

Dairy Industry: Controlling *Listeria monocytogenes* & *Salmonella* in Food Processing using Phage technology

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Abstract

Phages are the most abundant microorganisms in the world and are used for targeted bacterial control in food processing. Phages can effectively be applied as surface intervention against *Listeria* in ready to eat food production and as post harvest intervention against *Salmonella* on fresh poultry. Critical success factors to effectively apply phages in food processing environments are distribution over the food surface, the concentration and the contact time. Food processors can apply phage by spraying or dipping on the surface of food products, on food contact surfaces like slicers and belts, or as part of the sanitation regime combatting biofilms. Phage kills pathogenic bacteria up to 99.9% on food products. *Listeria* contamination is typically found on the outside of food products. Phages are very specific, *Listeria* phages only kill the *Listeria* genus. Therefore, phage technology cannot mask bad hygiene, nor will it interfere with starter cultures in cheese making. Phages are considered a processing aid, hence no labeling is required, and there is no effect on the colour, texture or taste. *Salmonella* continues to be a major cause for foodborne illnesses, despite the use of chemical interventions. 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, 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. Phage technology is a natural and organic antimicrobial intervention that kills *Salmonella* with no impact on workers safety leading to safer products.

From leaves of lettuce and cheddar cheese in a Cobb salad to frozen pre-cooked meals, the foods we eat remain under constant threat of contamination by microbial pathogens, which can subsequently be transmitted to the consumer. Recently, the Foodborne Disease Burden Epidemiology Reference Group (FERG) was established by the World

Health Organization to monitor foodborne illness across the world. monitored the 31 foodborne pathogens that caused the highest morbidity and mortality in humans. In their most recent estimate of the global burden of foodborne illness, approximated that 600 million foodborne infections occurred in 2010, resulting in over 400,000 deaths. Of the top five microorganisms causing foodborne illness, four were bacteria: *Escherichia coli* (~111 million), *Campylobacter* spp. (~96 million), non-typhoid *Salmonella enterica* (~78 million), and *Shigella* spp. (~51 million), with estimates for the number of foodborne-related deaths caused by these bacteria ranging from ~15,000 for *Shigella* spp. to ~63,000 for *E. coli* [1]. Strikingly, children under five years old were disproportionately impacted; they account for 40% of deaths while representing just 9% of the world population [1]. These foodborne illnesses are also a tremendous drain on the economy of nations; for example, in the United States the average incident is estimated to cost ~\$1500/person, with the total annual estimated cost of these foodborne diseases reaching over \$75 billion [2].

Several approaches are used to help improve the safety of our foods. Heat pasteurization is commonly used to reduce bacterial numbers in liquids and dairy items, most notably milk. However, pasteurization is not suitable for many fresh food items, as the process results in the items being cooked. Another method used to reduce pathogens in foods is High Pressure Processing (HPP) which exposes foods to high pressure to inactivate microbes. This technique has been successfully used on liquid products and pre-cooked meals, meant to be frozen; however, as with heat pasteurization, it is generally not used with fresh meats and produce, as it can affect the appearance (color) and/or nutritional content of these products.

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