



How phages reduce food pathogens in raw pet food processing

PGS

PGL

PGE

A large, curved, semi-transparent blue graphic on the left side of the page contains a microscopic image of numerous bacteriophages. The phages are small, hexagonal structures with long, thin tails, appearing in various orientations and colors (light blue, green, yellow) against a darker blue background.

Page 4. Power of bacteriophages

Bacteriophages and their ability to precisely control bacterial populations, including food pathogens

Page 4. Benefit of phages

The benefits of our bacteriophage solutions for controlling food pathogen in raw pet food processing

Page 5. Secured palatability

External study conducted to assess the impact of our solutions on sensory attributes related to the palatability of raw pet food

Page 6. Chicken formulation

Efficacy of our solutions against *Salmonella*, *Listeria*, and *E. coli* in commercially available raw pet food chicken formulation

Page 8. Beef formulation

Efficacy of our solutions against *Salmonella*, *Listeria*, and *E. coli* in commercially available raw pet food beef formulation

Page 10. Lamb formulation

Efficacy of our solutions against *Salmonella*, *Listeria*, and *E. coli* in commercially available raw pet food lamb formulation

Page 12. Collaborations

Overview of collaborating universities and research institutes

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Overview of approvals for Phageguard S (PGS), Phageguard L (PGL), and Phageguard E (PGE)

Page 14. Partner of the industry

Overview of industrial implementations to address food safety challenges throughout the food industry

Power of bacteriophages

Bacteriophages: Nature's answer to controlling bacterial populations

Bacteriophages (or phages) serve as nature's own system for regulating bacteria. Every 48 hours, phages reduce half of the world's bacterial population. This effect is due to their immense abundance. Phages are everywhere and outnumber bacteria by a factor of 10, making them the most common biological entity on our planet. A pinch of soil can contain 15 million phages, and the gut of dogs and cats naturally contains phages that are part of a balanced microbial environment.

Advancing the unique ability of phages

Phages are highly diverse, with each phage having the ability to target a specific bacterial species. This specificity is used to our benefit. By identifying phages that target *Salmonella*, *Listeria*, or *E. coli*, food safety can be enhanced by harnessing nature's own mechanisms.

Phages: the future of food safety

Since 2005, Phageguard has provided phage solutions that specifically target *Salmonella*, *Listeria*, and pathogenic *E. coli*. These precision-targeted products support improved food safety management without affecting product taste or introducing harsh chemicals into the production environment.



Benefit of phages

Preserve palatability and all the goodness your product formulations offer

The nutrients and sensory qualities of meat and fish, such as taste, texture, color, and juiciness, originate from the animal's own tissues, including muscle, fat, and connective tissue. These tissues are complex structures composed of proteins, fats, vitamins, minerals, and naturally occurring water. The phages used in our solutions are highly specific and act only on their respective target food pathogens. They do not interact with good bacteria or the tissues that determine a product's nutritional value or sensory characteristics. As a result, the nutritional profile and palatability of meat and fish products remain unchanged.

Maintaining natural, carnivore-based diets for your customer audience






Improve the food safety of your raw pet food products while ensuring alignment with the values of your customer audience. As nature's own system to controlling bacteria, our solutions support the control of *Salmonella*, *Listeria*, and *E. coli*, without compromising the natural standard of your raw pet food products.

Versatile application for various operation sizes and production settings

Spray systems

Bucket / Dip

Other existing equipment

-  Natural and clean-label solutions
-  Non-hazardous (harmless to humans, animals, and plants)
-  Non-corrosive to production equipment
-  No wastewater pretreatment required
-  Can be applied after applying other food safety interventions to contribute to a multi-hurdle, multi-technology approach

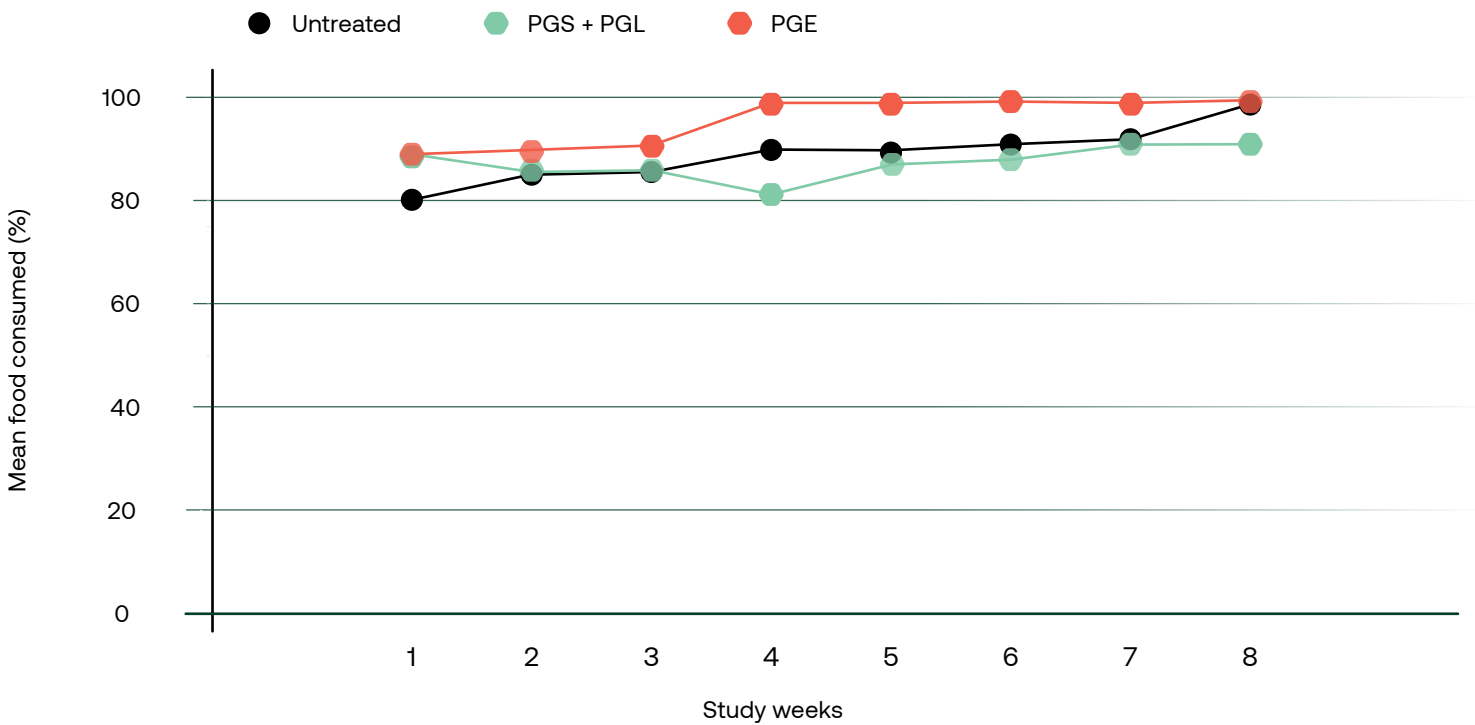
Secured palatability

External pet study on the impact of phages to product sensory attributes

To further substantiate the absence of impact on sensory attributes related to the palatability of raw pet food, an external study on pet food consumption was conducted. Cats were selected as test panel due to their high sensitivity to sensory attributes such as taste and odor. The study included 28 cats of the same breed but of different ages. The cats were offered three diet conditions: (a) non-dry pet food without the addition of Phageguard solutions, (b) non-dry pet food with the addition of Phageguard S (PGS) and Phageguard L (PGL), and (c) non-dry pet food with the addition of Phageguard E (PGE). During the first two weeks, all cats received only non-dry pet food. After this period, the cats were fed either non-dry pet food with PGS and PGL or non-dry pet food containing PGE for a total of five weeks. An untreated control group represents cats that received non-dry pet food without phage addition throughout the entire eight-week study.

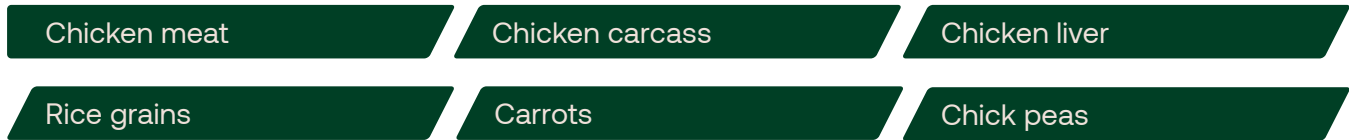
0%
Impact

The chart below presents the outcome of the study. During the eight-week study period, no significant differences were observed, indicating the absence of impact on sensory qualities related to the application of our phage solutions in raw pet food formulations.



Chicken formulation

Improving food safety in raw pet food chicken formulations

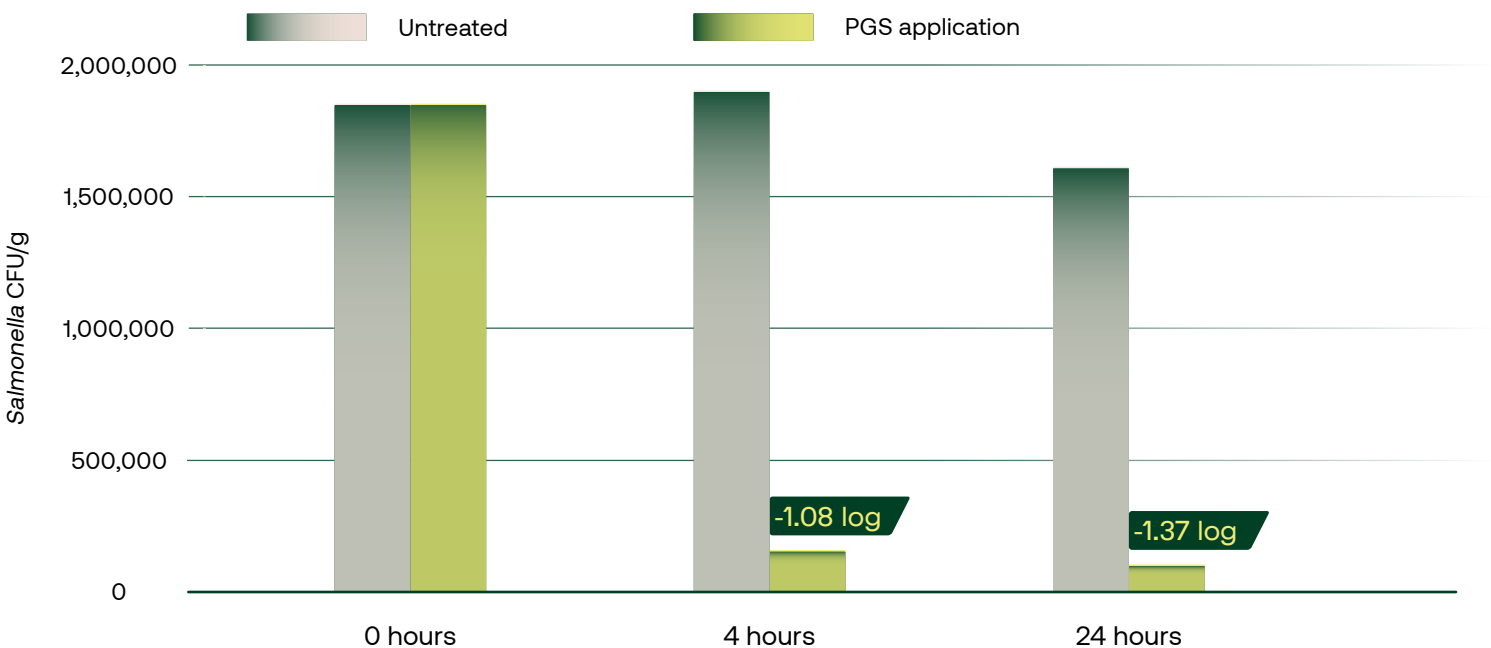


To assess the efficacy of our solutions, a study was conducted using a commercially available raw pet food containing 75% chicken as the main ingredient. The contamination levels used do not reflect typical industrial conditions; pathogen counts (Y-axis: CFU/g) were set at levels higher than those observed in real-world production environments. In contrast, Phageguard solutions were applied at a dose representative of industrial use.

PGS Achieved *Salmonella* reductions

1.37_{log}
Reduction

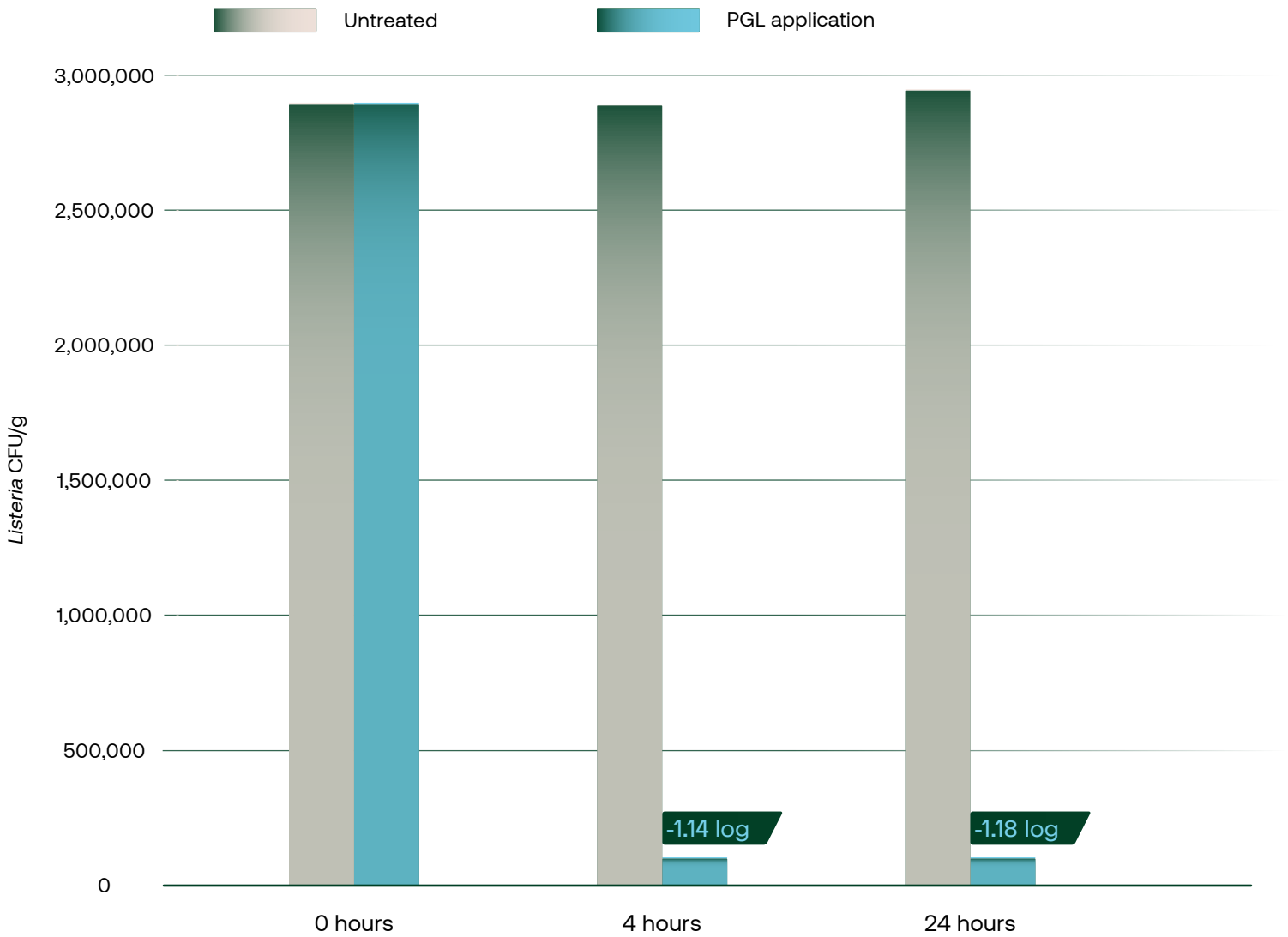
PGS applied to the raw pet food chicken formulation delivered *Salmonella* reductions of 1.08 log (92%) at 4 hours post-application. After 24 hours, the total reduction increased to 1.37 log, corresponding to a 96% decrease of *Salmonella*.



PGL Achieved *Listeria* reductions

1.18_{log}
Reduction

PGL applied to the raw pet food chicken formulation delivered *Listeria* reductions of 1.14 log (93%) at 4 hours post-application. After 24 hours, the total reduction increased to 1.18 log.



Beef formulation

Improving food safety in raw pet food beef formulations

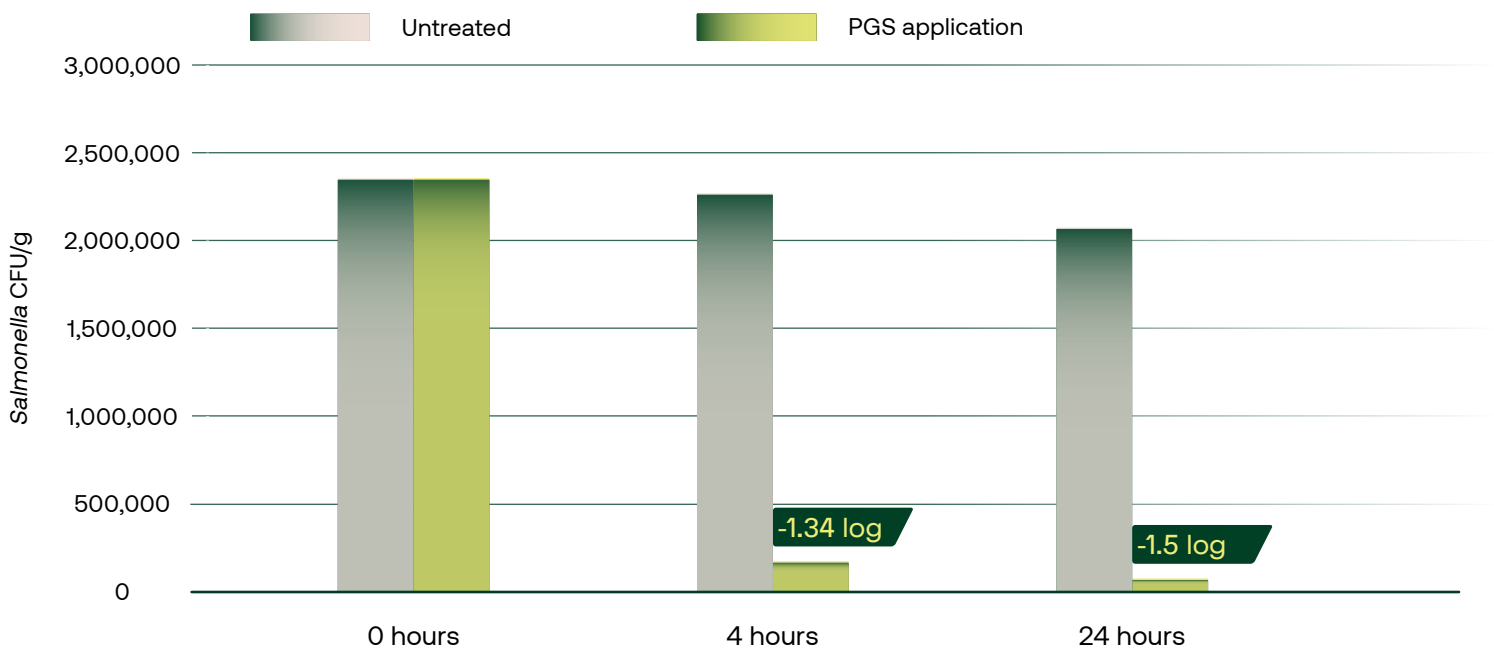


To assess the efficacy of our solutions, a study was conducted using a commercially available raw pet food containing 79% beef as the main ingredient. The contamination levels used do not reflect typical industrial conditions; pathogen counts (Y-axis: CFU/g) were set at levels higher than those observed in real-world production environments. In contrast, Phageguard solutions were applied at a dose representative of industrial use.

PGS Achieved *Salmonella* reductions

1.5 log
Reduction

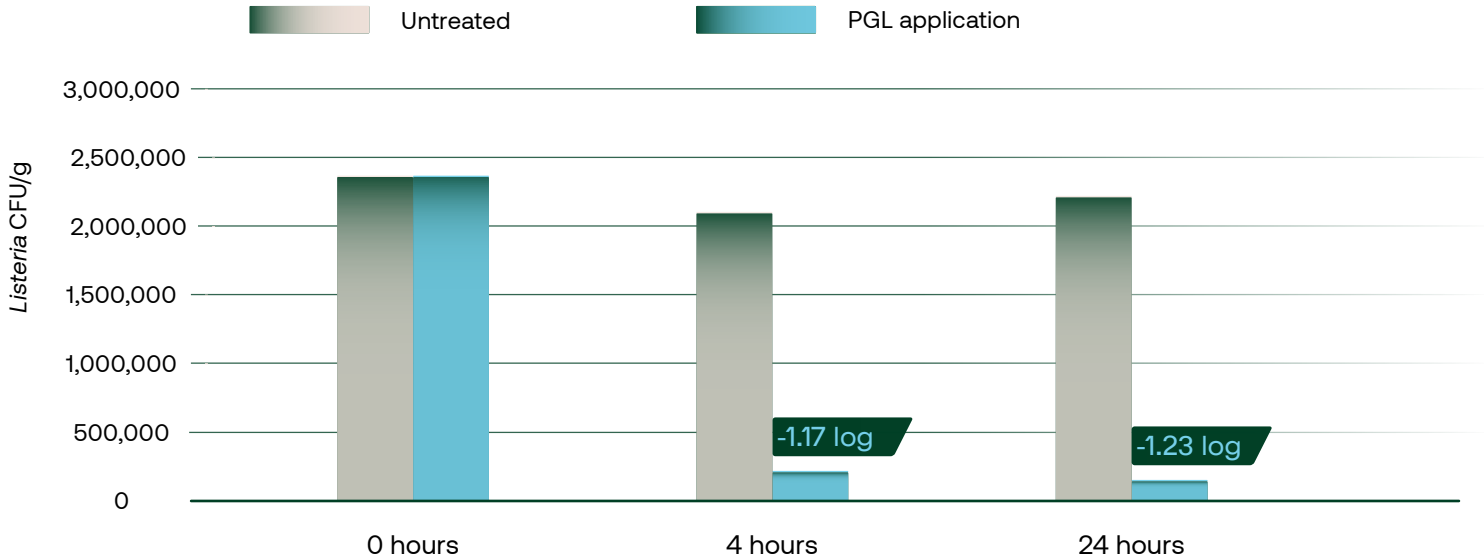
PGS applied to the raw pet food beef formulation delivered *Salmonella* reductions of 1.34 log (95%) at 4 hours post-application. After 24 hours, the total reduction increased to 1.5 log, corresponding to a 97% decrease of *Salmonella*.



PGL Achieved *Listeria* reductions

1.23_{log}
Reduction

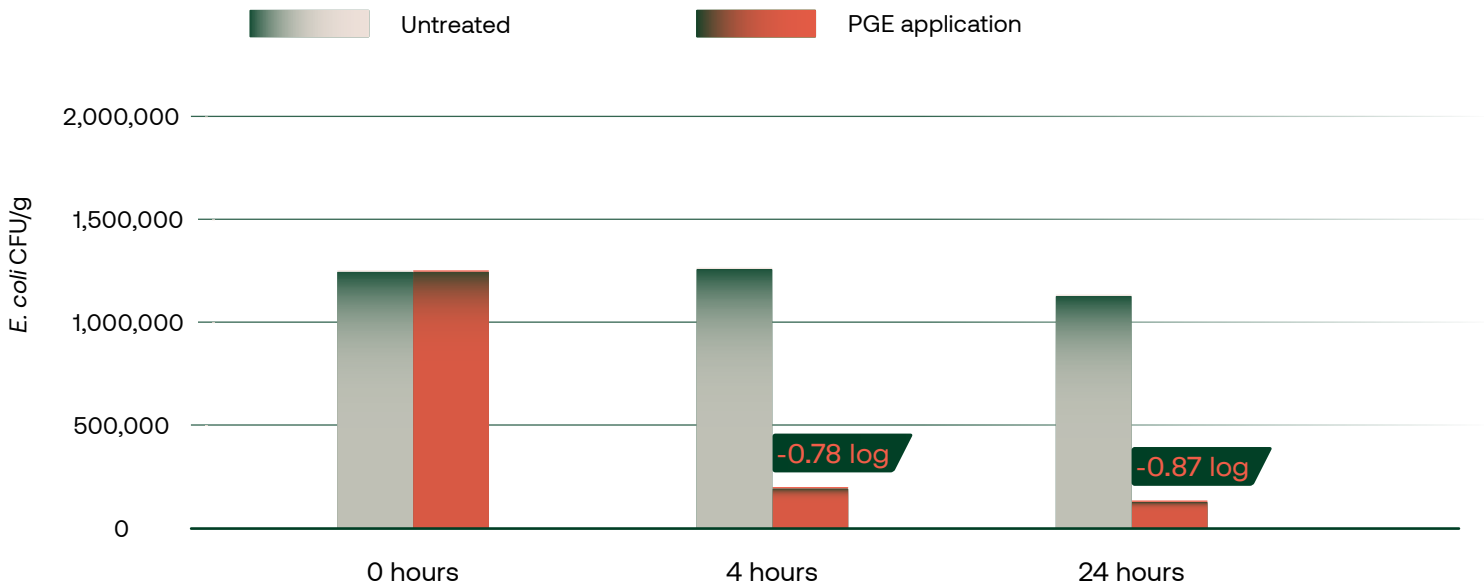
PGL applied to the raw pet food beef formulation delivered *Listeria* reductions of 1.17 log (93%) at 4 hours post-application. After 24 hours, the total reduction increased to 1.23 log, corresponding to a 94% decrease of *Listeria*.



PGE Achieved *E. coli* reductions

0.87_{log}
Reduction

PGE applied to the raw pet food beef formulation delivered *E. coli* O157 reductions of 0.78 log (83%) at 4 hours post-application. After 24 hours, the total reduction increased to 0.87 log, corresponding to a 87% decrease of *E. coli*.



Lamb formulation

Improving food safety in raw pet food lamb formulations

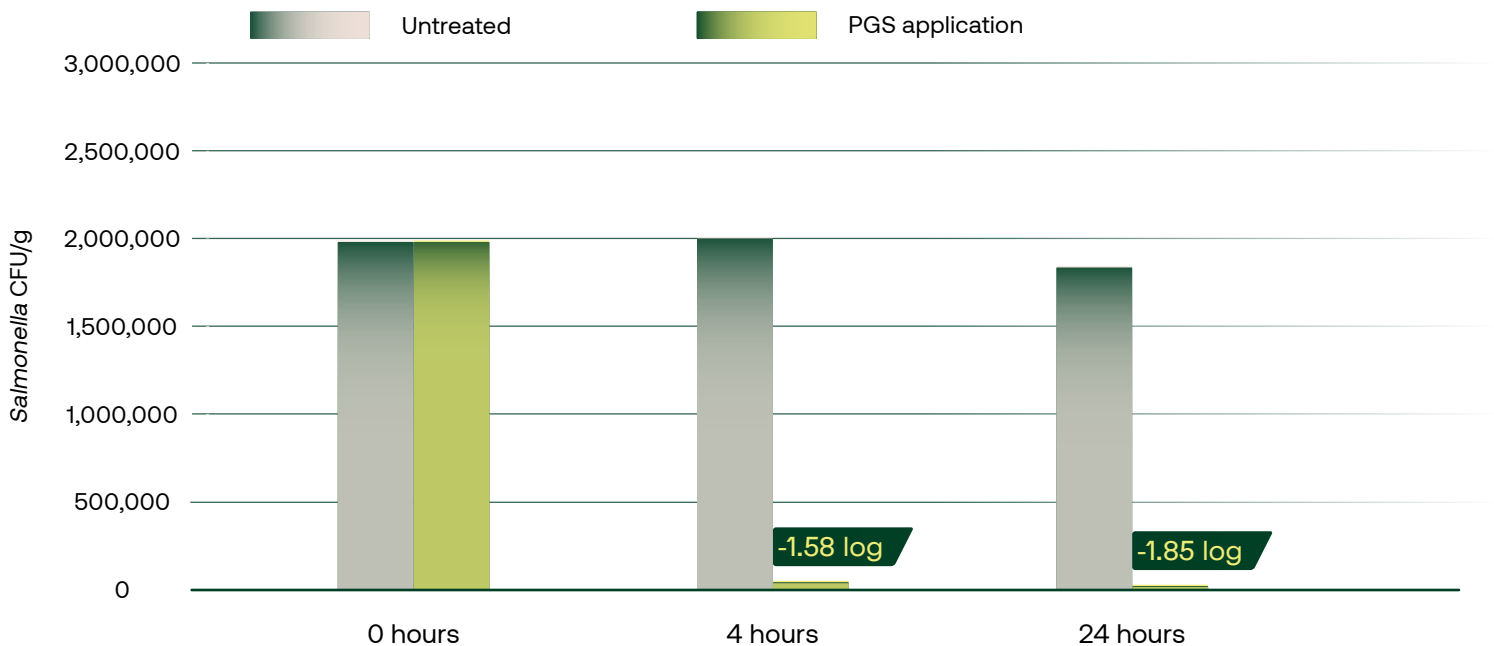


To assess the efficacy of our solutions, a study was conducted using a commercially available raw pet food containing 75% lamb as the main ingredient. The contamination levels used do not reflect typical industrial conditions; pathogen counts (Y-axis: CFU/g) were set at levels higher than those observed in real-world production environments. In contrast, Phageguard solutions were applied at a dose representative of industrial use.

PGS Achieved *Salmonella* reductions

1.85_{log}
Reduction

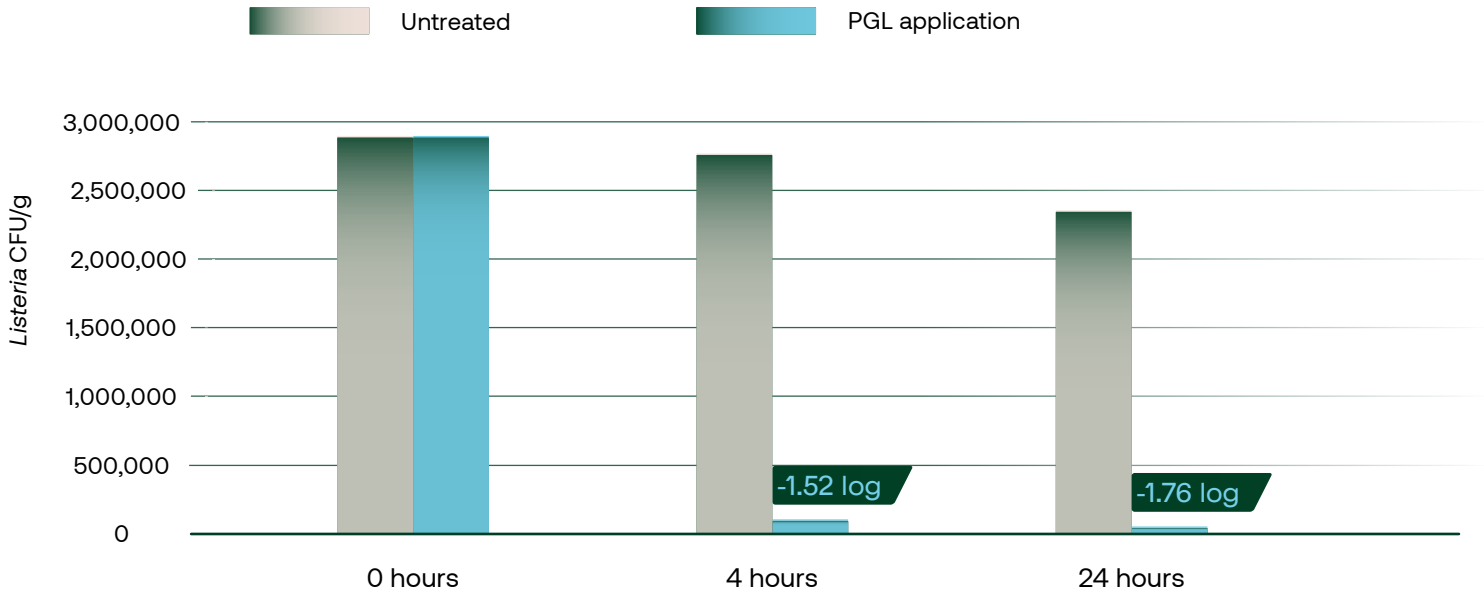
PGS applied to the raw pet food lamb formulation delivered *Salmonella* reductions of 1.58 log (97%) at 4 hours post-application. After 24 hours, the total reduction increased to 1.85 log, corresponding to a 99% decrease of *Salmonella*.



PGL Achieved *Listeria* reductions

1.76_{log}
Reduction

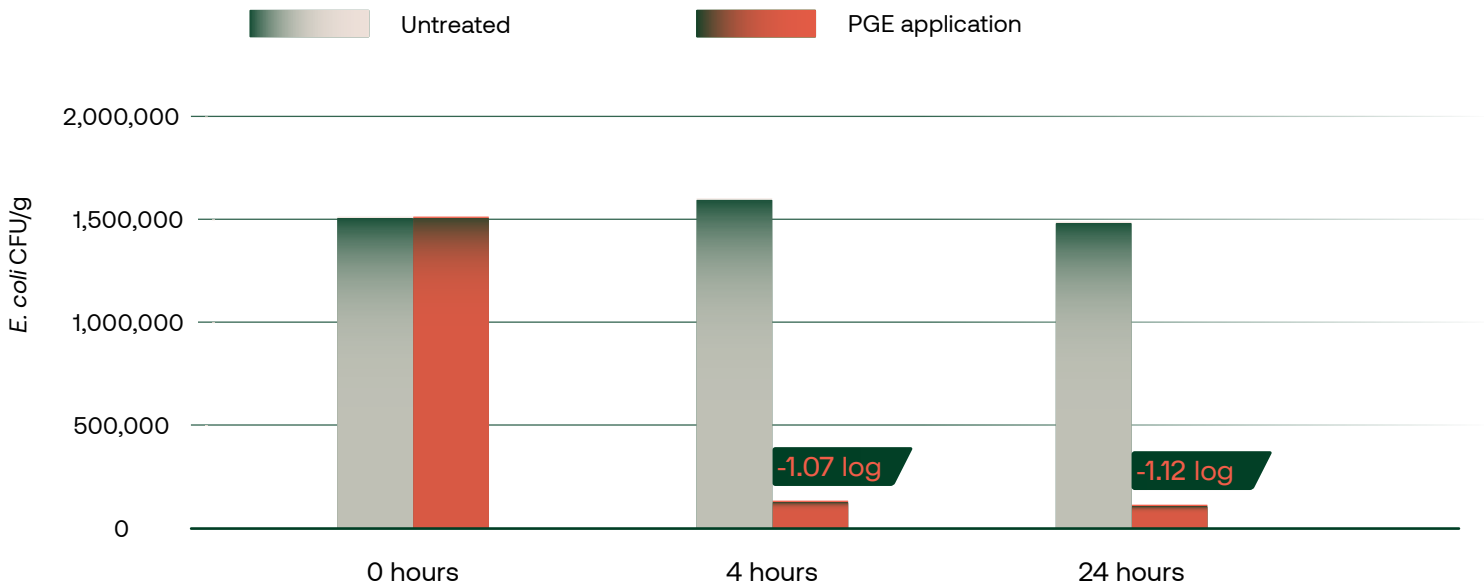
PGL applied to the raw pet food lamb formulation delivered *Listeria* reductions of 1.52 log (97%) at 4 hours post-application. After 24 hours, the total reduction increased to 1.76 log, corresponding to a 98% decrease of *Listeria*.



PGE Achieved *E. coli* reductions

1.12_{log}
Reduction

PGE applied to the raw pet food lamb formulation delivered *E. coli* O157 reductions of 1.07 log (91%) at 4 hours post-application. After 24 hours, the total reduction increased to 1.12 log, corresponding to a 92% decrease of *E. coli*.



Collaborations

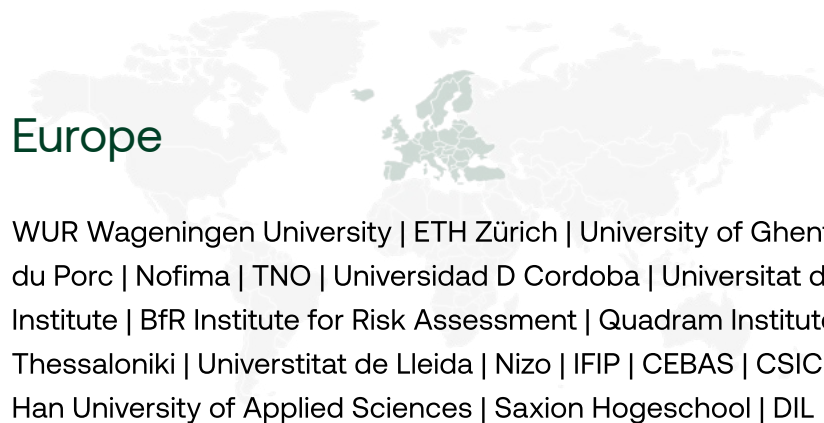
Collaborations with universities and research institutes

Phageguard has collaborated with numerous universities and research institutes to build a strong scientific foundation supporting our applied phage technology for controlling food pathogens. Published studies over the years demonstrate its effectiveness, versatile application across various food products, and compatibility with other food safety interventions in multi-hurdle approaches commonly used in industry.



The Americas

University of Nevada | Mississippi State University | California Polytechnic State University | Cornell University | University of Connecticut | University of Maryland | University of Wisconsin-Madison | Oregon State University | Food Science Institute | McMaster University | Aemtek | Instituto Tecnológico de Querétaro | Universidade Federal da Bahia



Europe

WUR Wageningen University | ETH Zürich | University of Ghent | Utrecht University | Institut Pasteur | Institut du Porc | Nofima | TNO | Universidad D Cordoba | Universitat de Lleida | Radboud University | Max Ruber Institute | BfR Institute for Risk Assessment | Quadram Institute | Food Valley | Aristotle University of Thessaloniki | Universtiat de Lleida | Nizo | IFIP | CEBAS | CSIC | ISS | RCT Gelderland | Oost NL | Han University of Applied Sciences | Saxion Hogeschool | DIL | KU Leuven

Compliance

Trusted by government institutes around the globe

PGS

Anti *Salmonella* phage solution

USA, FDA GRAS (GRN 468) - 2013

USA, USDA approved processing aid (Directive 7120.1) - 2016

Canada, Health Canada: Processing aid – 2016

Australia / New Zealand, FSANZ: Processing aid – 2012

India, FSSI: food contact surfaces and processing aid - 2021

Chile, Undersecretary of Public Health (MINSAL) (ORD. B34/N794) - 2022

Vietnam, HCMC Food Safety Department - 2025

Dubai, DM Food Safety Department - 2025

Costa Rica, Ministry of Health of the Government of Costa Rica - 2026

PGL

Anti *Listeria* phage solution

USA, FDA GRAS (GRN 218) - 2006

USA, USDA approved processing aid (Directive 7120.1) - 2007

Canada, Health Canada: Processing aid – 2011

Australia / New Zealand, FSANZ: Processing aid – 2012

Israel, Food Control Services Ministry of Health: Approved processing aid – 2014

Chile, Undersecretary of Public Health (MINSAL) (ORD. B34/N794) - 2022

Dubai, DM Food Safety Department - 2025

Costa Rica, Ministry of Health of the Government of Costa Rica - 2026

PGE

Anti *E. coli* phage solution

USA, FDA GRAS (GRN 757) – 2018

USA, USDA approved processing aid (Directive 7120.1) – 2018

Canada, Health Canada: Processing aid - 2019

Dubai, DM Food Safety Department - 2025

Costa Rica, Ministry of Health of the Government of Costa Rica - 2026

Partner of the industry

From lab bench to solving food safety challenges throughout the food chain

With a continuous focus on collaboration, multiple R&D projects have led to successful applications of our phage solutions. We take pride in how our team, together with industry partners, contributes to the development of applied phage technology to overcome food safety challenges throughout the food industry.

PGS Industrial implementations - *Salmonella* control

Poultry

Meat

Seafood

Raw pet food

Dairy

Production surfaces

PGL Industrial implementations - *Listeria* control

Seafood

Dairy

Ready-to-eat

Raw pet food

Vegetables

Production surfaces

PGE Industrial implementations - *E. coli* O157 control

Preharvest animal hides

Meat

Raw pet food

Applied phage technology to control food pathogens



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