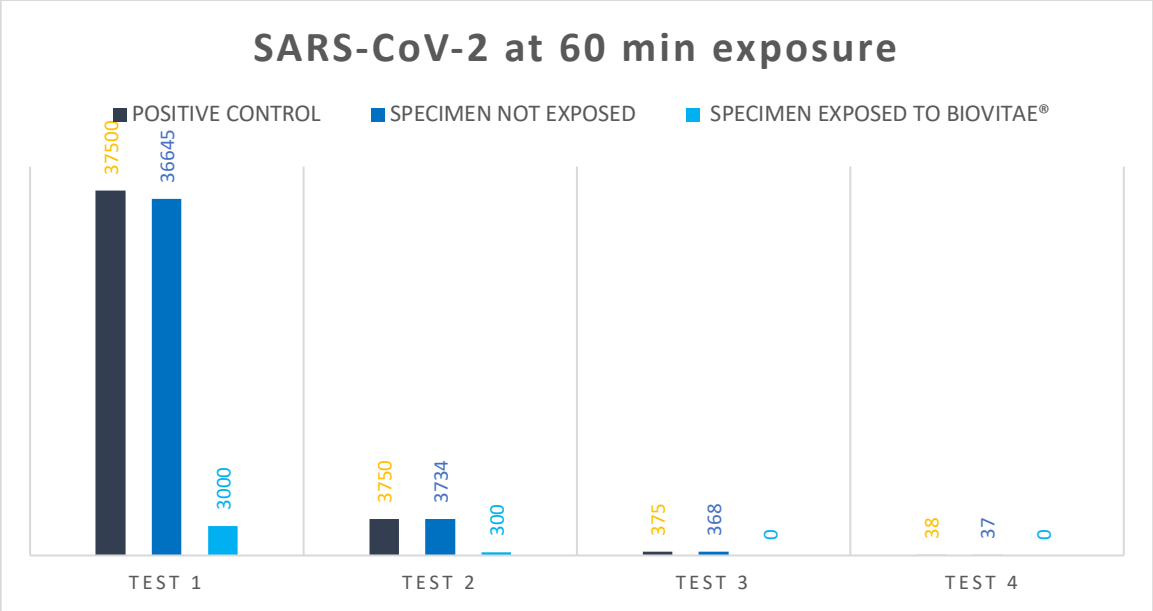

Table 6 - TEST 2 LEG 1*

The BIOVITAE technology test on SARS-CoV-2 (Severe Acute Respiratory Syndrome) was made at the Scientific Department of the Celio Military Hospital, Rome, Italy, which is part of the European Biodefence Laboratory Network (EBLN). Data are expressed in PFU/ml, and tests are performed in quadruplicate. Data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 60 minutes, the BIOVITAE technology achieved an abatement of the original viral load ranging from 92% to 100%.

* Tests were conducted with viruses in liquid suspension.

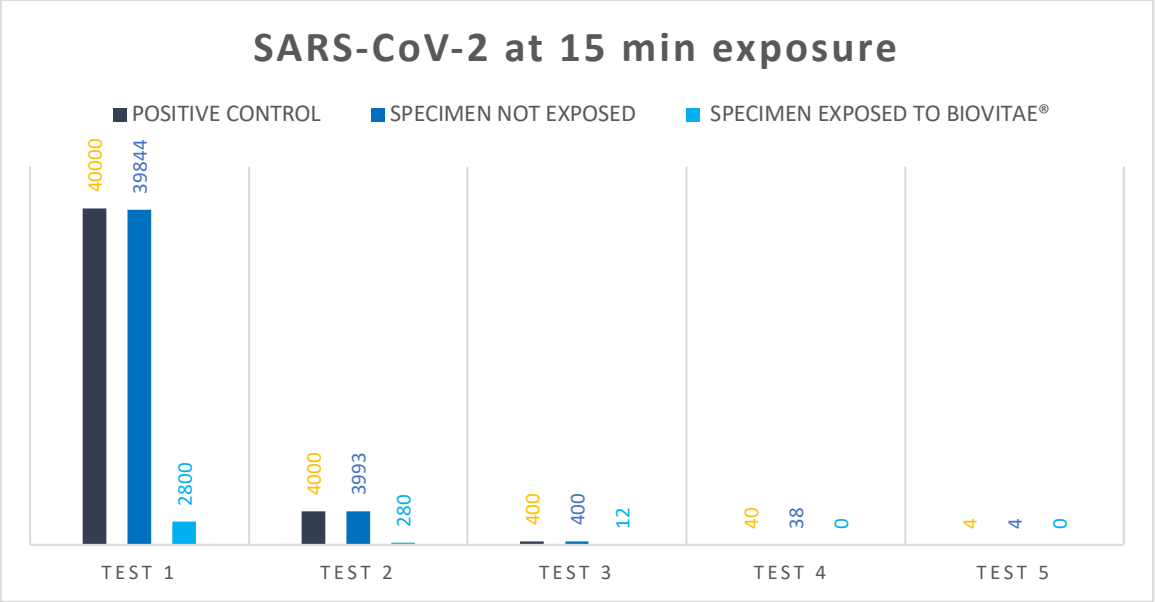

Table 7 - TEST 2 LEG 2*

The BIOVITAE technology test on SARS-CoV-2 (Severe Acute Respiratory Syndrome) was made at the Scientific Department of the Celio Military Hospital, Rome, Italy, which is part of the European Biodefence Laboratory Network (EBLN). Data are expressed in PFU/ml, and tests are performed in quadruplicate. Data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 15 minutes, the BIOVITAE technology achieved an abatement of the original viral load ranging from 93% to 100%.

* Tests were conducted with viruses in liquid suspension.

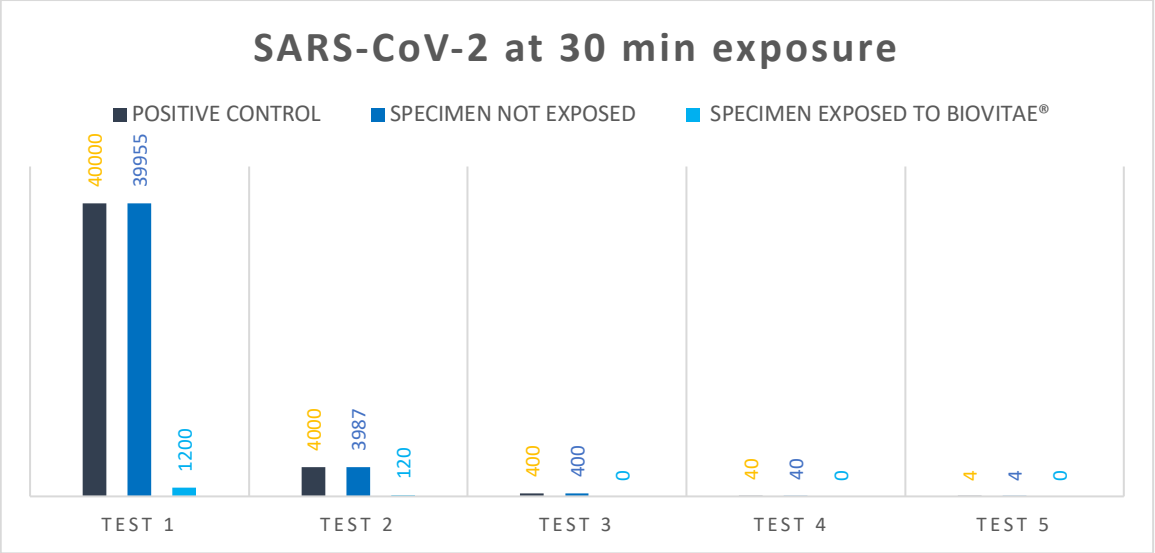

Table 8 - TEST 2 LEG 2*

The BIOVITAE technology test on SARS-CoV-2 (Severe Acute Respiratory Syndrome) was made at the Scientific Department of the Celio Military Hospital, Rome, Italy, which is part of the European Biodefence Laboratory Network (EBLN). Data are expressed in PFU/ml, and tests are performed in quadruplicate. Data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 30 minutes, the BIOVITAE technology achieved an abatement of the original viral load ranging from 97% to 100%.

* Tests were conducted with viruses in liquid suspension.

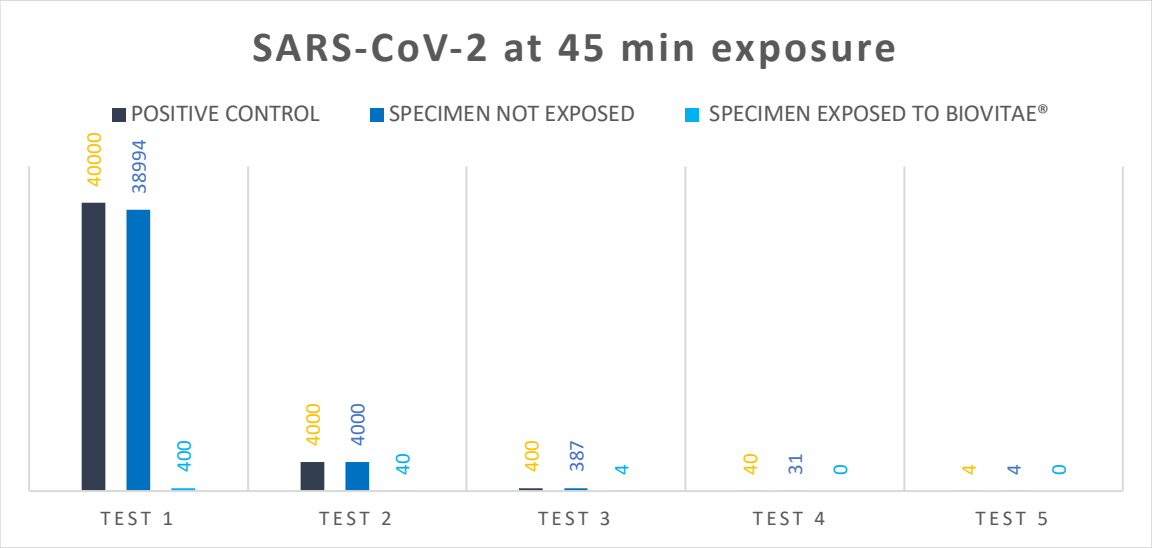

Table 9 - TEST 2 LEG 2*

The BIOVITAE technology test on SARS CoV-2 (Severe Acute Respiratory Syndrome) was made at the Scientific Department of the Celio Military Hospital, Rome, Italy, which is part of the European Biodefence Laboratory Network (EBLN). Data are expressed in PFU/ml, and tests are performed in quadruplicate. Data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 45 minutes, the BIOVITAE technology achieved an abatement of the original viral load ranging from 99% to 100%.

* Tests were conducted with viruses in liquid suspension.

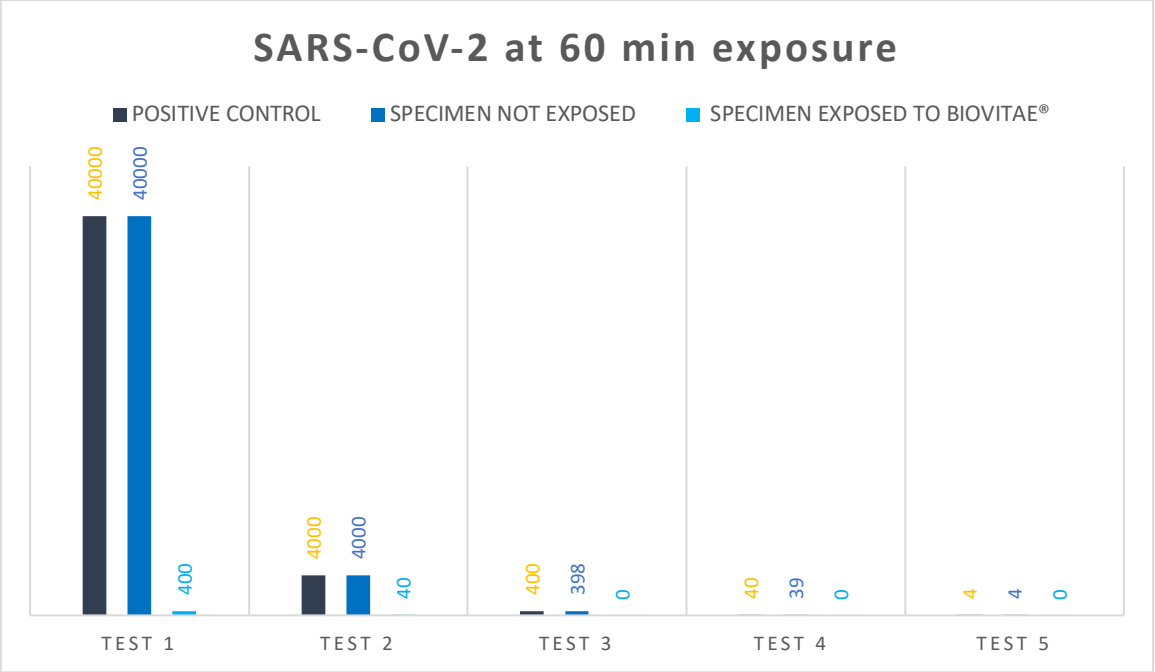

Table 10 - TEST 2 LEG 2*

The BIOVITAE technology test on SARS-CoV-2 (Severe Acute Respiratory Syndrome) was made at the Scientific Department of the Celio Military Hospital, Rome, Italy, which is part of the European Biodefence Laboratory Network (EBLN). Data are expressed in PFU/ml, and tests are performed in quadruplicate. Data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 60 minutes, the BIOVITAE technology achieved an abatement of the original viral load ranging from 99% to 100%.

* Tests were conducted with viruses in liquid suspension.

SARS-CoV-2 (ICGEB, Italy)

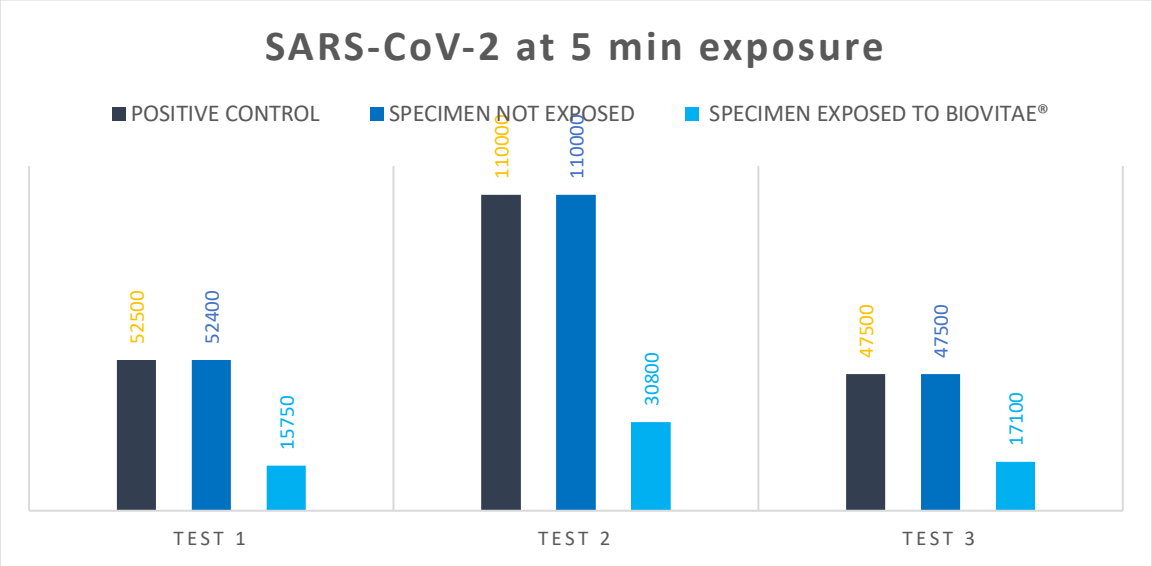

Table 11 - TEST 3 LEG 1*

The BIOVITAE technology test on SARS-CoV-2 (Severe Acute Respiratory Syndrome) was made at the International Centre for Genetic Engineering and Biotechnology (ICGEB). Data are expressed in PFU/ml, and tests are performed in quadruplicate. Data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 5 minutes, the BIOVITAE technology achieved an abatement of the original viral load ranging from 64% to 72%.

* Tests were conducted with viruses in liquid suspension.

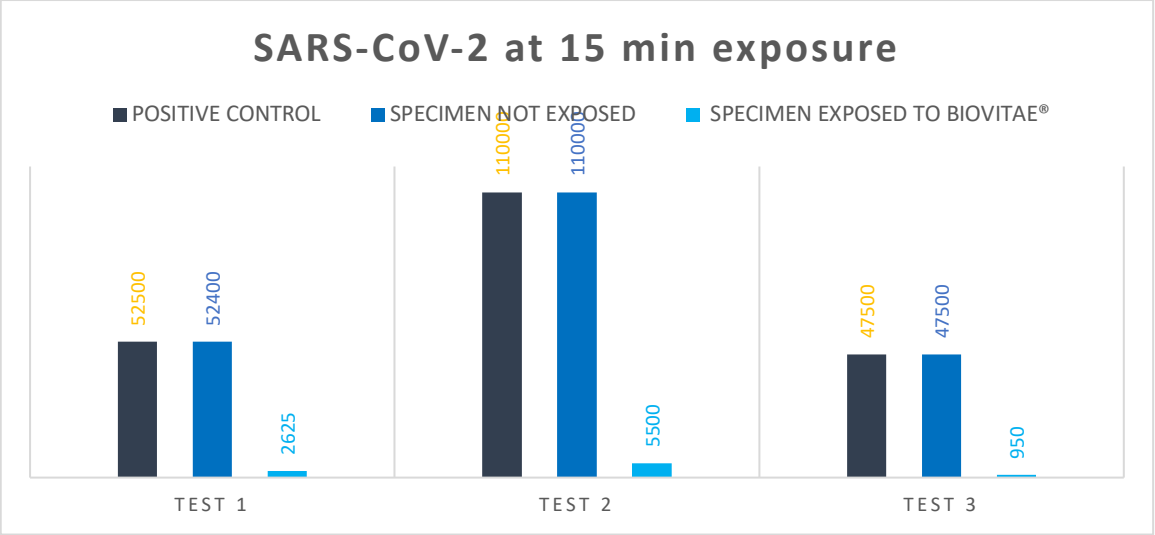

Table 12 - TEST 3 LEG 1*

The BIOVITAE technology test on SARS-CoV-2 (Severe Acute Respiratory Syndrome) was made at the International Centre for Genetic Engineering and Biotechnology (ICGEB). Data are expressed in PFU/ml, and tests are performed in quadruplicate. Data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 15 minutes, the BIOVITAE technology achieved an abatement of the original viral load ranging from 95% to 98%.

* Tests were conducted with viruses in liquid suspension.

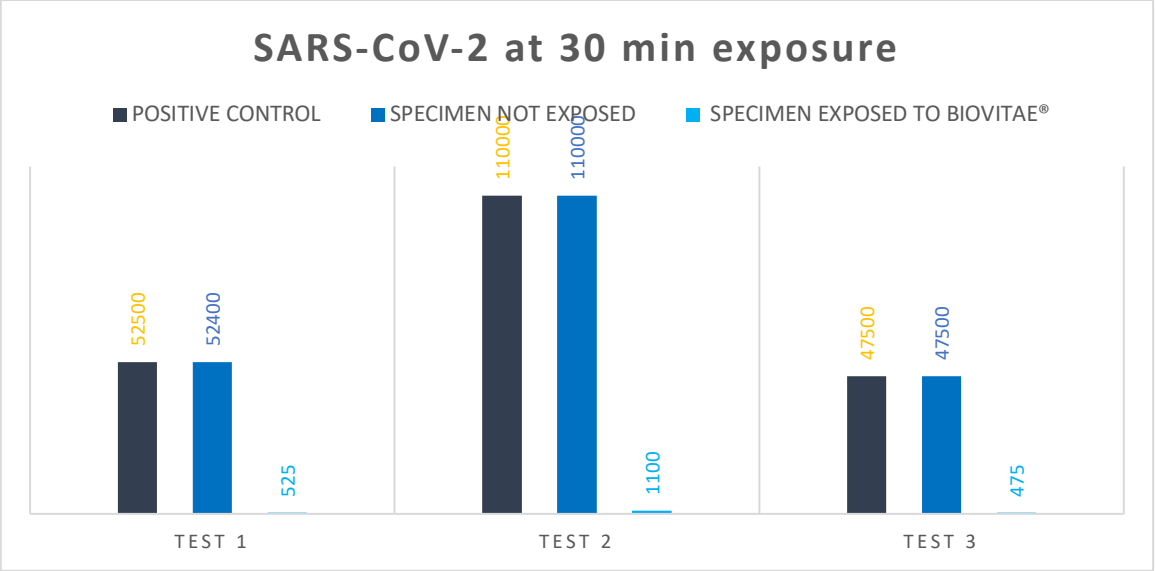

Table 13 - TEST 3 LEG 1*

The BIOVITAE technology test on SARS-CoV-2 (Severe Acute Respiratory Syndrome) was made at the International Centre for Genetic Engineering and Biotechnology (ICGEB). Data are expressed in PFU/ml, and tests are performed in quadruplicate. Data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 30 minutes, the BIOVITAE technology achieved an abatement of the original viral load ranging from 99% to 99.5%.

* Tests were conducted with viruses in liquid suspension.

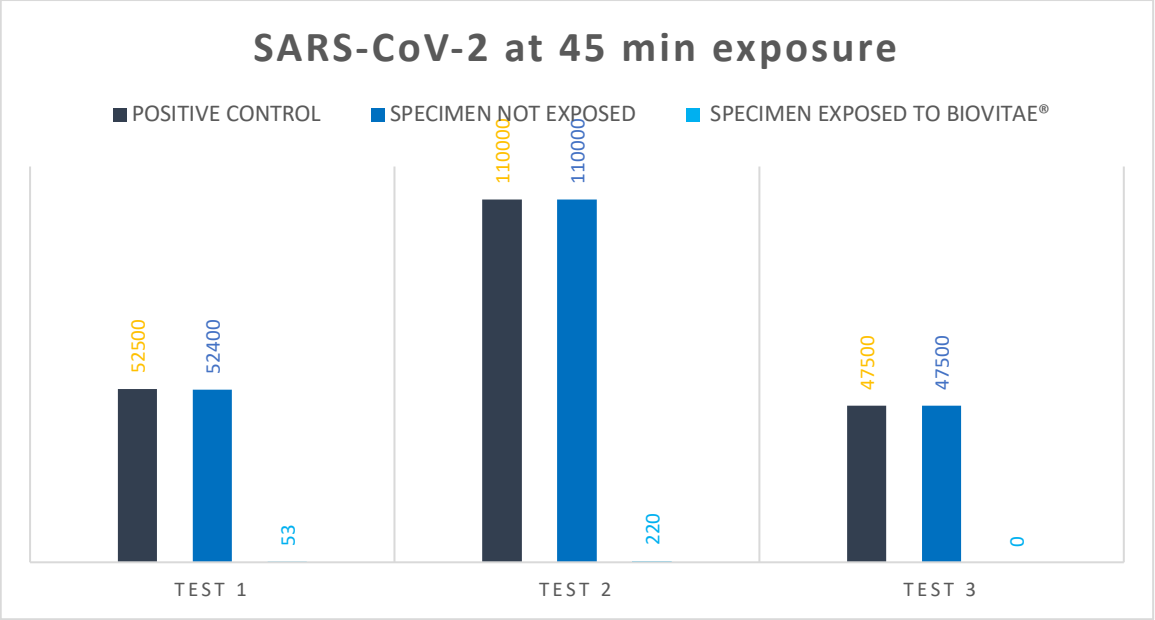

Table 14 - TEST 3 LEG 1*

The BIOVITAE technology test on SARS-CoV-2 (Severe Acute Respiratory Syndrome) was made at the International Centre for Genetic Engineering and Biotechnology (ICGEB). Data are expressed in PFU/ml, and tests are performed in quadruplicate. Data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 45 minutes, the BIOVITAE technology achieved an abatement of the original viral load ranging from 99% to 100%.

* Tests were conducted with viruses in liquid suspension.

SARS-CoV-2 (CEA, France)

This experimental set test the effectiveness of BIOVITAE technology by comparing it with the normal mortality rate of the SARS-CoV-2 virus on a surface. The viral suspension was dried in the airflow of the BSC before treatment. Abatements are calculated with reference to the normal mortality rate and not to the starting population.

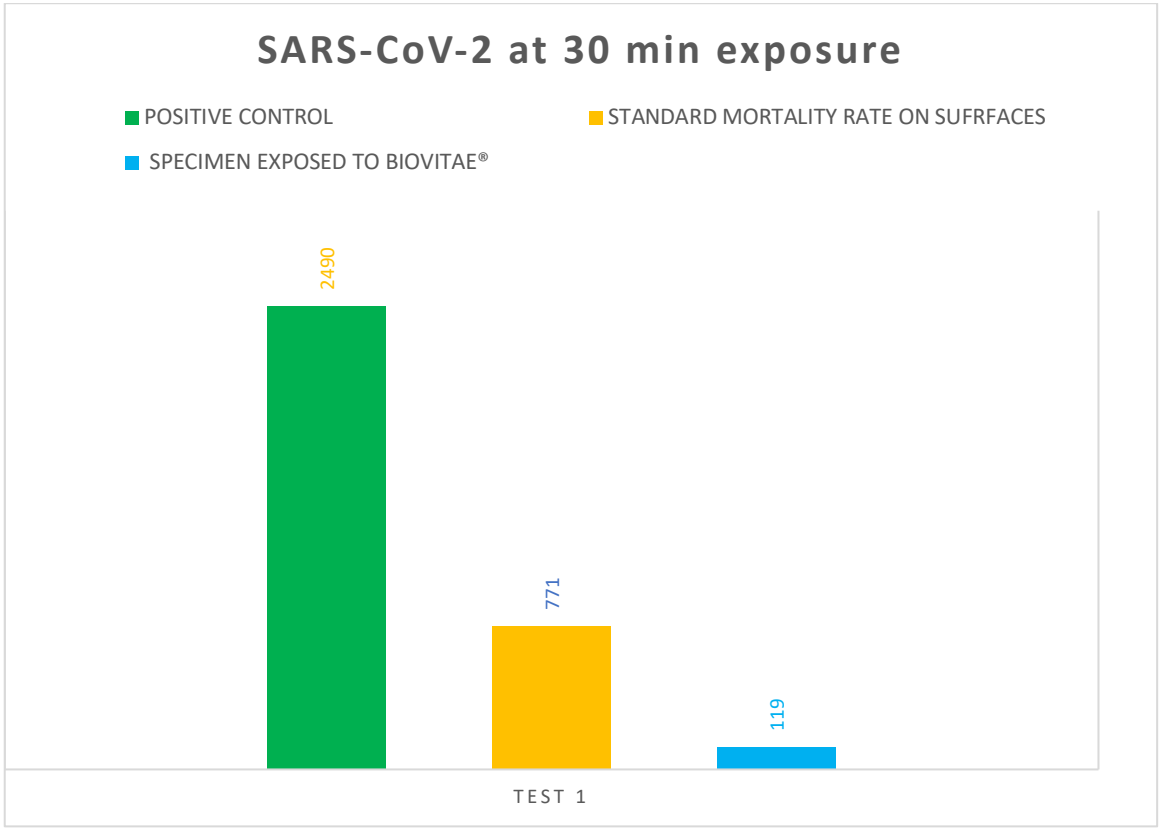

Table 15 - TEST 4 LEG 1 (custom device)

The BIOVITAE technology test on SARS-CoV-2 (Severe Acute Respiratory Syndrome) dried condition was made at France Institut des sciences de vivant Frederic Joliot (CEA). Data are expressed in PFU/ml, and tests are performed in quadruplicate. Data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 30 minutes the BIOVITAE technology achieved an 85% abatement of the original viral load.

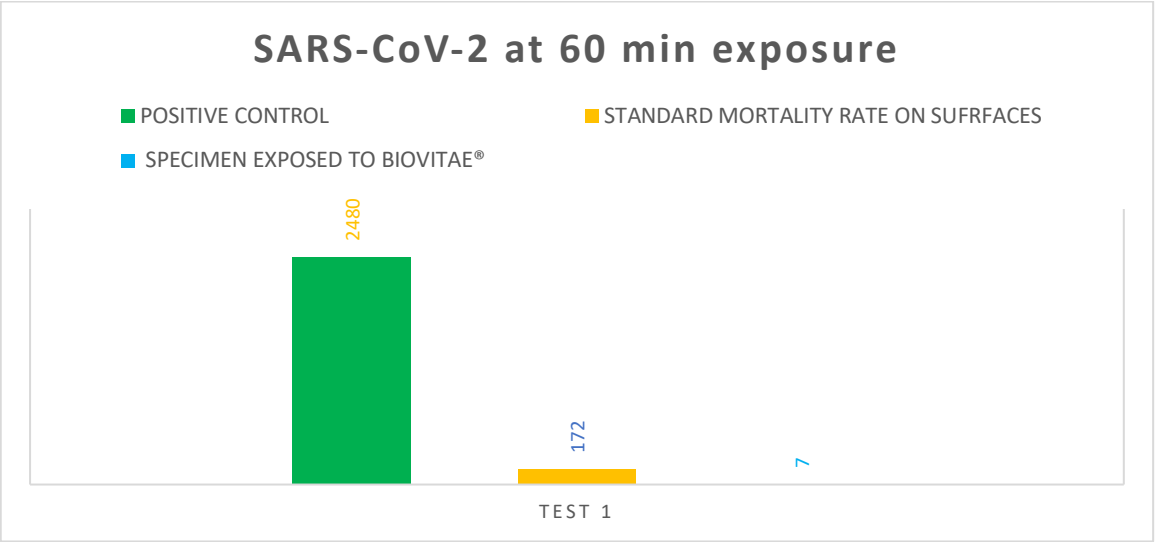

Table 16 - TEST 4 LEG 1 (custom device)

The BIOVITAE technology test on SARS-CoV-2 (Severe Acute Respiratory Syndrome) dried condition was made at France Institut des sciences de vivant Frederic Joliot (CEA). Data are expressed in PFU/ml, and tests are performed in quadruplicate. Data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 60 minutes the BIOVITAE technology achieved an 95% abatement of the original viral load.

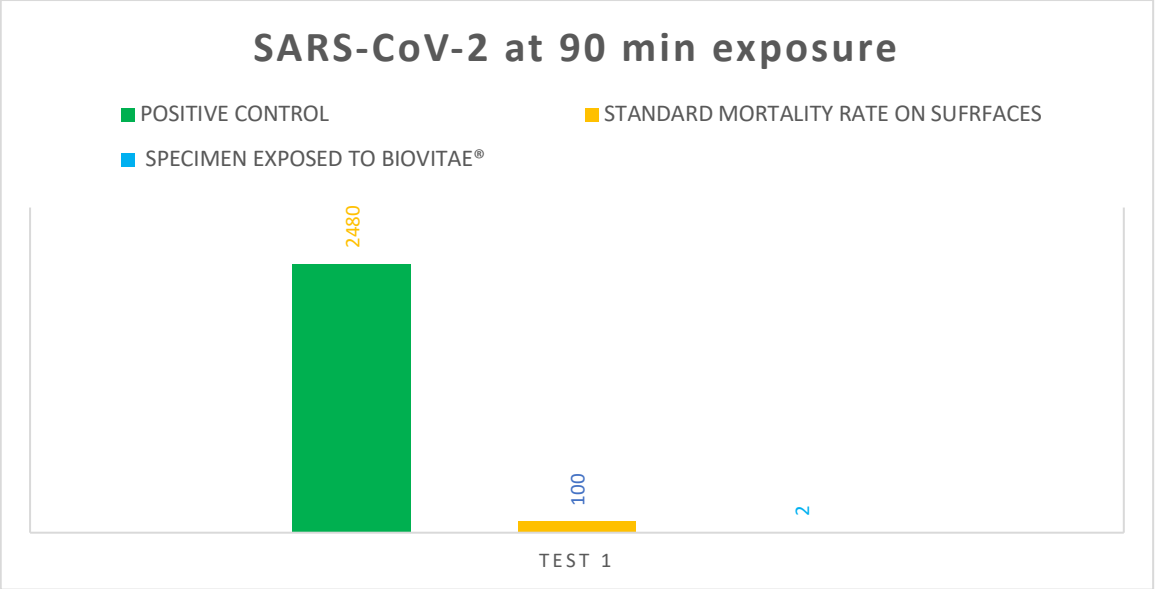

Table 17 - TEST 4 LEG 1 (custom device)

The BIOVITAE technology test on SARS-CoV-2 (Severe Acute Respiratory Syndrome) dried condition was made at France Institut des sciences de vivant Frederic Joliot (CEA). Data are expressed in PFU/ml, and tests are performed in quadruplicate. Data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 90 minutes the BIOVITAE technology achieved an 98% abatement of the original viral load.

SARS- CoV-2 (Celio Military Hospital, Italy)

The following test was conducted using a BIOVITAE Domus A60 light bulb and T8 AUROSUN 60 cm tube powered by BIOVITAE. The test with SARS CoV-2 was performed in liquid suspension.

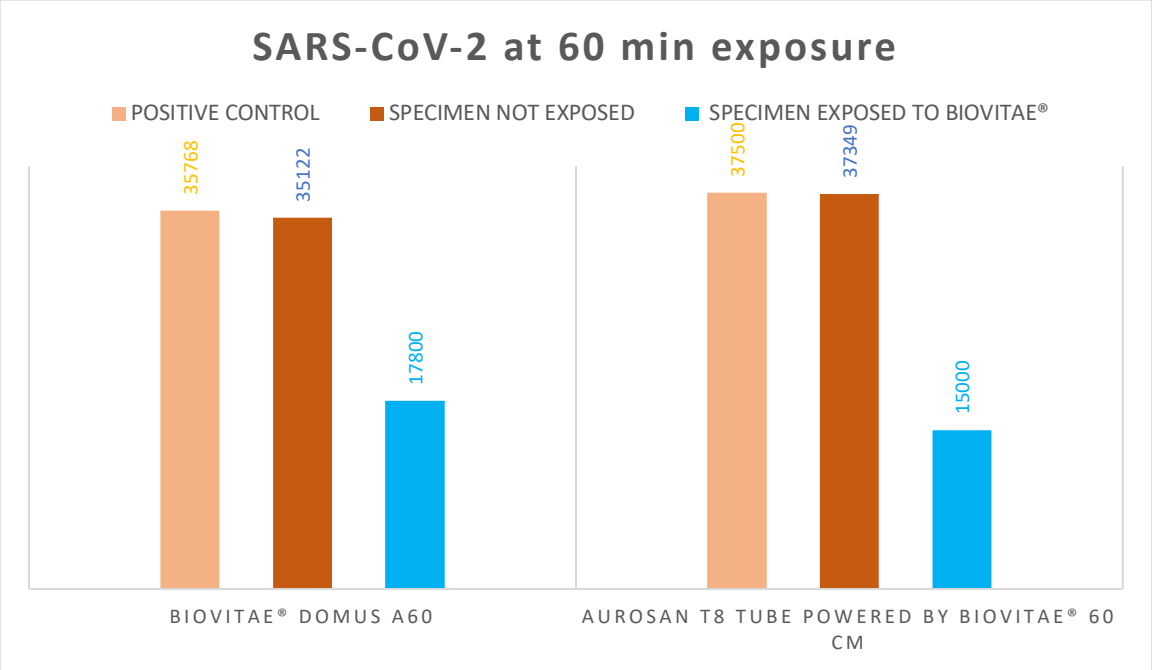

Table 18 - TEST 5 (BIOVITAE Domus A60 bulb – AUROSUN T8 2ft tube)

The BIOVITAE technology test on SARS-CoV-2 (Severe Acute Respiratory Syndrome) was made at the Scientific Department of the Celio Military Hospital, Rome, Italy, which is part of the European Biodefence Laboratory Network (EBLN). Data are expressed in PFU/ml, and tests are performed in quadruplicate. Data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 60 minutes, the BIOVITAE technology achieved an abatement of the original viral load ranging 50% for BIOVITAE Domus A60 9W, and 60% AUROSUN T8 2ft powered by BIOVITAE.

Vaccinia Virus, ATCC® VR-1508™ (Perfectus Biomed Group, UK)

This test was performed using a BIOVITAE Domus A60 light bulb in according with EN16777:2018 "Quantitative non-porous surface test without mechanical action for the evaluation of virucidal activity in chemical disinfectants used in the medical area". The quantity of virus recovered is determined by $TCID_{50}$.

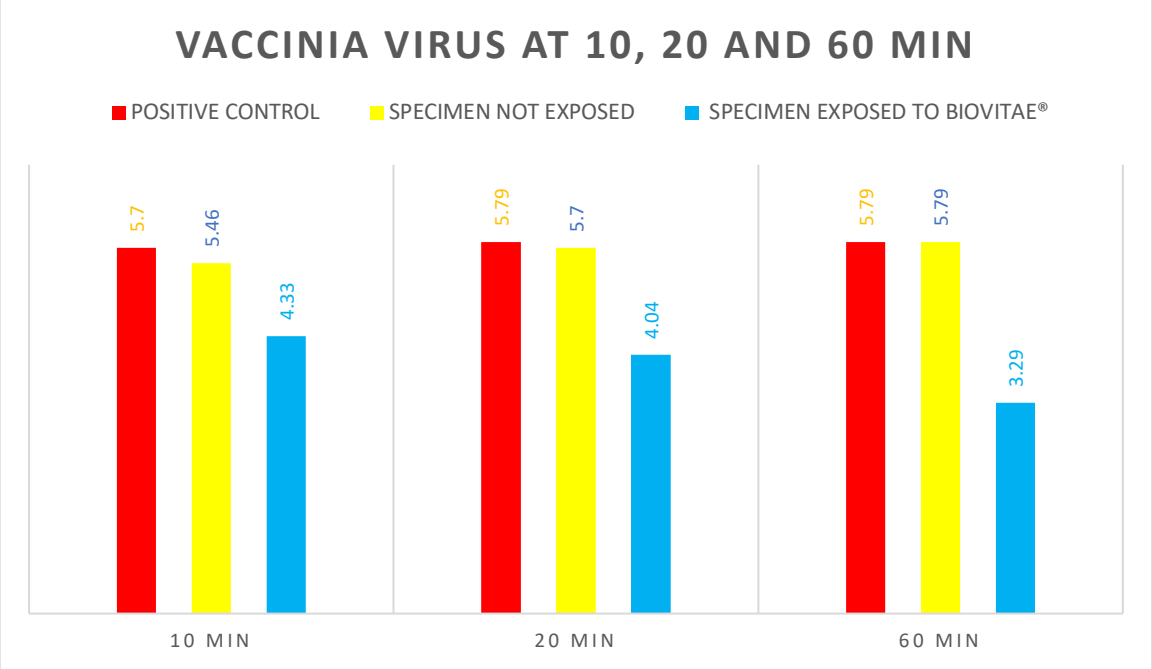

Table 19 - TEST 6 (BIOVITAE Domus A60 bulb)

The BIOVITAE technology test on Vaccinia Virus (ATCC® VR-1508™) was made at Perfectus Biomed Group. Data are expressed in PFU/ml, and tests are performed in triplicate. Data shown in the graph represent the mean value of the three repetitions. It can be seen how with an irradiance of 10, 20 and 60 minutes, the BIOVITAE technology (BIOVITAE Domus A60 9W) achieved an abatement of the original viral load ranging 92,5% in 10 minutes (1.13 Log_{10} $TCID_{50}$), 98,2% in 20 minutes (1.75 Log_{10} $TCID_{50}$), 98% in 60 minutes (1.71 Log_{10} $TCID_{50}$).

S. aureus (Tecniplast, Italy)

The bacteria subject to the test are the pathogens most frequently implicated in living diseases and which show a marked resistance to disinfectants and antibiotics.

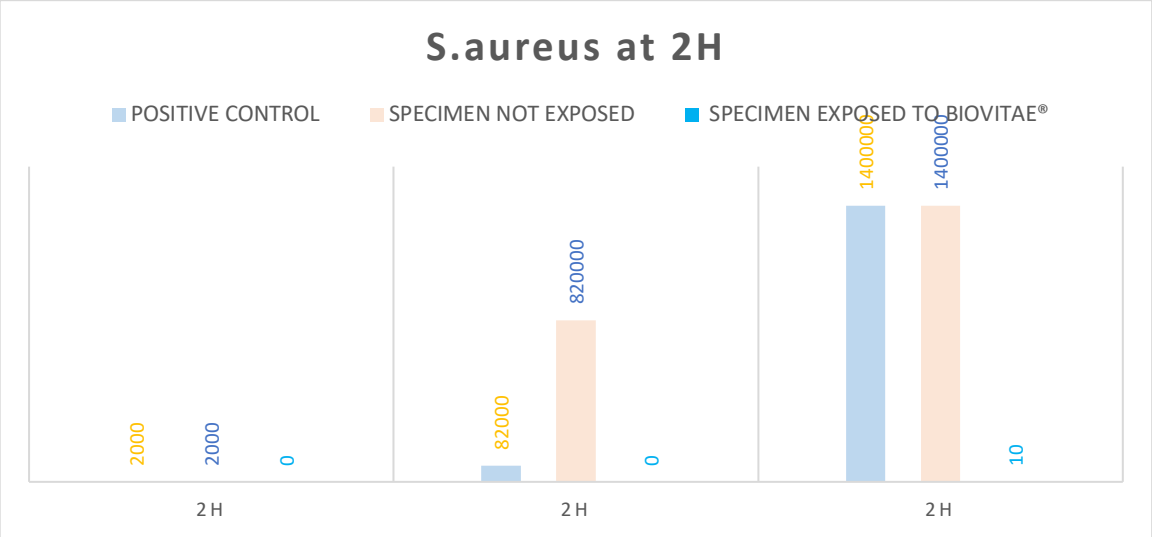

Table 20 - TEST 7 LEG 1 (custom device)

The BIOVITAE technology test on S. aureus dried on steel plate was made at Tecniplast Microbiological lab. Data are expressed in CFU, and tests are performed in quadruplicate. Data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 2 hours the BIOVITAE technology achieved an abatement of the original bacterial load ranging from 99.9% to 100%.

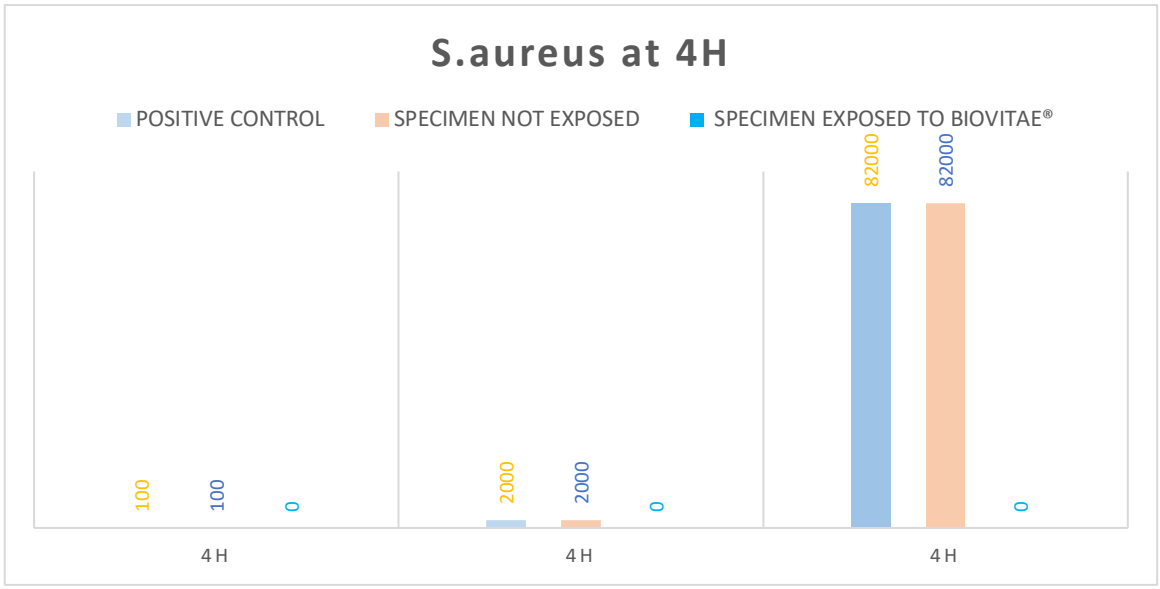

Table 24 - TEST 7 LEG 2 (custom device)

The BIOVITAE technology test on S.aureus dried on steel plate was made at Tecniplast Microbiological lab. Data are expressed in CFU, and tests are performed in quadruplicate. Data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 4 hours the BIOVITAE technology achieved a 100% abatement of the original bacterial load.

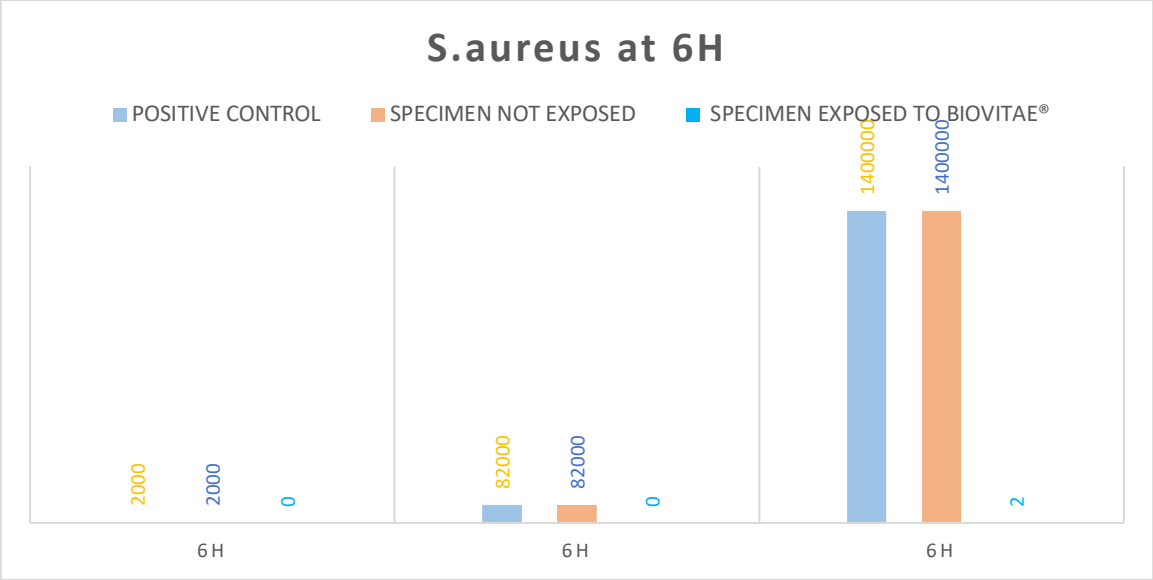

Table 28 - TEST 7 LEG 3 (custom device)

The BIOVITAE technology test on S. aureus dried on steel plate was made at Tecniplast Microbiological lab. Data are expressed in CFU, and tests are performed in quadruplicate. Data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 6 hours, the BIOVITAE technology achieved an abatement of the original bacterial load ranging from 99.9% to 100%.

B. atrophaeus (Tecniplast, Italy)

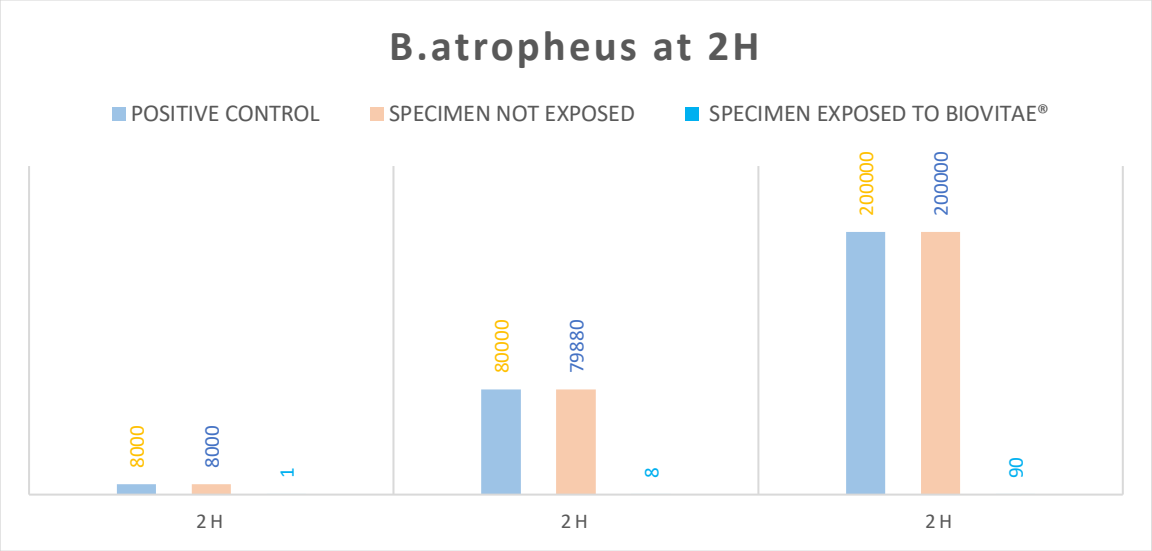

Table 21 - TEST 7 LEG 1 (custom device)

The BIOVITAE technology test on B. atrophaeus dried on steel plate was made at Tecniplast Microbiological lab. Data are expressed in CFU, and tests are performed in quadruplicate. Data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 2 hours the BIOVITAE technology achieved an abatement of the original bacterial load ranging from 99.8% to 100%.

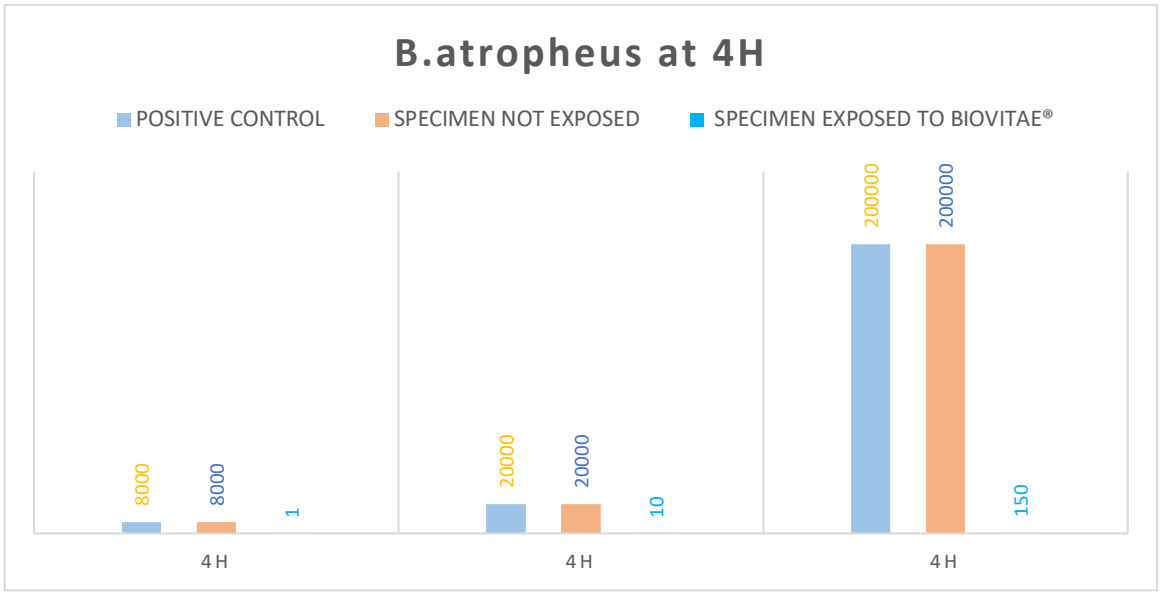

Table 25 - TEST 7 LEG 2 (custom device)

The BIOVITAE technology test on B. atrophaeus dried on steel plate was made at Tecniplast Microbiological lab. Data are expressed in CFU, and tests are performed in quadruplicate. Data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 4 hours the BIOVITAE technology achieved an abatement of the original bacterial load ranging from 99.9% to 99.99%.

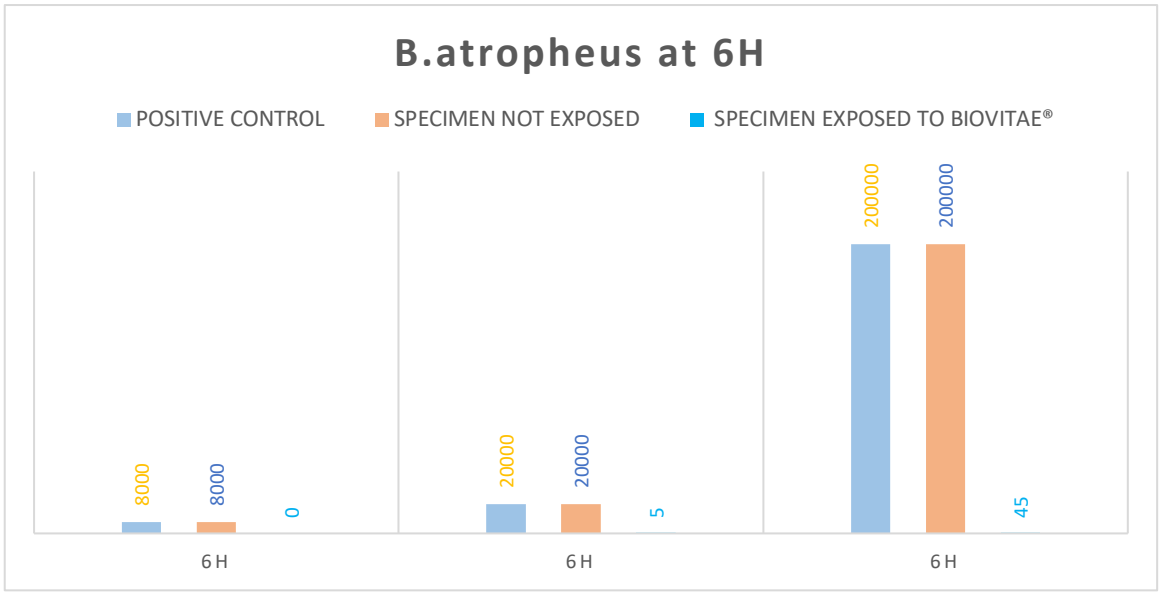

Table 29 - TEST 7 LEG 3 (custom device)

The BIOVITAE technology test on B. atrophaeus dried on steel plate was made at Tecniplast Microbiological lab. Data are expressed in CFU, and tests are performed in quadruplicate. Data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 6 hours the BIOVITAE technology achieved an abatement of the original bacterial load ranging from 99.9% to 100%.

E. coli (Tecniplast, Italy)

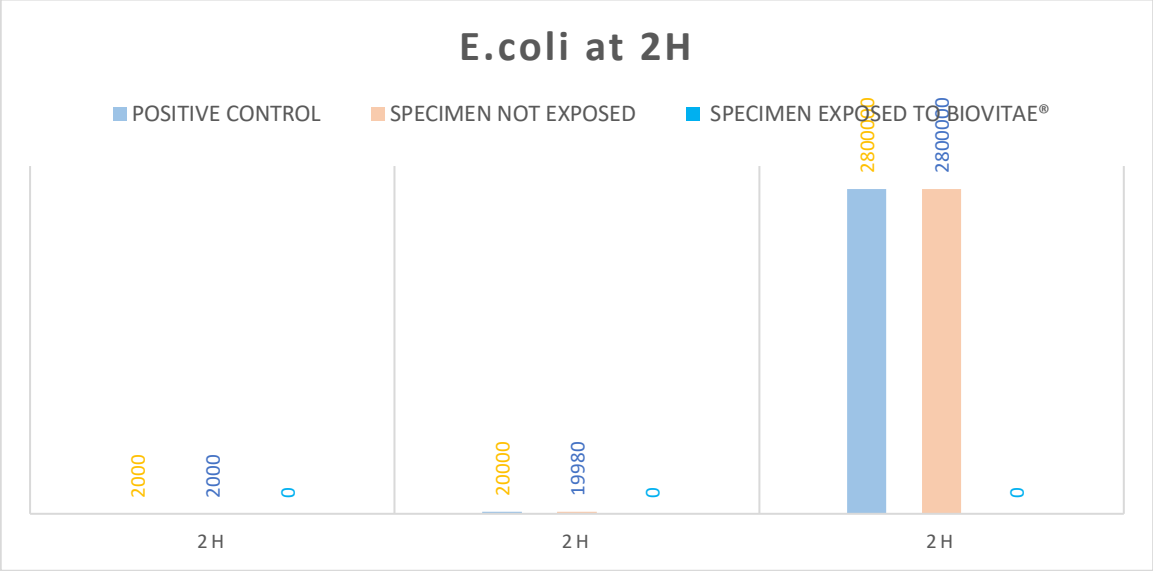

Table 22 - TEST 7 LEG 1 (custom device)

The BIOVITAE technology test on E. coli dried on steel plate was made at Tecniplast Microbiological lab. Data are expressed in CFU, and tests are performed in quadruplicate. Data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 2 hours the BIOVITAE technology achieved a 100% abatement of the original bacterial load.

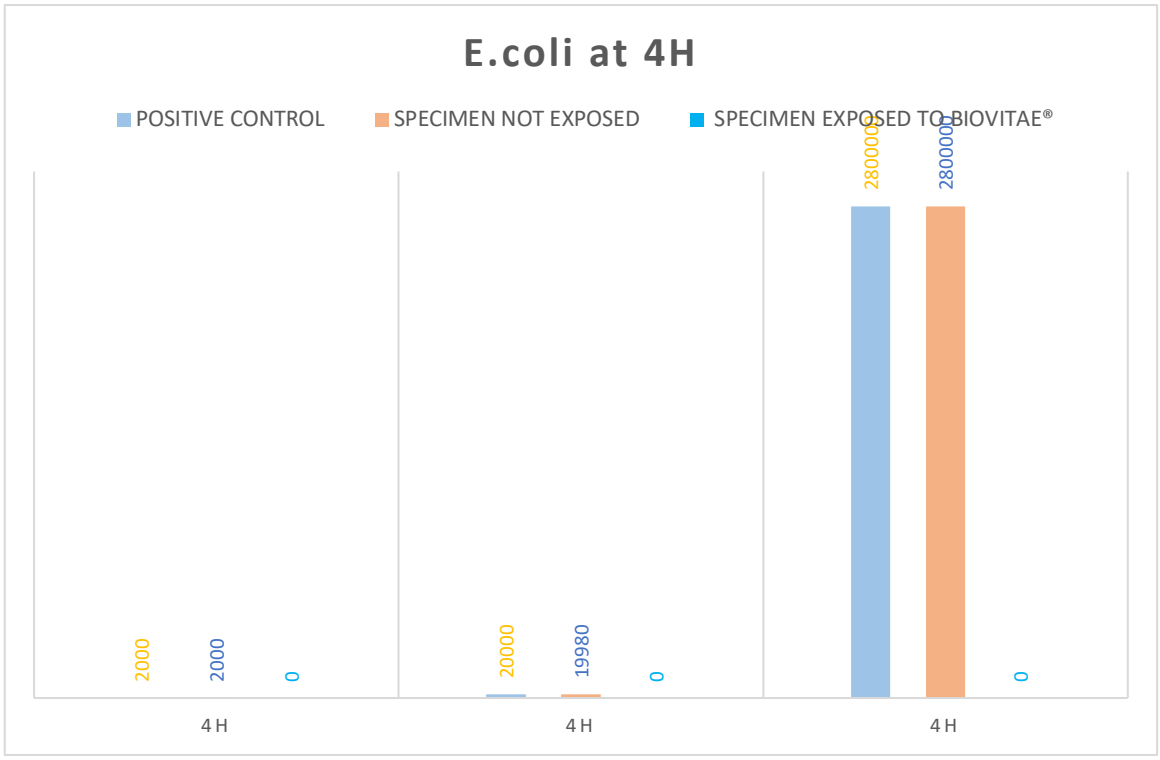

Table 26 - TEST 7 LEG 2 (custom device)

The BIOVITAE technology test on E. coli dried on steel plate was made at Tecniplast Microbiological lab. Data are expressed in CFU, and tests are performed in quadruplicate. Data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 4 hours the BIOVITAE technology achieved a 100% abatement of the original bacterial load.

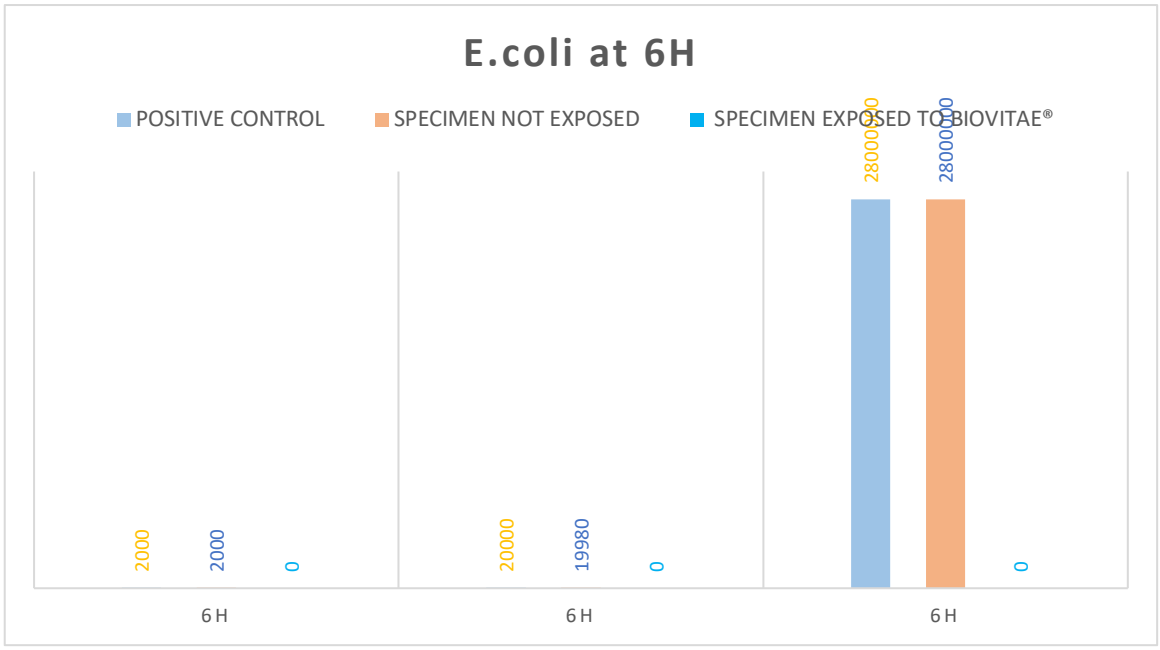

Table 30 - TEST 7 LEG 3 (custom device)

The BIOVITAE technology test on E. coli dried on steel plate was made at Tecniplast Microbiological lab. All data are expressed in CFU, and tests are performed in quadruplicate. The data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 6 hours the BIOVITAE technology achieved a 100% abatement of the original bacterial load.

P. aeruginosa (Tecniplast, Italy)

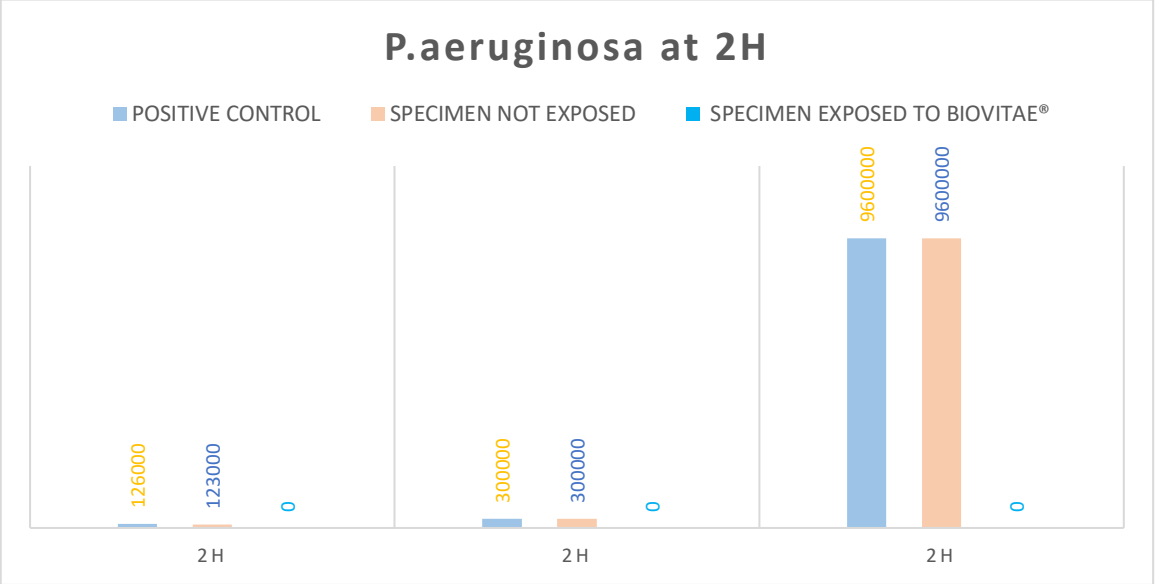

Table 23 - TEST 7 LEG 1 (custom device)

The BIOVITAE technology test on P. aeruginosa dried on steel plate was made at Tecniplast Microbiological lab. Data are expressed in CFU, and tests are performed in quadruplicate. Data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 2 hours the BIOVITAE technology achieved a 100% abatement of the original bacterial load.

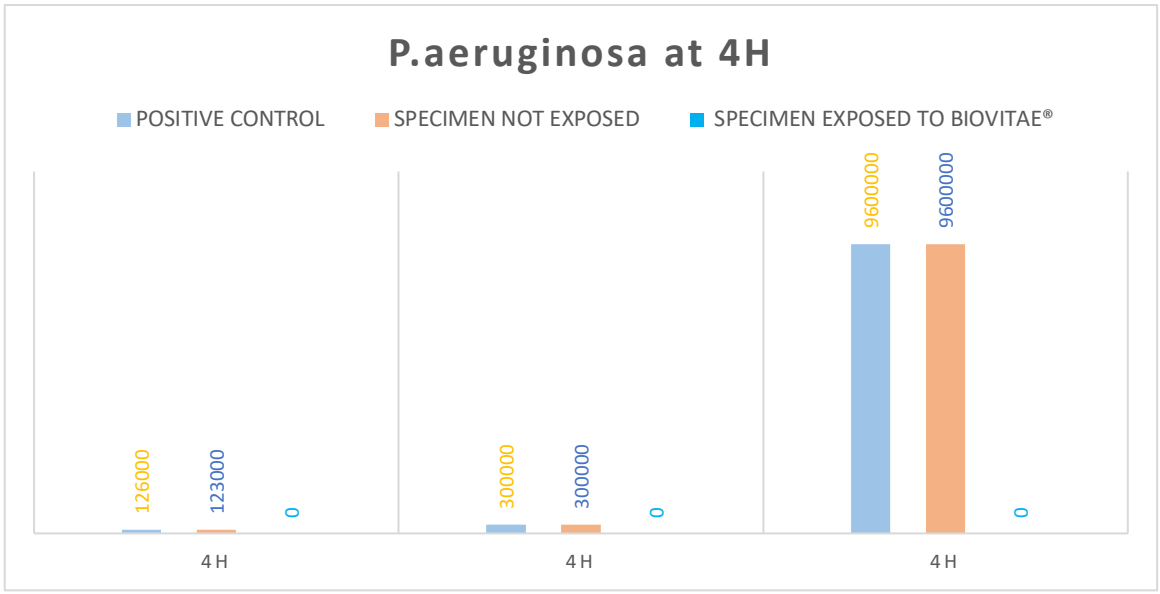

Table 27 - TEST 7 LEG 2 (custom device)

The BIOVITAE technology test on P. aeruginosa dried on steel plate was made at Tecniplast Microbiological lab. Data are expressed in CFU, and tests are performed in quadruplicate. Data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 4 hours the BIOVITAE technology achieved a 100% abatement of the original bacterial load.

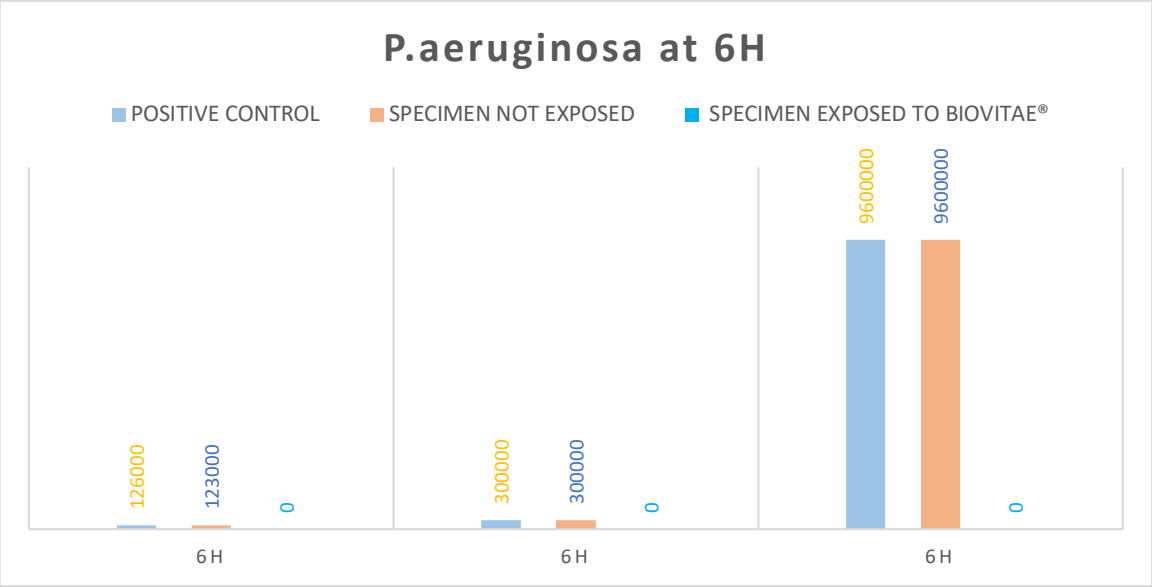

Table 31 - TEST 7 LEG 3 (custom device)

The BIOVITAE technology test on P. aeruginosa dried on steel plate was made at Tecniplast Microbiological lab. Data are expressed in CFU, and tests are performed in quadruplicate. Data shown in the graph represent the mean value of the four repetitions. It can be seen how with an irradiance of 6 hours the BIOVITAE technology achieved a 100% abatement of the original bacterial load.

E. coli (ICGEB, Italy)

This test shows how BIOVITAE technology behaves when acting on a microorganism such as E. coli when it is in a culture medium suitable (in solid) for its growth. Under these conditions the micro-organism is in the best possible conditions of development.

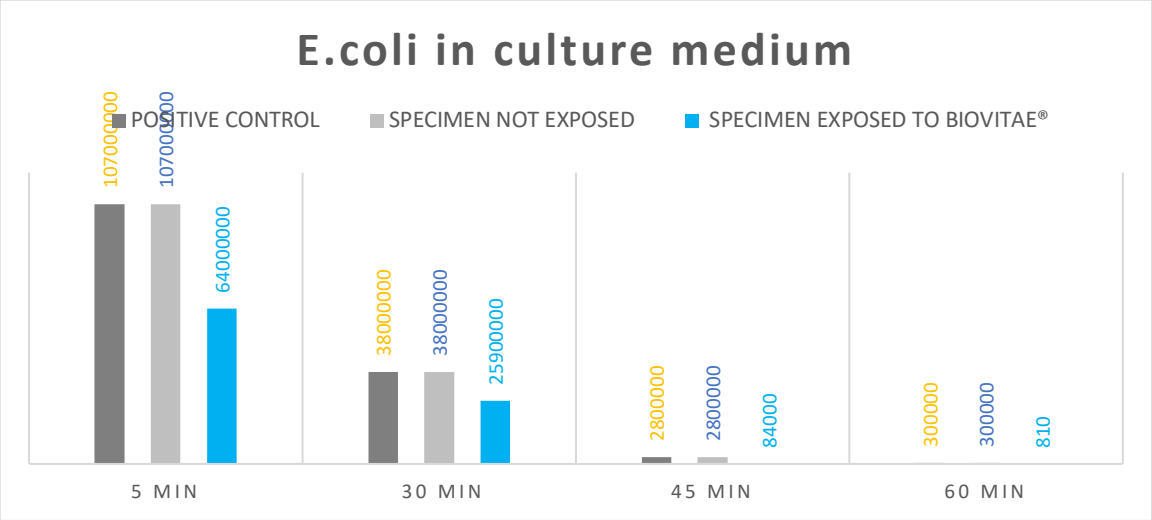

Table 32 - TEST 8 LEG 1 (custom device)

The BIOVITAE technology test on E. coli was made at the International Centre for Genetic Engineering and Biotechnology (ICGEB). Data are expressed in CFU, tests are performed in triplicate. Data shown in the graph represent the mean value of the three repetitions. It can be seen how with an irradiance of 5 minutes the BIOVITAE technology achieved a 40% abatement of the original bacterial load, 65% in 30 minutes, 94% in 45 minutes, and 99.7% in 60 minutes.

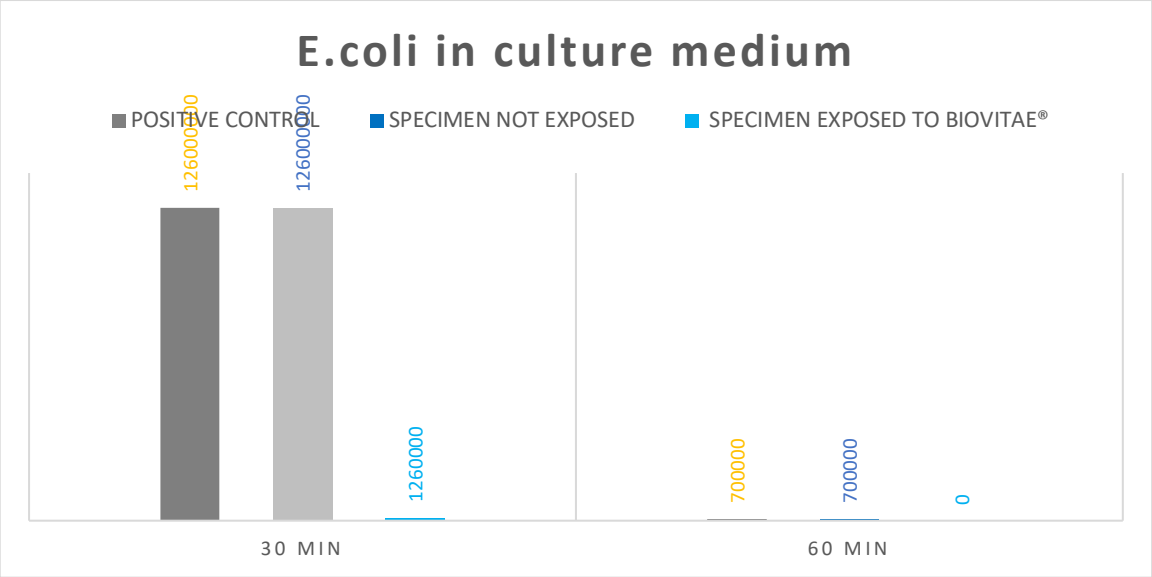

Table 33 - TEST 8 LEG 2 (custom device)

The BIOVITAE technology test on E. coli was made at the International Centre for Genetic Engineering and Biotechnology (ICGEB). Data are expressed in CFU, tests are performed in triplicate. Data shown in the graph represent the mean value of the three repetitions. It can be seen how with an irradiance of 30 minutes, the BIOVITAE technology achieved a 99% abatement of the original bacterial load, and 100% in 60 minutes.

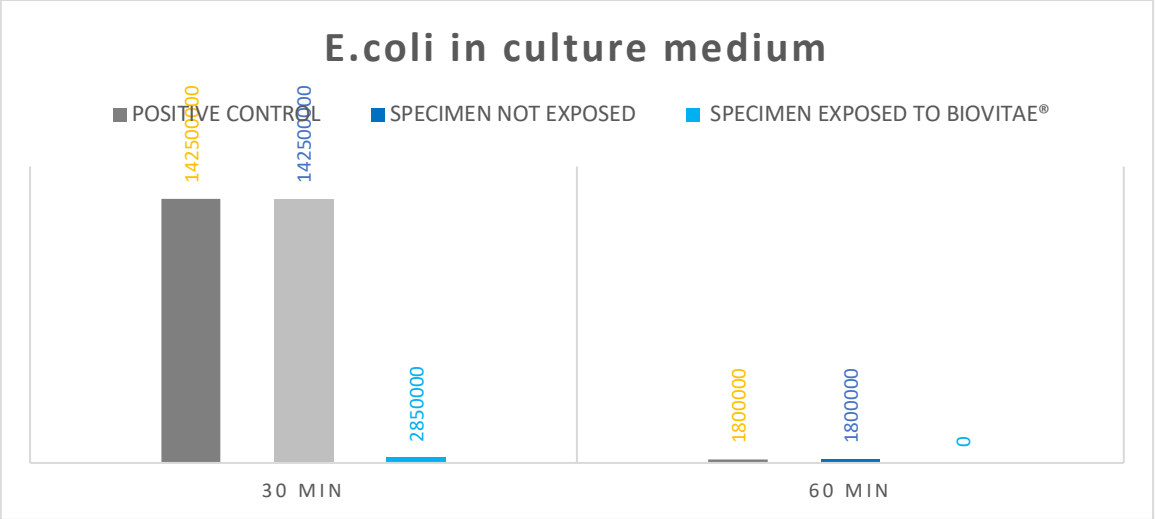

Table 34 - TEST 8 LEG 3 (custom device)

The BIOVITAE technology test on E. coli was made at the International Centre for Genetic Engineering and Biotechnology (ICGEB). Data are expressed in CFU, tests are performed in triplicate. Data shown in the graph represent the mean value of the three repetitions. It can be seen how with an irradiance of 30 minutes, the BIOVITAE technology achieved a 98% abatement of the original bacterial load, and the 100% in 60 minutes.

New Delhi (K. pneumoniae - University of Pisa, Italy)

New Delhi is a new strain of Klebsiella, multidrug-resistant to drugs. These microorganisms are transmitted through the hands of healthcare professionals or invasive medical procedures, wounds, contact with infected medical devices or feces of colonized patients. In this test, the response of the microorganism to continuous sanitization was investigated. We started from a known concentration of microorganisms and studied the decrease in the population compared to the exposure time, thus creating a curve of abatement of the microbial load.

The five phases of the tests were followed by each other, starting from a high concentration of microorganisms the ability to kill at different time intervals was verified, the next phase started from a concentration of microorganisms comparable to the maximum abatement achieved in the previous phase and so on.

The results clearly show that BIOVITAE technology effectively controls the microbial load and is the more effective the higher the microbial load. On low microbial loads there is always a dejection, but it is less evident. This allows to never achieve sterility performances.

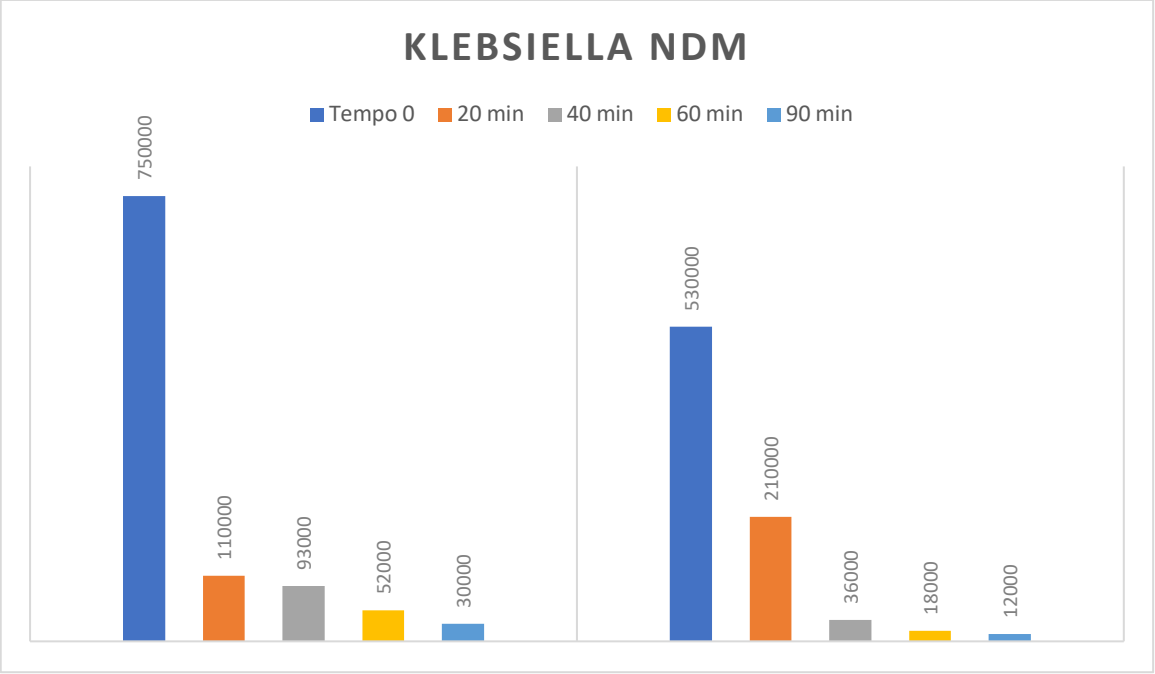

Table 35 - TEST 9 LEG 1 (custom device)

The BIOVITAE technology test on Klebsiella was made at the University of Pisa, Department of Translational Research, New Technologies in Medicine and Surgery. Data are expressed in CFU, tests are performed in triplicate. Data shown in the graph represent the mean value of the three repetitions. It can be seen how with an irradiance of 20 minutes, the BIOVITAE technology achieved a 72% abatement of the original bacterial load, 90% in 40 minutes, 95% in 60 minutes, 99% in 90 minutes.

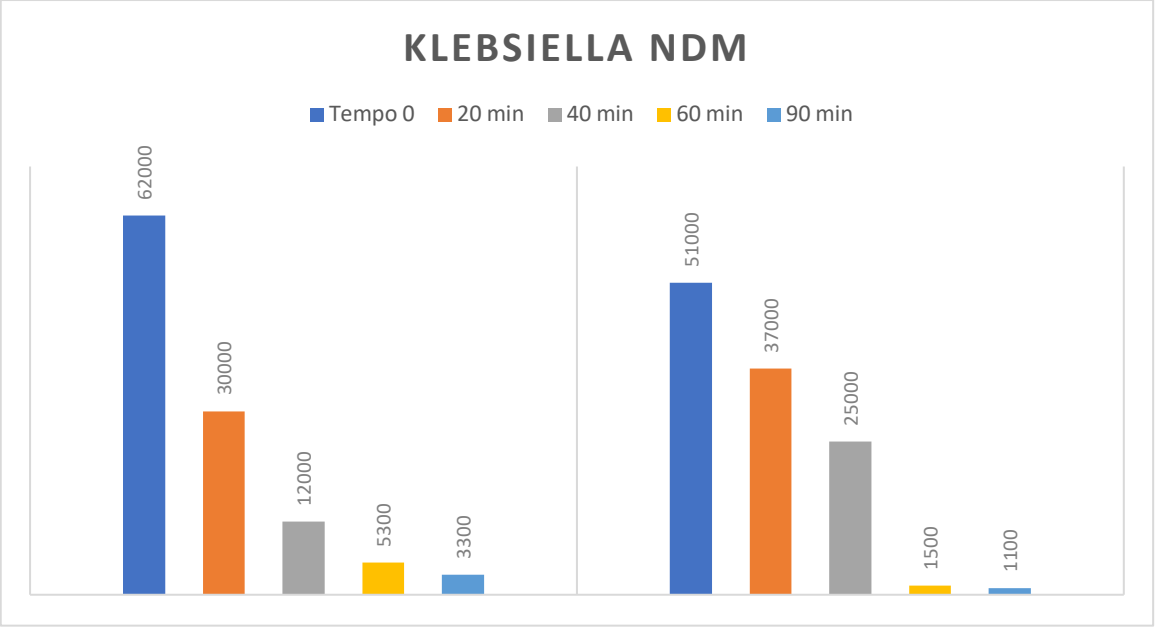

Table 36 - TEST 9 LEG 2 (custom device)

The BIOVITAE technology test on Klebsiella was made at the University of Pisa, Department of Translational Research, New Technologies in Medicine and Surgery. Data are expressed in CFU, tests are performed in triplicate. Data shown in the graph represent the mean value of the three repetitions. It can be seen how with an irradiance of 20 minutes, the BIOVITAE technology achieved a 42% abatement of the original bacterial load, 65% in 40 minutes, 93.5% in 60 minutes, and 96% in 90 minutes.

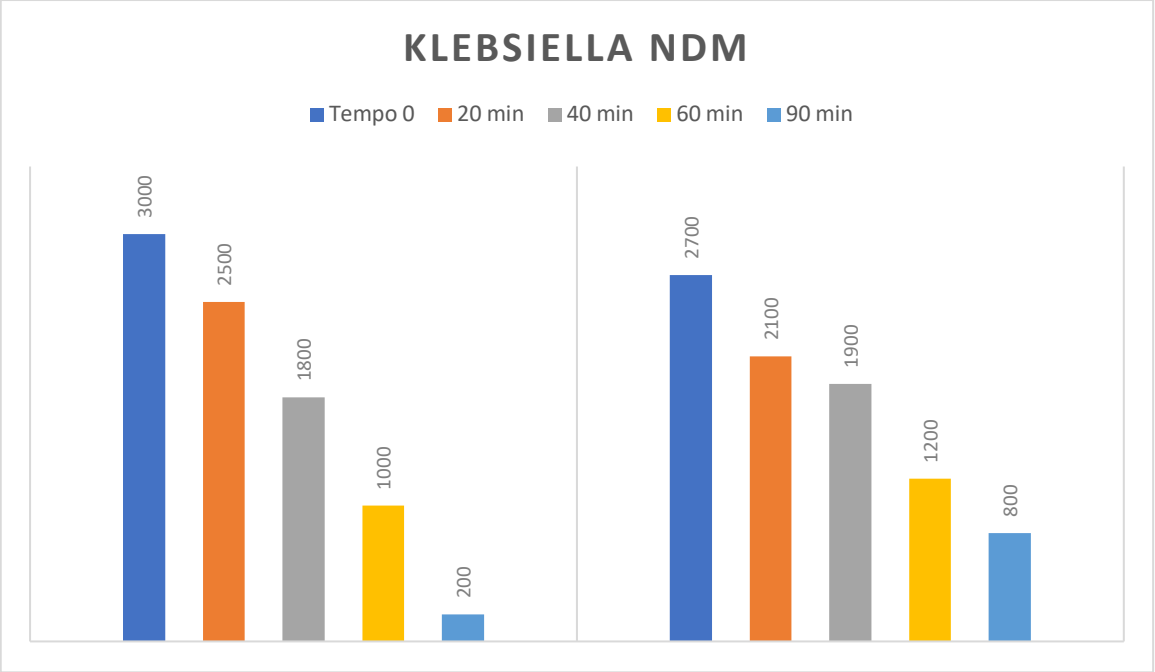

Table 37 - TEST 9 LEG 3 (custom device)

The BIOVITAE technology test on Klebsiella was made at the University of Pisa, Department of Translational Research, New Technologies in Medicine and Surgery. Data are expressed in CFU, tests are performed in triplicate. Data shown in the graph represent the mean value of the three repetitions. It can be seen how with an irradiance of 20 minutes, the BIOVITAE technology achieved a 23% abatement of the original bacterial load, 37% in 40 minutes, 61% in 60 minutes, and 84% in 90 minutes.

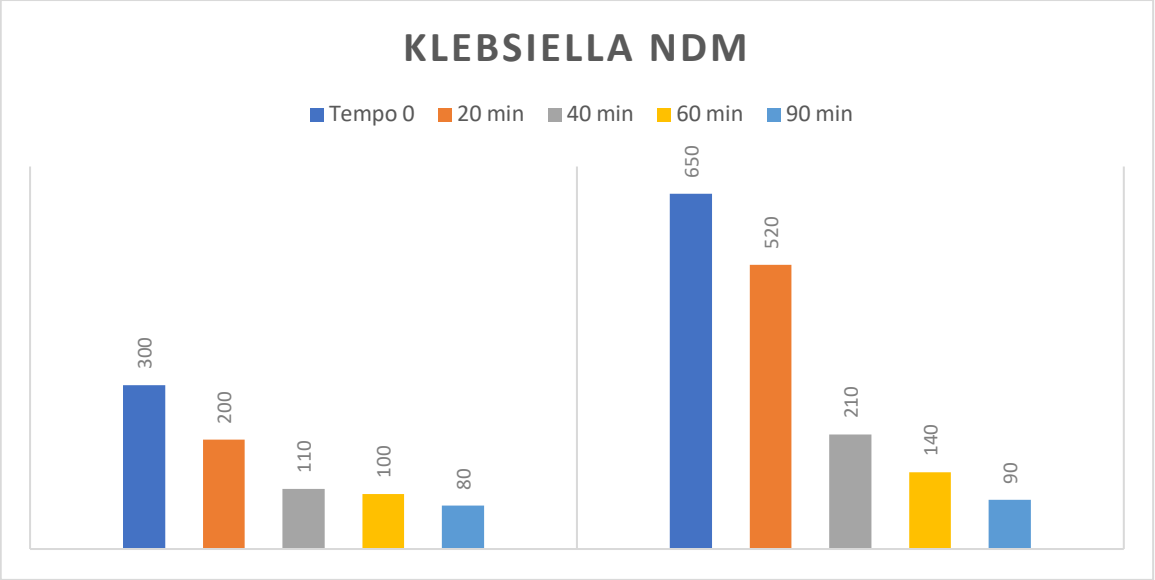

Table 38 - TEST 9 LEG 4 (custom device)

The BIOVITAE technology test on Klebsiella was made at the University of Pisa, Department of Translational Research, New Technologies in Medicine and Surgery. Data are expressed in CFU, tests are performed in triplicate. Data shown in the graph represent the mean value of the three repetitions. It can be seen how with an irradiance of 20 minutes, the BIOVITAE technology achieved a 2% abatement of the original bacterial load, 66% in 40 minutes, 44% in 60 minutes, and 53% in 90 minutes.

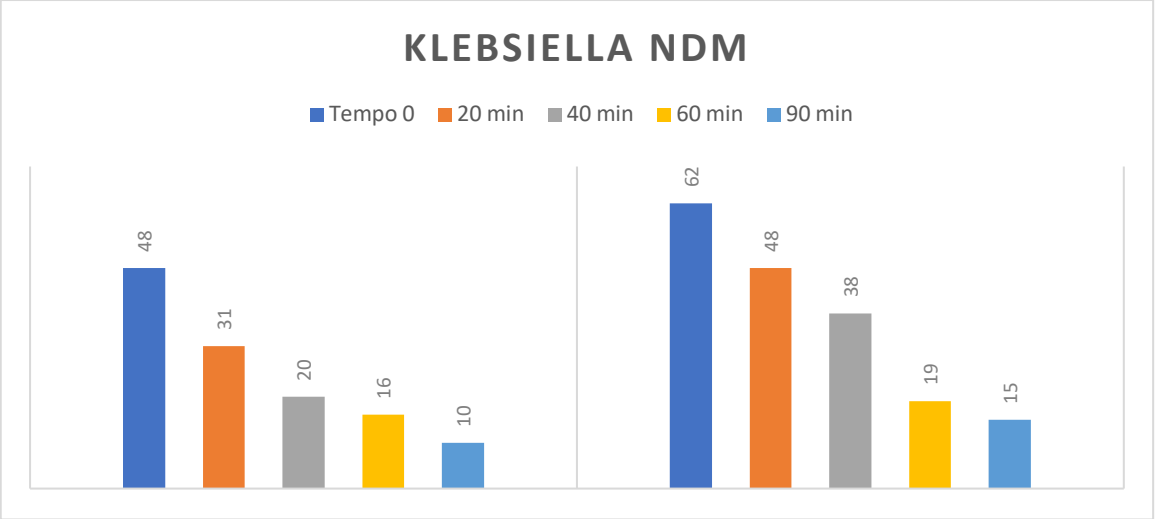

Table 39 - TEST 9 LEG 5 (custom device)

The BIOVITAE technology test on Klebsiella was made at the University of Pisa, Department of Translational Research, New Technologies in Medicine and Surgery. Data are expressed in CFU, tests are performed in triplicate. Data shown in the graph represent the mean value of the three repetitions. It can be seen how with an irradiance of 20 minutes the BIOVITAE technology achieved a 31% abatement of the original bacterial load, 46% in 40 minutes, 66% in 60 minutes, and 79% in 90 minutes.

E. coli (CENAM, Mexico)

The goal of the test is to show how BIOVITAE Domus A60 9W light bulb behaves when acting on a microorganism such as E. coli when it is (in solid) in a culture medium suitable for its growth.

Table 40 - TEST 10 LEG 1 (BIOVITAE Domus A60 bulb)

The BIOVITAE technology test on E. coli was made at the Centro Nacional de Metrologia (CENAM). Data are expressed in CFU, tests are performed in triplicate. Data shown in the graph represent the mean value of the three repetitions. It can be seen how with an irradiance of 3 hours, the BIOVITAE Domus A60 9W achieved a 9,5% abatement of the original bacterial load for concentration $1e10^6$, in 3 hours 46% for concentration $1e10^5$, in 3 hours 66% for concentration $1e10^4$.

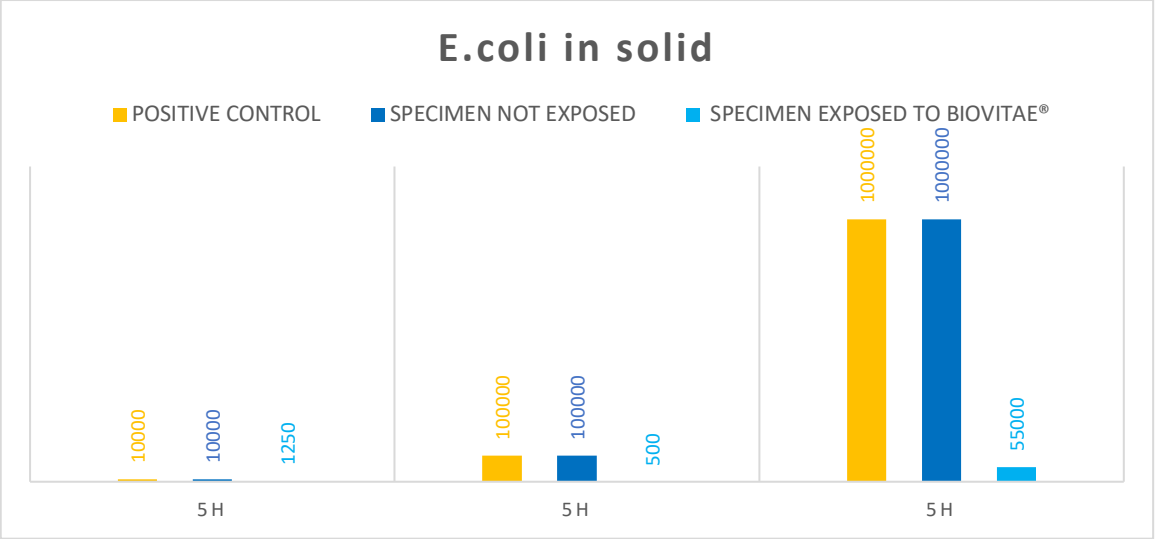

Table 41 - TEST 10 LEG 2 (BIOVITAE Domus A60 bulb)

The BIOVITAE technology test on E. coli was made at the Centro Nacional de Metrologia (CENAM). Data are expressed in CFU, tests are performed in triplicate. Data shown in the graph represent the mean value of the three repetitions. It can be seen how with an irradiance of 5 hours, the BIOVITAE Domus A60 9W achieved a 94,5% abatement of the original bacterial load for concentration $1e10^6$ in 5 hours 99,5% for concentration $1e10^5$, and in 5 hours 87,5% for concentration $1e10^4$.

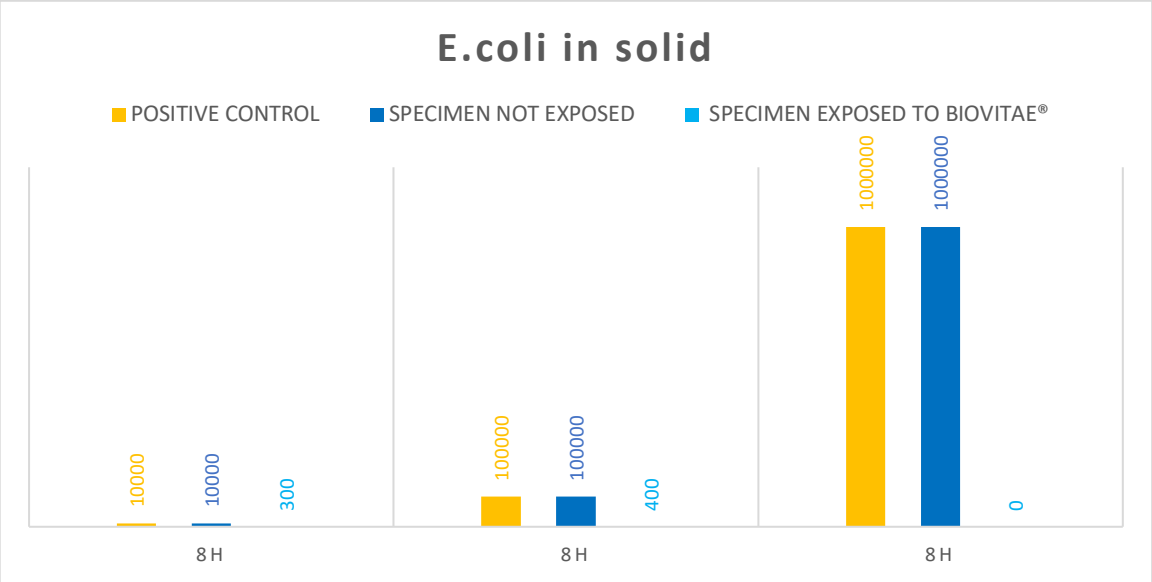

Table 42 - TEST 10 LEG 3 (BIOVITAE Domus A60 bulb)

The BIOVITAE technology test on E. coli was made at the Centro Nacional de Metrologia (CENAM). Data are expressed in CFU, tests are performed in triplicate. Data shown in the graph represent the mean value of the three repetitions. It can be seen how with an irradiance of 8 hours, the BIOVITAE Domus A60 9W achieved a 100 % abatement of the original bacterial load for concentration $1e10^6$ in 8 hours 99,6% for concentration $1e10^5$, and in 8 hours 97% for concentration $1e10^4$.

B. subtilis (HAIER, China)

This test aims to verify the ability of BIOVITAE Domus A60 9W light bulb to break down the microbial load suspended in aerosols. B. subtilis is a very interesting microorganism because it can form a protective endospore with a hard shell that can tolerate extreme environmental conditions.

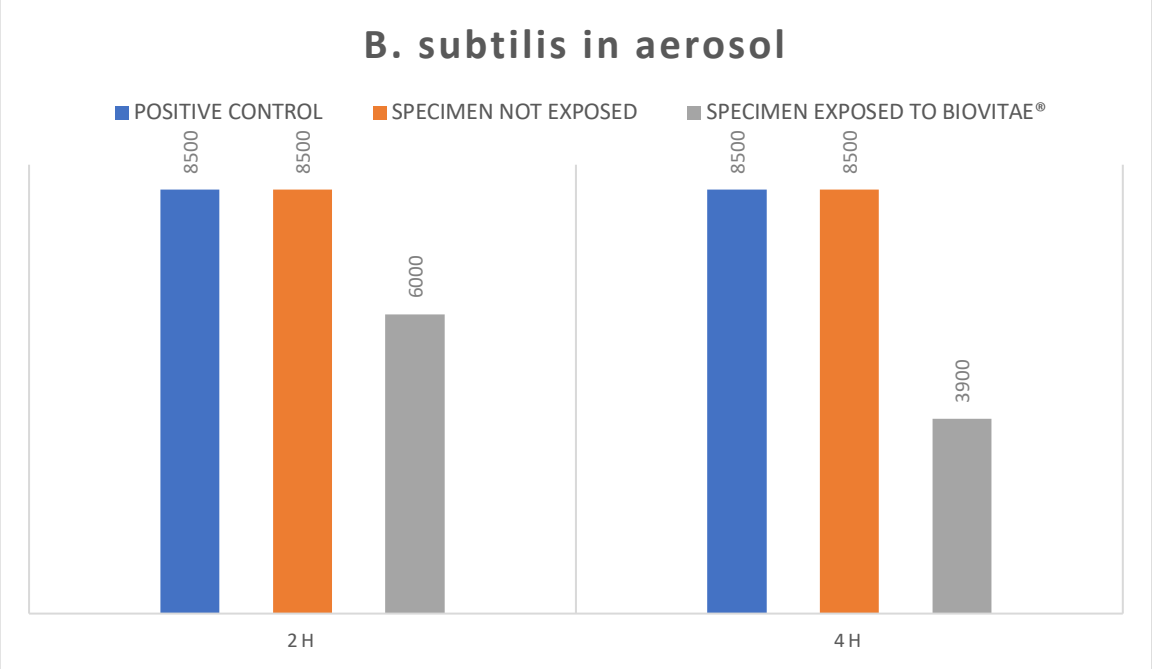

Table 43 - TEST 11 (custom product)

The BIOVITAE technology test on B. subtilis dispersed in aerosol was made at the Hope Laboratories (Haier Open Partnership Ecosystem). Data are expressed in CFU/m^3, tests are performed in triplicate. Data shown in the graph represent the mean value of the three repetitions. It can be seen how with an irradiance of 2 hours, the BIOVITAE Domus A60 9W achieved a 29,5% abatement of the original bacterial load; in 4 hours 54%.

S. enterica (La Sapienza University, Italy)

Microbiological control in the food sector is of fundamental importance for public health. The objective of the test is to test the effectiveness of devices with BIOVITAE technology LP60-600-1B-11 and LP81-600-1B8 made to be used in food industry fridges, against the Salmonella Enterica serovar Typhi Ty21a (ATCC 33459).

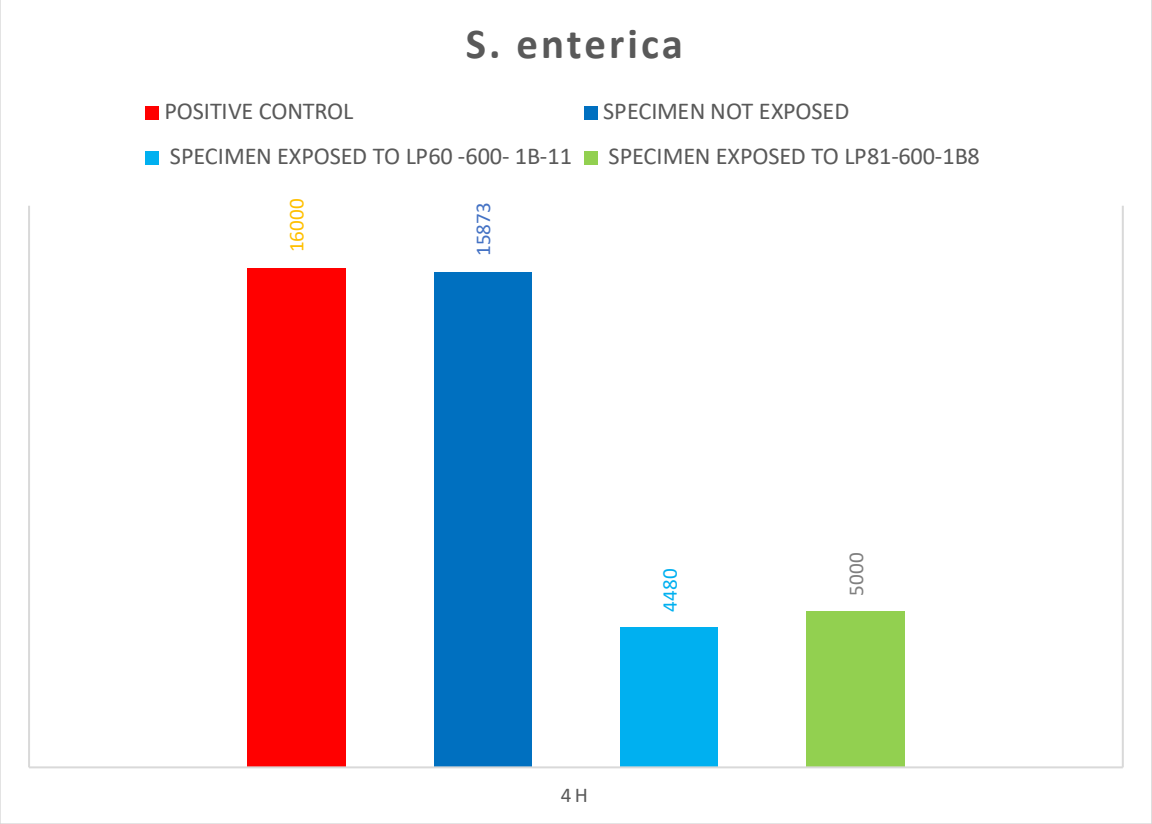

Table 44 - TEST 12 (custom product)

The BIOVITAE technology tests were made on a Salmonella Enterica serovar Typhi Ty21a strain dried on glass surfaces. Data are expressed in CFU/ml, tests are performed in triplicate. Data shown in the graph represent the mean value of the three repetitions. It can be seen how with an irradiance of 4 hours, the BIOVITAE powered device LP-600-1B-11 achieved a 72% abatement of the original bacterial load for concentration, and device LP81-600-1B8 shows an 68,75% after 4 hours.

LIST OF IN-VIVO TESTS

Total Mesophile Load (VTT, Finland)

The aim of this test is verifying the effectiveness of BIOVITAE panel ceiling 60X60 in vivo in the First Aid hospital of Rome's airport Fiumicino deals with any emergency raised from both the staff of the Airport and the companies operating therein, overall administering about 11,000 first aid services per year. The study has been conducted by VTT - Technical Research Centre of Finland during July 2019.

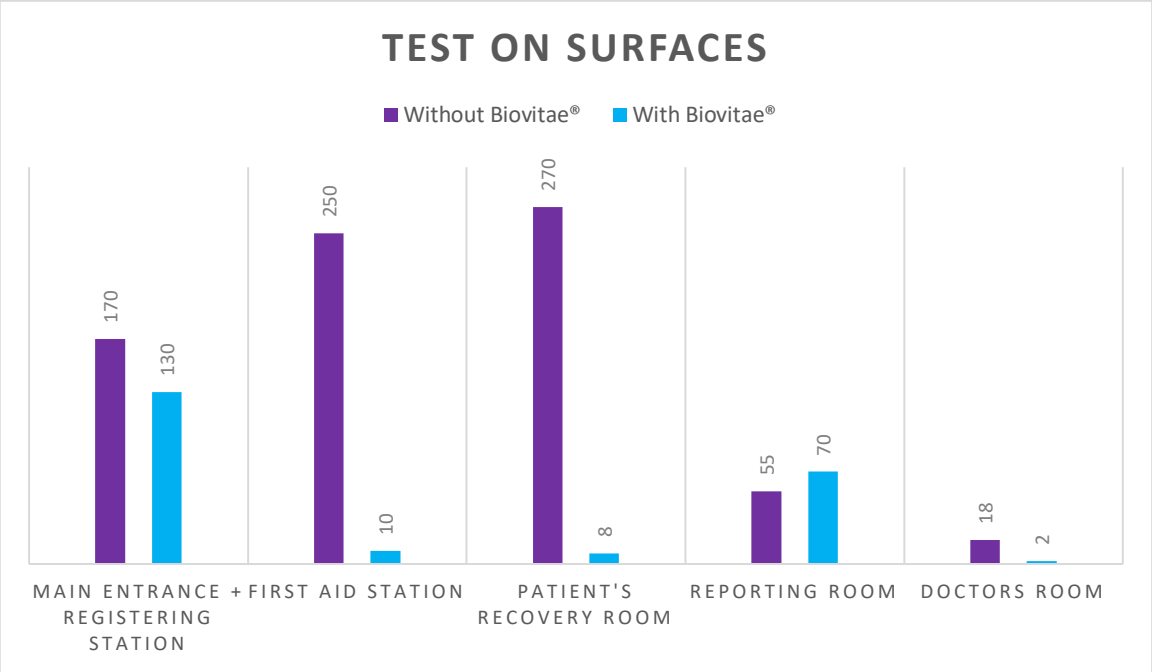

Table 45 - TEST 13 (BIOVITAE Panels 600x600)

The BIOVITAE technology test in was made in the first aid Hospital of Rome Fiumicino Airport from Technical Research Centre of Finland (VTT). Data are expressed in CFU/cm^2. Tests were conducted under conditions of normal use of the facilities and cleaning routines were not changed. Data shown in the graph represent the average of the samples taken before and after the installation of BIOVITAE Panels 600x600. In the Main Entrance and registering station area the decrease is 35%, in the First Aid Station the decrease is 95%, in the Patient's recovery room is 94%, in the reporting room the decrease is +15%, and in doctors' room the decrease is 94%.

CBT (Servizio Ambiente Srl, Italy)

The aim of this test is verifying the effectiveness of BIOVITAE Battens 120 in-vivo in the two meeting rooms during normal activity, with people inside. In this experimental set, different surfaces other than the aerosol were tested.

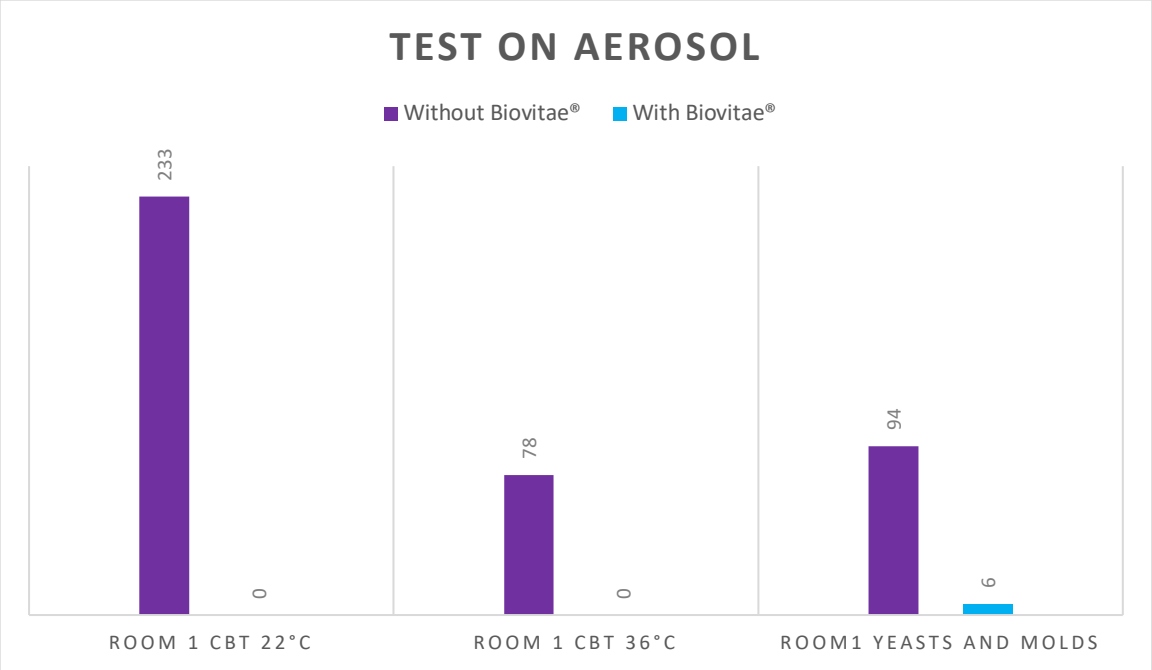

Table 46 - TEST 14 LEG 1 (BIOVITAE Panel 600x600 and Panel 1200x300)

Data are expressed in CFU/m³. Tests were conducted under conditions of normal use of the facilities and cleaning routines were not changed. Data shown in the graph represent the average of the samples taken before and after the installation of BIOVITAE devices. In room 1 BIOVITAE Panels show a 100% decrease related to CBT 22°, a 100% decrease related to CBT 36°, and a 93,6 % decrease related to Yeasts and Molds.

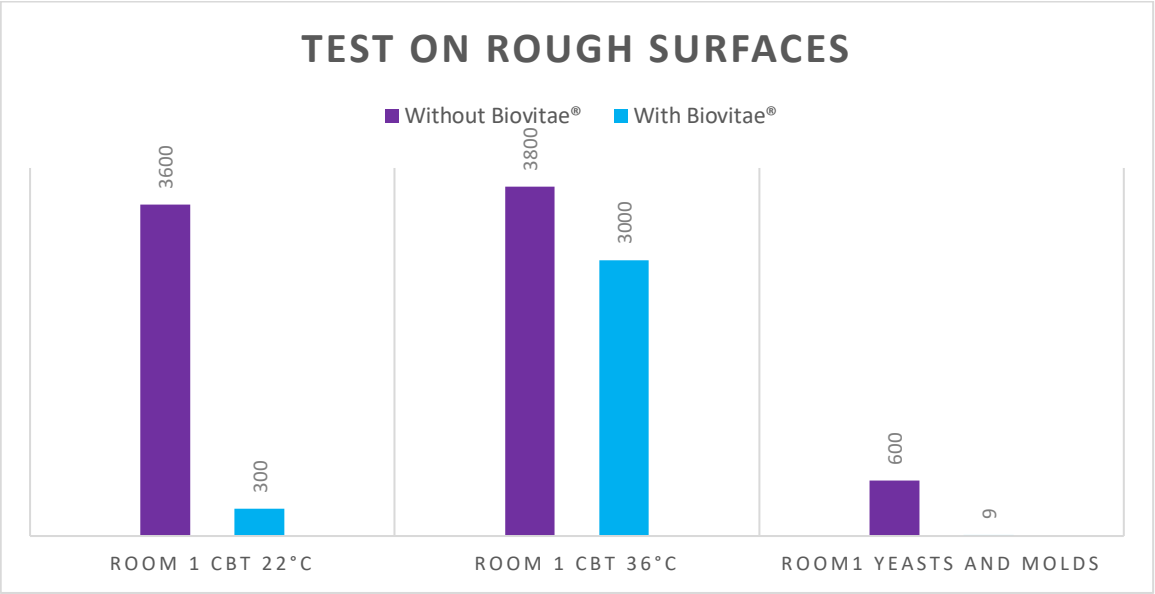

Table 47 - TEST 14 LEG 1 (BIOVITAE Panel 600x600 and Panel 1200x300)

Data are expressed in CFU/cm². Tests were conducted under conditions of normal use of the facilities and cleaning routines were not changed. Data shown in the graph represent the average of the samples taken on rough surface before and after the installation of BIOVITAE devices, and in particular on the back of an armchair. In room 1 (armchair sampling) BIOVITAE Panel shows a 91,6% decrease related to CBT 22°, 21% decrease related to CBT 36°, and 98,5% decrease related to Yeasts and Molds.

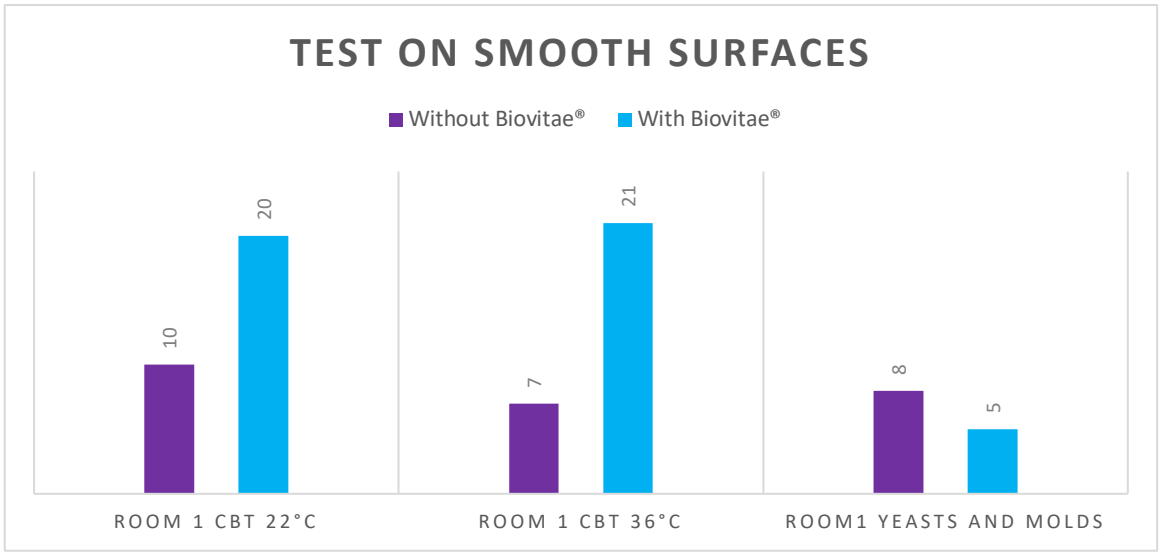

Table 48 - TEST 14 LEG 1 (BIOVITAE Panel 600x600 and Panel 1200x300)

Data are expressed in CFU/cm². Tests were conducted under conditions of normal use of the facilities and cleaning routines were not changed. Data shown in the graph represent the average of the samples taken on smooth surfaces before and after the installation of BIOVITAE devices, and in particular on a meeting table. In room 1 (table sampling) BIOVITAE Panels show a 37% decrease related to Yeasts and Molds.

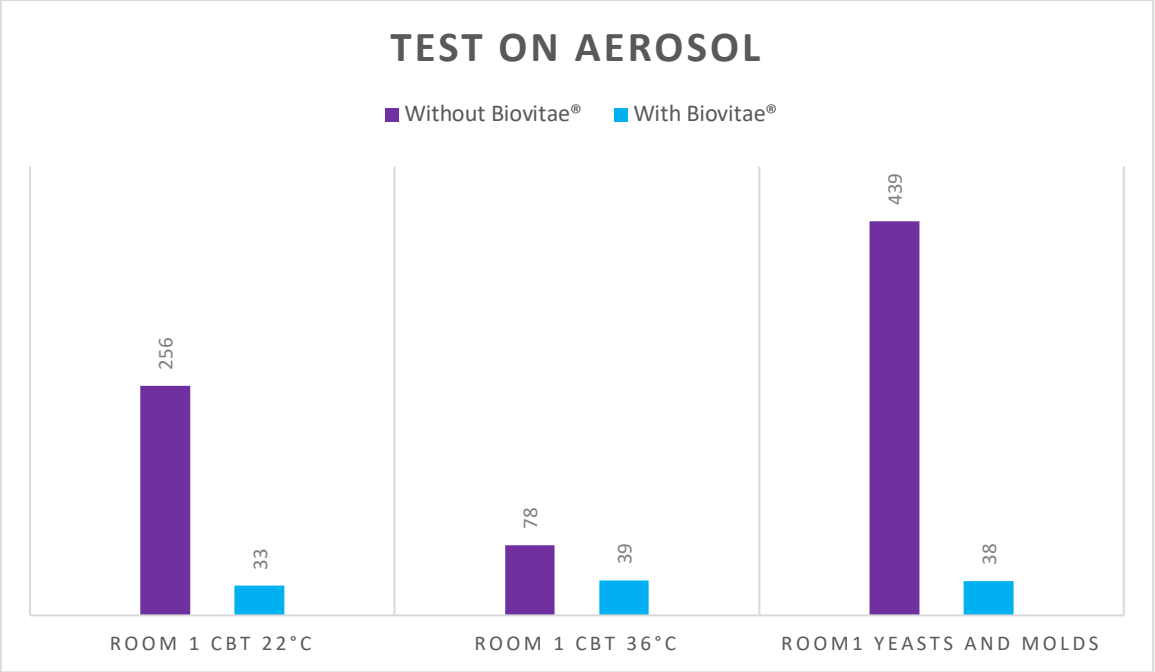

Table 49 - TEST 14 LEG 2 (BIOVITAE Panel 600x600 and Panel 1200x300)

Data are expressed in CFU/m³. Tests were conducted under conditions of normal use of the facilities and cleaning routines were not changed. Data shown in the graph represent the average of the samples taken before and after the installation of BIOVITAE. In room 2 BIOVITAE Panels show an 87% decrease related to CBT 22°, a 50% decrease related to CBT 36°, and a 91% decrease related to Yeasts and Molds.

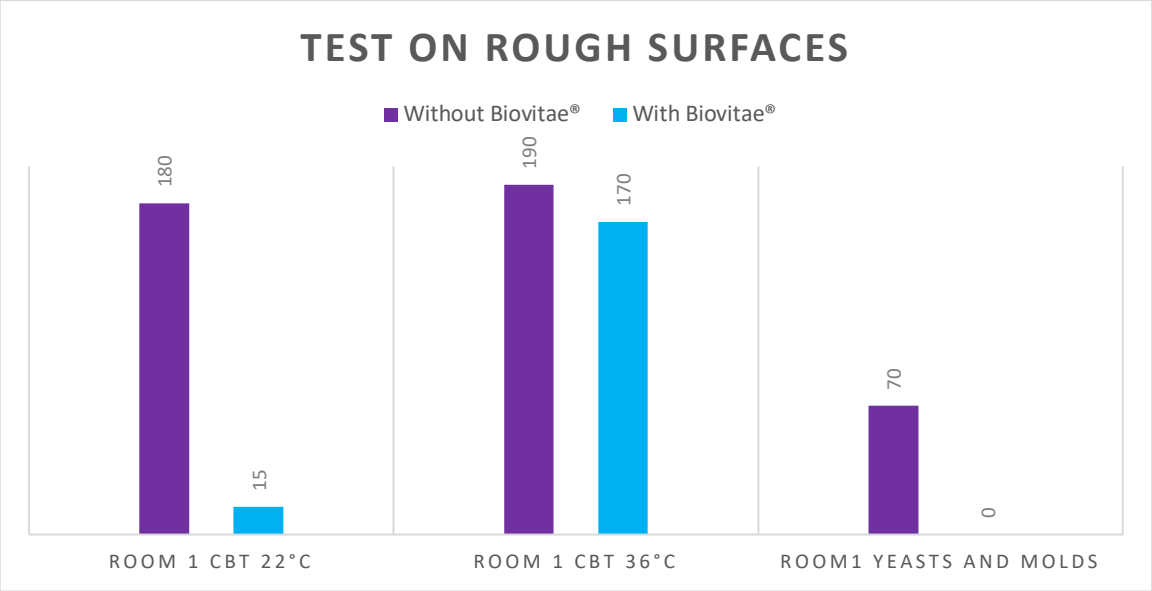

Table 50 - TEST 14 LEG 2 (BIOVITAE Panel 600x600 and Panel 1200x300)

Data are expressed in CFU/cm². Tests were conducted under conditions of normal use of the facilities and cleaning routines were not changed. Data shown in the graph represent the average of the samples taken on rough surfaces before and after the installation of BIOVITAE devices, and in particular on the back of an armchair in faux leather. In room 2 (armchair sampling) BIOVITAE Panels show a 91% decrease related to CBT 22°, a 10% decrease related to CBT 36°, and a 100 % decrease related to Yeasts and Molds.

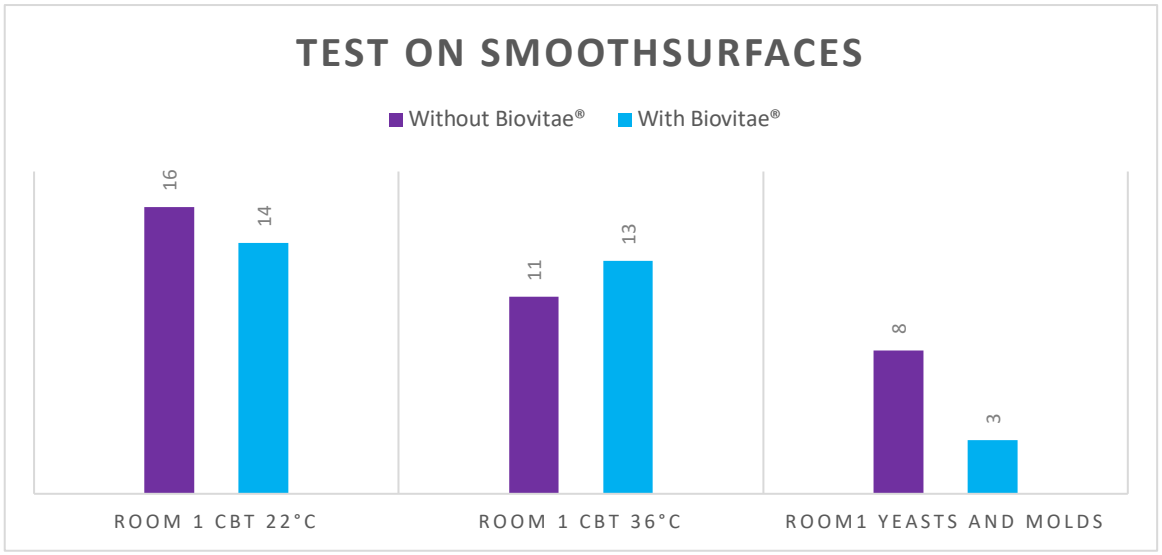

Table 51 - TEST 14 LEG 2 (BIOVITAE Panel 600x600 and Panel 1200x300)

Data are expressed in CFU/cm². Tests were conducted under conditions of normal use of the facilities and cleaning routines were not changed. Data shown in the graph represent the average of the samples taken on smooth surfaces before and after the installation of BIOVITAE devices, and in particular on a meeting table. In room 2 (table sampling) BIOVITAE Panels show a 37,5% decrease related to Yeasts and Molds; an 12,5% decrease related to CBT 22°.

Bacteria and Yeast (Alliance Medical, Italy)

What we did in this test was to evaluate in real life the activity of BIOVITAE Battens 150 reducing the bacterial load in a sport setting, represented by the locker rooms of a football team. The room where the test took place consists of an area where athletes change and shelter their clothes and an area where they take a shower after training or football matches.

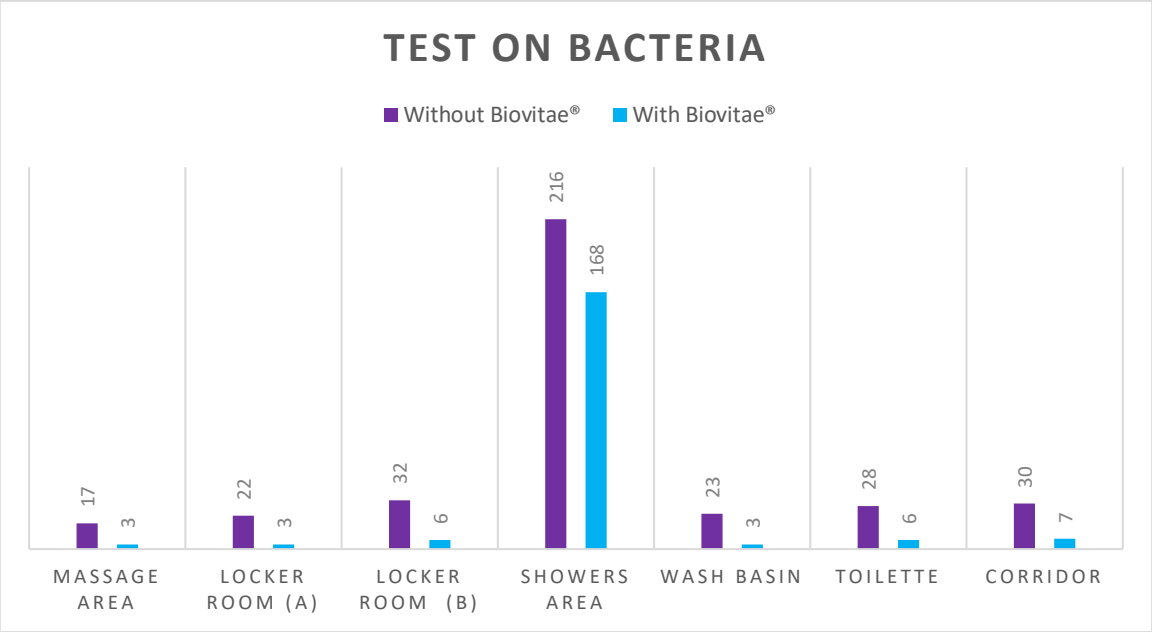

Table 52 - TEST 15 (BIOVITAE Batten 150)

Data are expressed in CFU/cm². Tests were conducted under conditions of normal use of the facilities and cleaning routines were not changed. Data shown in the graph represent the average of the samples taken before and after the installation of BIOVITAE devices. In the Massage area BIOVITAE batten shows an 82% decrease, in the Locker room (A) an 86% decrease, in the Locker room (B) an 81% decrease, in the Showers area a 22,2% decrease, in the Wash basin an 87% decrease, in the Toilette area a 78% decrease, and in the Corridor a 76% decrease.

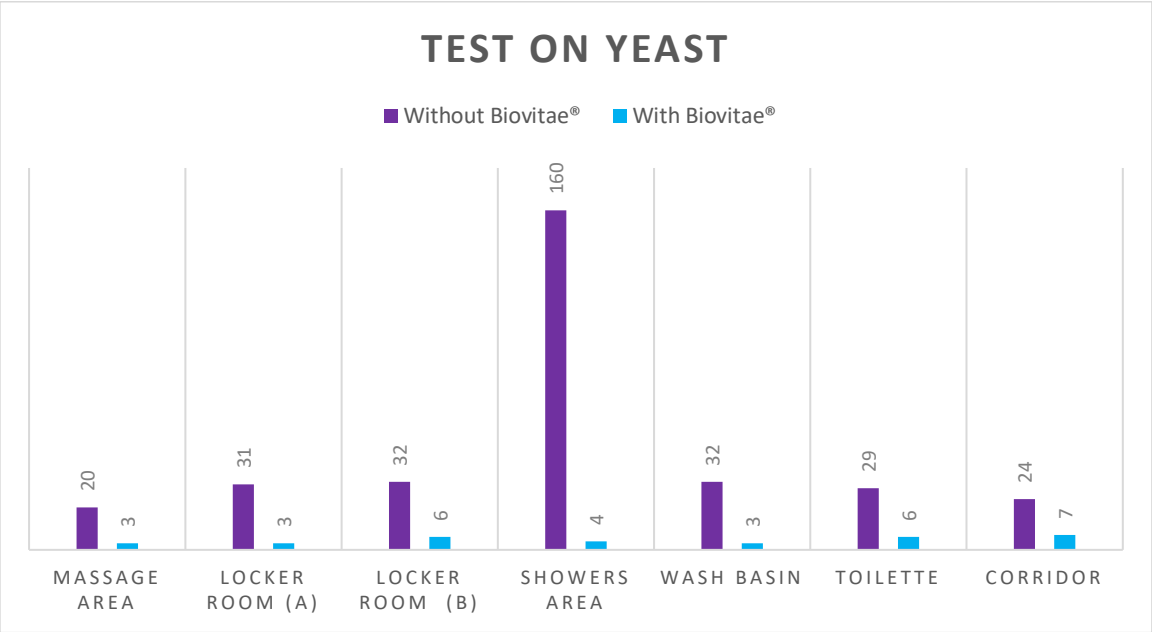

Table 53 - TEST 15 (BIOVITAE Batten 150)

The data are expressed in CFU/cm^2. Tests were conducted under conditions of normal use of the facilities and cleaning routines were not changed. Data shown in the graph represent the average of the samples taken before and after the installation of BIOVITAE devices. In the Massage area BIOVITAE batten shows an 85% decrease, in the Locker room (A) a 90% decrease, in the Locker room (B) an 81% decrease, in the Showers area a 97% decrease, in the Wash basin a 90% decrease, in the Toilette area a 79% decrease, and in the Corridor a 70% decrease.

Total Mesophile Load and Aerosol (Technische Hochschule Ulm, Germany)

This test aims to verify the effectiveness in real conditions of the Aurosun Linear 150 product installed in a classroom of the St. Walburg elementary school in Eichstätt, Germany.

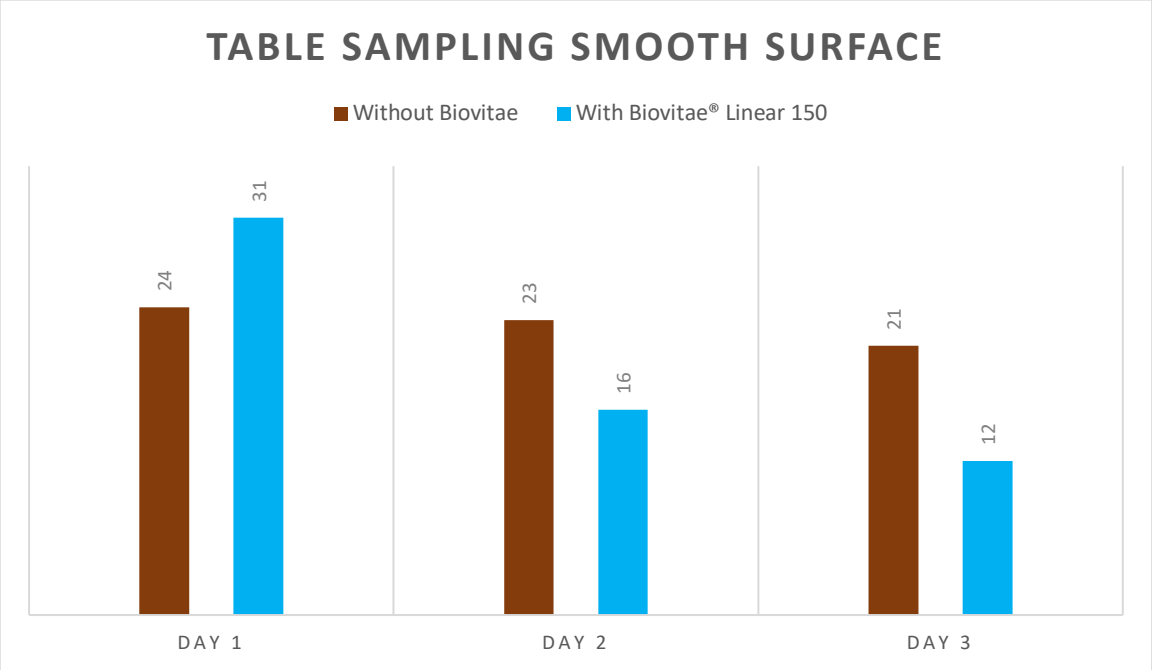

Table 54 - TEST 16 (AUROSUN linear 150 powered by BIOVITAE)

Data are expressed in CFU/cm². Tests were conducted under conditions of normal use of the facilities and cleaning routines were not changed. Data shown in the graph represent the average of the samples taken before and after the installation of AUROSUN linear 150 devices. On day 1 over smooth surfaces (table) AUROSUN Linear powered by BIOVITAE shows a 30% increase, on day 2 over smooth surfaces (table) AUROSUN Linear powered by BIOVITAE shows a 43% decrease, on day 3 over smooth surfaces (table) AUROSUN Linear powered by BIOVITAE shows a 45% decrease.

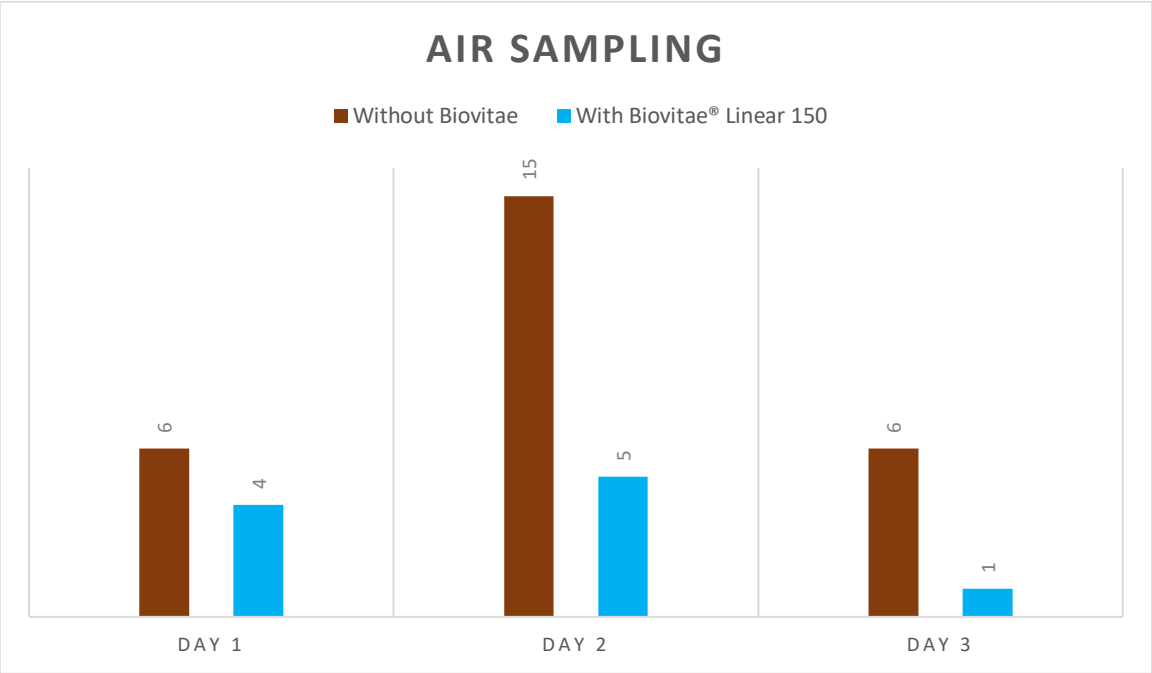

Table 55 - TEST 16 (AUROSUN linear 150 powered by BIOVITAE)

Data are expressed in CFU/cm². Tests were conducted under conditions of normal use of the facilities and cleaning routines were not changed. Data shown in the graph represent the average of the samples taken before and after the installation of Aurora linear 150 devices. On day 1 over smooth surfaces (table) AUROSUN Linear powered by BIOVITAE shows a -35% decrease, on day 2 on smooth surfaces (table) AUROSUN Linear powered by BIOVITAE shows a -66% decrease, on day 3 over smooth surfaces (table) AUROSUN Linear powered by BIOVITAE shows a -81% decrease.

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