

PhageGuard S reduces *Salmonella* on fresh poultry

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Smart

- PhageGuard S applied on fresh poultry, can reduce *Salmonella* up to 2 logs and can outperform chemicals such as PAA.
- PhageGuard S kills all *Salmonella* serovars including those that are antibiotic resistant and USDA's top 20 most virulent.

Green

- Phages are the most abundant microorganism on the planet
- As the natural enemy of bacteria, phages kill pathogens including *Salmonella*.
- Does not require labeling and can be applied in organic foods.
- No worker safety risk

Easy

PhageGuard S can be applied using various methods

- On line dipping / immersion / spray
- Spray into a final package
- Spray onto product prior to grinding

Phage has no effect on taste, color or smell of the final product

Salmonella on fresh poultry

According to the Centers for Disease Control and Prevention (CDC), it is estimated that *Salmonella* causes one million illnesses, 19,000 hospitalizations, and 380 deaths every year in the U.S. (CDC, 2016), whereas from 2000 to 2008, *Salmonella* was the leading foodborne pathogen causing the largest number of deaths (CDC, 2012). Due to this significant public health concern, the U.S. Department of Agriculture's (USDA) Food Safety and Inspection Service (FSIS) released the *Salmonella* Action Plan, a combination of comprehensive strategies to improve robust food safety systems to reduce *Salmonella* contamination in meat and poultry products (USDA-FSIS, 2013).

Even though food companies in North America have a large number of chemical interventions in place to eradicate *Salmonella* it continues to be a major cause for foodborne illnesses. Recently FSIS began on line posting of individual establishments' category status for *Salmonella* performance standards for poultry carcasses, with parts standards soon to follow. This increases pressure on industry to meet or exceed USDA's published standards. In addition, and from another direction, industry is beginning to feel pressure by workers and inspectors related to health hazards associated with the use of harsh chemicals, especially peracetic acid. Combined, these pressures along with providing safe food to consumers highlights the importance of finding new and innovative approaches to reduce or eliminate *Salmonella* in fresh meats. PhageGuard S is an antimicrobial intervention which provides a natural and organic solution that kills *Salmonella*. PhageGuard S is tasteless and odorless, it has no impact on the organoleptic properties of the treated product and there is no risk in regard to workers safety. By applying PhageGuard S on fresh meat pre-grinding or pre-packaging, *Salmonella* is reduced by up to 99%. PhageGuard S is an effective anti-*Salmonella* hurdle during processing of fresh meats, leading to safer products.

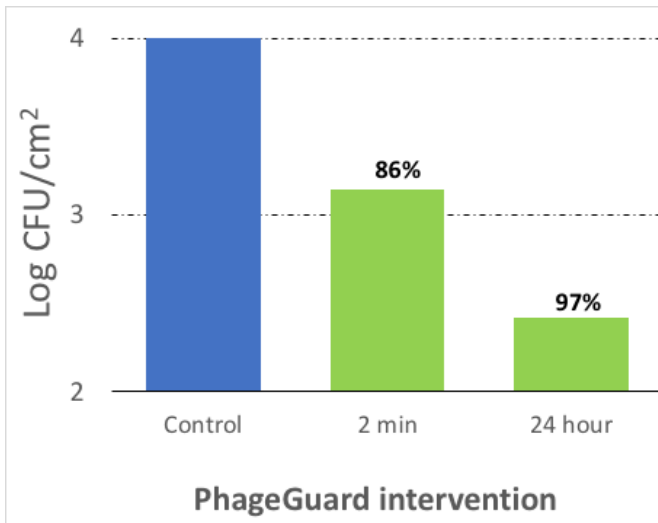


Figure 1. PhageGuard S on Skin-on, Bone-in Chicken thighs reduces *Salmonella* contamination.

Skin-on, Bone-in chicken thighs were contaminated with *Salmonella enterica* and then treated with 1% PhageGuard S at 5C. Efficacy is within minutes and increases over time up to 24 hrs.

Certified Labs June 2014

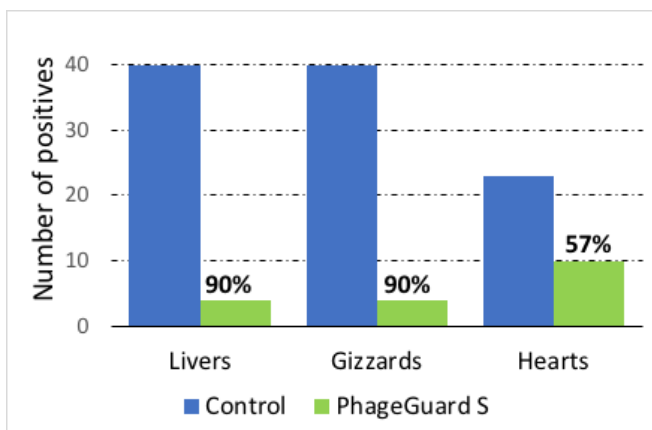


Figure 2. PhageGuard S reduces *Salmonella* on naturally contaminated giblets

Naturally contaminated Livers and Gizzards were treated with 1% PhageGuard S or tap water (control) at 4C and subsequently crust frozen for 24 hours. The samples were rinsed and tested following the USDA method. Lab work shows a 1.3 log reduction on livers and a 1 log reduction on hearts.

Plant data 2017

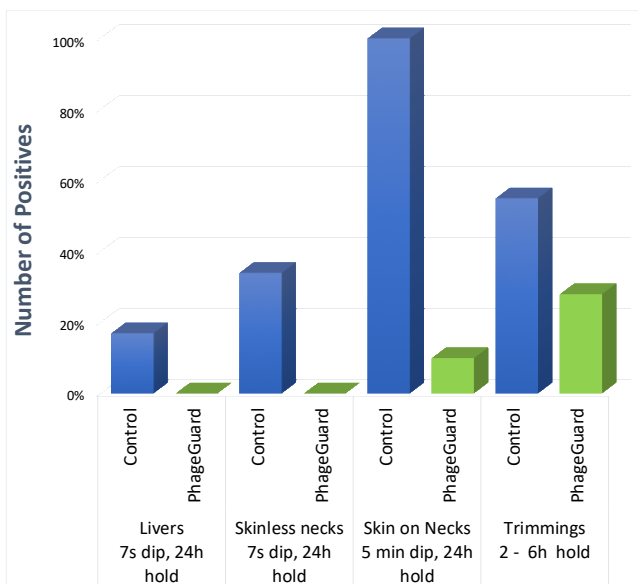


Figure 3. PhageGuard S on various fresh poultry parts

PhageGuard efficacy has been proven in various plant trials. The number of *Salmonella* positives reduced significantly. Number of positives for livers came down from 17% to zero; skinless necks from 34% to zero; skin on necks from 100% to 10%. For trimmings the number of positives was reduced by approximately 50%.

Plant data 2016

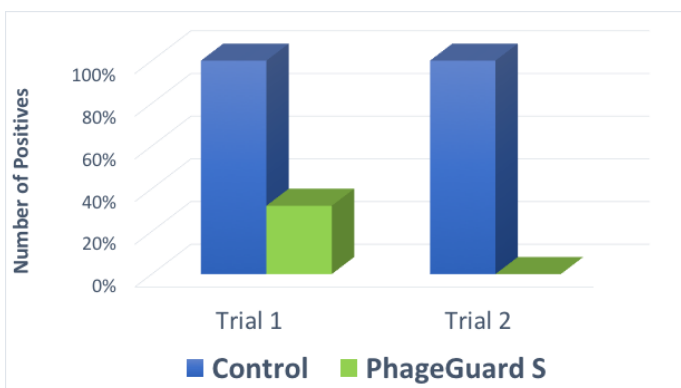


Figure 4. PhageGuard S reduces *Salmonella* on naturally contaminated turkey backs

Turkey backs were processed through a commercially available auger system in a 4% PhageGuard S concentration and immediately ground in a POSS system. All chemical interventions had no effect while PhageGuard S reduced the number of positives up to 100%.

Plant data 2017

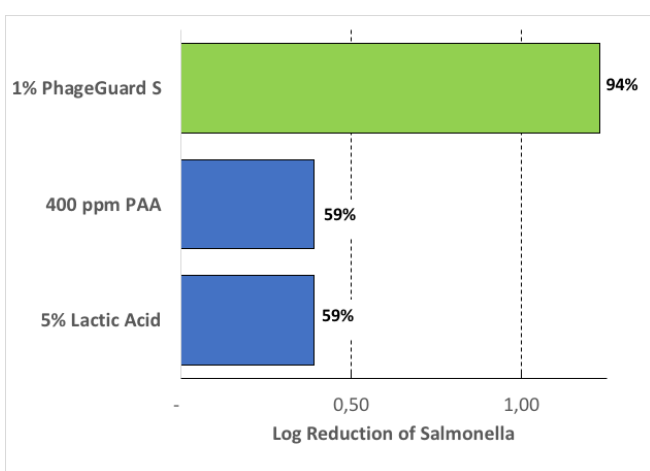


Figure 5. PhageGuard S outperforms PAA and Lactic Acid on beef trimmings pre-grinding

Organic acids including lactic and peracetic have a limited effect on reduction of *Salmonella* in ground meat. To our knowledge no comparison studies have been conducted benchmarking phage intervention against chemical treatments.

Yeh et al from the University of Nevada published a paper in Meat Science where the effect of PhageGuard S on beef trimmings was compared with 400 ppm PAA and 5 % LA.

A 1% Phage solution applied pre-grinding gave more than 1 log reduction (94%), where both chemicals gave less than 0.4 log or 59% reduction.

Where to use PhageGuard S in the production process

PhageGuard can be used at various points during the manufacturing process from post scald through debone, by either a spray or dip. Phages work instantly, typically show >1 log kill within 20 minutes and a 1.5 - 2 log kill in 6 hours.

PhageGuard-S can be applied using various methods

- On line dipping / immersion
- On line spray – be it hydraulic or electrostatic spray
- Spray product prior to a holding period, such as when filling a tote
- Spray into a final package
- Spray onto product prior to grinding

How to use PhageGuard S

We work closely with our customers and equipment suppliers to determine optimal application solutions.

- PhageGuard S is effective in solution between 32-90F (+0°C and 35°C). Phage Guard S is diluted with tap water prior to application. Free chlorine should be < 1 ppm.
- Phages cannot be used directly in combination with harsh chemicals such as PAA, Lactic Acid, Chlorine and Bromine. As these chemicals react away quickly, PhageGuard can be used as an additional intervention, ideally use phage treatment as the final intervention
- Is most effective when used on the smallest surface area/weight possible. As example: spray trim before grinding
- PhageGuard S has a dose response, the higher the concentration, the higher the level of kill
- At a 1% concentration results from various internal and external trials show reductions ranging from 1-2 log

Detection & Validation

- The concentration of phages in a PhageGuard S solution can be measured easily on a production line via a handheld conductivity meter, or alternatively by using a double agar overlay (DLA) method in a micro lab.

PhageGuard S

PhageGuard S is supplied in 100ml and 1 liter bottles at a concentration of 2×10^{11} phages per ml. Larger volume packaging is available.

Regulatory

PhageGuard S is for both USDA and FDA GRAS. Processing aid approvals for USDA appear in 7120.1. It is further accepted as a processing aid in Canada, Australia, Israel and others. It is OMRI listed (organic), Halal and Kosher

Conclusions



www.PhageGuard.com

PhageGuard S reduces *Salmonella* up to 2 log on various types of fresh poultry meats and beef

- > 0.5 log reduction within minutes and 1 - 2 log reduction after up to 24 hours
- PhageGuard S outperforms common chemicals used in the industry
- Ideal when harsh chemicals cannot be used

For more information regarding this application data bulletin please use the following contact information.

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