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Efficacy of a Commercial Phage Cocktail in Reducing Salmonella Contamination on Poultry Products- Laboratory Data and Industrial Trial Data

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Objectives

We endeavored to test the efficacy of 2 phages that show an extremely broad host range in in vitro studies on poultry products using a) artificial contamination studies and b) by assessing their usefulness in factory settings with naturally contaminated products.

Materials and Methods

The commercial *Salmonella* phage product PhageGuard S was used in these experiments. For the artificial contamination, poultry products (skin-on and skinless) were purchased from local stores. A streptomycin resistant *Salmonella*. Enteritidis strain was used to contaminate both products with $\sim 10^4$ CFU/cm². Phage was applied at 1 and 2×10^7 pfu/cm² after 30 min. Bacteria were retrieved from treated and control samples after 24, 48, and 144 h. Duplicate samples were used and experiments were repeated twice. After stomaching dilutions were spread on *Salmonella* selective agar plates supplemented with streptomycin to further reduce background flora. In the tests in industrial trials phages were applied by dipping the products in phage solutions containing 1 to 4% of the phage product resulting in similar numbers of phages as used in the artificial contamination studies. All food products were tested twice. Experiments were performed off-line allowing comparison with regular non-treated product. In these trials absence/presence in a given sample was recorded using the detection methods preferred by the respective establishment. Different poultry producers were involved in the trials which were performed on-site. In short chicken livers, necks and breasts as well as turkey backs were treated and absence/presence

of *Salmonella* was established according to the establishments (USDA-approved) testing method and compared to an equal number of untreated control samples (180, 120, 450, and 74 tested samples in total respectively).

Results

Both on skinless and skin-on poultry products phage application resulted in > 1 log reductions for both phage concentrations used. The reduction in cells did not increase after 24 h indicating that phage are active for a short period of time. In the industrial trials 19/90 untreated chicken liver samples were positive (21%) whereas in the treated group 1/90 samples was ($\sim 1\%$). 50/60 untreated neck samples were found to be positive (83%) whereas in the treated samples 21 were positive. In the chicken breast trial 49% of the control samples (94/190) were positive and 13% of treated samples were (33/260). For the turkey backs all 37 control samples were positive whereas only 8 on the treated samples were. This translates in reduction of positive samples by 94, 58, 80, and 88%, respectively. Analysis using Fischers' exact test shows that the differences are statistically significant.

Conclusion

The results from the artificial contamination experiments show that phage can significantly reduce Salmonella on poultry products. The results from the industry trials show that this translates into meaningful reductions in real life and that phages offer a valuable new tool to enhance food safety.