COMMENTARY

Microbiological evaluation of broiler mash heat treatment at a laboratory scale to measure Salmonella decrease during feed conditioning

Caroline Thomas

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ABSTRACT

Salmonella is the bacteria most commonly linked to feed and dry food contamination, and it is the source of numerous foodborne outbreaks. Conditioning and retention systems are implemented in most feed mills to optimize the pelleting process as well as serve as a kill step to minimize the microbial load of the feed grain. A study was conducted to investigate the inactivation kinetics of Salmonella spp. in broiler feed treated with superheated steam on laboratory scale since knowledge regarding the efficacy of this kill-step at varied process parameters in specific feed matrices is sparse. A literature analysis was used to identify Salmonella strains often linked with feed ingredients. After screening five Salmonella strains for heat resistance, Salmonella Agona was chosen as one of the most heat-resistant serotypes. After screening three strains of this serotype, S. Agona RA1052 (isolated from animal feed) was chosen as the best suited strain for determining D- and z-values in broiler feed at various moisture levels and temperatures. The D-values for S. Agona strain RA1052 in broiler feed mash adjusted to 12% moisture were 178.2 s and 3.1 s, respectively, were measured in a modified autoclave at 65°C and 85°C. D-values with 19 percent moisture were 81.1 seconds at 65°C and 0.7 seconds at 85°C. The surrogate Enterococcus faecium ATCC 8459 (NRRL B-2354) with an equal heat resistance to S. Agona RA1052 was used for on-site challenge experiments. The information gathered will be used to validate conditioning and retention as a Salmonella spp. kill step in pilot and industrial scale studies.

Key Words: *Salmonella; Microbiology*

INTRODUCTION

Salmonella contamination of produced animal feeds and its constituents has been observed in several investigations. According to Li et al. (2012), the incidence of Salmonella in several categories of animal feeds was 9.4% in complete feeds, 19.4% in feed components, 7.1 percent in pet supplements, and 6.1 percent in pet foods/treats between 2007 and 2009. Between September 2017 and August 2018, there were 114 international notifications regarding Salmonella-contaminated feed. There has been a greater awareness of disease transmission from animal feed to people since the outbreak of bovine spongiform encephalopathy. Feed contamination introduces a pathogen into the food supply chain, posing a risk of human foodborne illness. Numerous foodborne outbreaks of salmonellosis may be linked back to contaminated animal feed, as documented by Crump et al. (2002), emphasizing the necessity for proven control methods. In addition, since 2016, a large number of human salmonellosis cases have been reported. According to a recent estimate, about 95,000 instances were recorded in Europe in 2016. There has been a rise in the proportion of diseases caused by S. Enteritidis. This Salmonella serotype has been linked to laying hens, broilers, and chicken meat in particular. It should also be emphasized that Salmonella in eggs was the source of the most outbreaks (1,882). The prevention of Salmonella introduction, presence, and proliferation in the manufacturing processes are now used to manage Salmonella in animal feed. Raw material management, well-designed equipment in compliance with sanitary design criteria, and regular inspection and cleaning of the most essential places in terms of contamination control are examples of these procedures. Because raw material contamination cannot be ruled out, a kill-step is required to assure safe feed, where a chemical and/or heat treatment can be used. A detailed validation procedure is required to demonstrate the success of such a step.

Chemicals, which are the primary means of controlling Salmonella, are becoming more limited as a result of the health risks to employees. Thermal treatment of feed is a safe option that is already used in feed mills as part of the pelleting process. Existing technologies may be leveraged to decrease feed safety concerns and chemical consumption by assuring feed safety through focused processing. The greatest effect in terms of microbial inactivation is likely to occur during conditioning and retentioning (30–240 s) during feed processing, while the residence duration is substantially less during pelleting. Superheated steam is added to the input material to condition it, providing heat and moisture to the system. The feed material is then blended and delivered to the retentioner, where the temperature of the product is maintained for a set period of time to guarantee even heat and moisture distribution. The process temperature ranges from 60°C to 90°C, with a retention period of 30–240 seconds and a moisture content of 12–22 percent at a water activity of 0.7–0.9. These process variables are also the ones that have a direct impact on microbial inactivation. Furthermore, various additional elements such as the organism's condition and matrix qualities such as particle size, acidity, fat content, and the presence of solutes have a substantial impact on the antimicrobial action during heat treatment.

In addition to the wide range of raw materials and recipes, as well as the possibility of recontamination, the low moisture content of feed makes microbial inactivation by heat treatment difficult. Salmonella heat resistance in low moisture meals has been shown to be greatly higher when compared to heat resistance in moist settings. When opposed to high moisture conditions, which may cause severe damage to nutrients in the feed, dry conditions require substantially higher temperatures and longer heating durations to produce the same antibacterial effect. In industrial processing, the influence of water activity on microbial inactivation has not been explored yet. Reduced water activity is thought to be the most important factor influencing increased heat resistance. Murrell and Scott (1966) found that the heat resistance of many bacterial spores rises when water activity decreases. Several investigations employing various strains and materials have been reported, demonstrating that low product water activity protects against heat inactivation. Despite the constraints of thermal treatment of feed, there is a significant potential for its use since it may be used to assure Salmonella inactivation using existing infrastructure and process technologies. Some earlier research has focused on naturally existing microflora in samples obtained at various stages of the manufacturing process, from raw material input through load-out. Direct comparison of samples is unsatisfactory due to the inhomogeneous distribution and varied species makeup of naturally existing flora. Furthermore, reliable results cannot be formed when only natural microflora is examined, because the features of microorganisms (e.g., heat resistance) are unknown. Systematic validation studies, including

Editorial Office, Journal of Clinical Microbiology and Infectious Disease, Windsor, United Kingdom

Correspondence: Caroline Thomas, Editorial Office, Journal of Clinical Biology and Infectious Disease, Windsor, United Kingdom, E-mail clinicalmicro@scienceresearchpub.org

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measurement of laboratory, pilot, and industrial scale inactivation rates in various matrices, are required to achieve a reliable kill-step by heat processing. According to the Grocery Manufacturers Association's criteria for "Validating the reduction of Salmonella and other pathogens in heat processed low-moisture foods", a research was conducted with the goal of validating the kill-step during animal feed conditioning. A literature review helped to identify potential target species. To discover which strains of each serotype were the most heat resistant in chicken feed mash treated with superheated steam, a laboratory-based screening research was undertaken utilizing strains of each serotype identified. D- and z-values for this strain were determined in a broiler feed matrix in the laboratory at various temperatures and moisture levels. Furthermore, a surrogate was chosen for additional validation experiments at the pilot and industrial scales.

CONCLUSION

Controlling Salmonella in feed by targeted processing and preventing recontamination after heat treatment would help to considerably minimize the risk associated with this infection. The current research is one of the first to determine the best Salmonella strains for dry feed materials, as well as fundamental D- and z-values for Salmonella inactivation in chicken feed. The data obtained demonstrates the impact of moisture content on inactivation, establishes a foundation for validation investigations, and defines an acceptable surrogate for use in industrial scale validations. This research may be used to upscaling kill-step validation testing to pilot and industrial scales. The impact of varied compositions and granulations on inactivation kinetics must also be evaluated during industrial validation. For the validation research, the worst-case scenario in terms of composition and particle size is proposed. To assure Salmonella control in feed by targeted processing, inactivation studies on an industrial scale or the capacity to reliably transfer results to an industrial scale are required.