RESEARCH IN PROCESS

Validating a Physically Heat-Treated Process for Poultry Litter in Industry Settings Using the Avirulent *Salmonella* Surrogates or Indicator Microorganisms

SUMMARY

Poultry litter has great value as a soil amendment and organic fertilizer for agricultural production. Physical heat treatment is considered one of the most effective methods to reduce or eliminate potential pathogens, such as *Salmonella* spp., in poultry litter. Due to biosafety concerns, it is not feasible to validate thermal processes with pathogenic bacteria in a poultry litter processing facility. One approach for estimating pathogen survival in a processing environment is to monitor the behavior of avirulent *Salmonella* surrogates or indigenous microflora as indicator microorganisms. In this study, potential indigenous indicator microorganisms, including enterococci and total aerobic bacteria, were selected for validating desiccation-adapted *Salmonella* reduction in physically heat-treated poultry litter. Major parameters, including temperature, moisture content, and type of poultry litter, were examined. Our results demonstrated that indigenous enterococci may be used to validate the thermal processing of broiler litter as they accurately mimic the survival behavior of desiccation-adapted *Salmonella* Senftenberg during heat treatment at both 75 and 85°C (R^2 = 0.87~0.98).

OBJECTIVES

Objective 1: Selection of avirulent *Salmonella* surrogates and indicator microorganisms for process validation of physically heat-treated poultry litter

Objective 2: Validating the thermal process for physically heat-treated poultry litter in industrial settings of both turkey litter and chicken litter processing plants using *Salmonella* surrogates and/or indicator microorganisms

METHODS

Objective 1: Aged broiler litter with 20, 30, 40, and 50% moisture contents was inoculated with desiccation-adapted *Salmonella* Senftenberg (ca. 10^7 log cfu/g) and then heat treated at 75 and 85°C for 3 h. *S.* Senftenberg was desiccation-adapted in broiler litter for 24 h prior to heat treatment. The surviving populations of *S.* Senftenberg, indigenous enterococci, and total aerobic bacteria were enumerated using TSA overlaid with XLT-4, BEA, and TSA, respectively.

Objective 2: To determine the residence time for the poultry litter inside the industrial dryer in our pilot-scale study, four colors (red, blue, violet, and yellow) of MicroTracers® were evaluated by mixing with poultry litter first, followed by magnetic separation and then color development by a developing solution.

BENEFITS TO THE INDUSTRY

Physically heat-treated poultry litter is commonly used as biological soil amendment or organic fertilizer by both organic and conventional farms; however, there is very limited research on the microbiological safety of these products as the raw poultry litter may be contaminated with human pathogens such as *Salmonella* spp. In this study, our results clearly demonstrated that indigenous enterococci can be used to predict and mimic the survival behavior of the most heat resistant *Salmonella* (due to desiccation adaption) during thermal processing of poultry litter. Therefore, it is feasible to develop a validation strategy to monitor the effectiveness of thermal processes, without introducing pathogens into the industrial environment. Moreover, thermal inactivation data from this study will assist poultry litter processors in designing some effective processing time-temperature regimes to ensure the microbiological safety of physically heat-treated poultry litter.

RESULTS TO DATE

There were rapid reductions in the populations of both desiccation-adapted *S.* Senftenberg and indigenous indicator microorganisms in all broiler litter samples during heat treatment at 75 and 85°C. (Figure 1 – broiler litter with 20 and 30% moisture contents at 85°C)

Microbial cells were inactivated much faster when temperature and moisture content of broiler litter increased ($P < 0.05$).

Compared to total aerobic bacteria, there were better correlations between mean log reductions of desiccation-adapted *S.* Senftenberg and indigenous enterococci in broiler litter samples with 20, 30, 40, and 50% moisture contents at 75°C, and 20, 30, and 40% moisture contents at 85°C (Table 1).

Based on our preliminary study, red, blue, and violet MicroTracers® can be used for pilot study, since they developed colors that can be readily differentiated from the background color of poultry litter (Figure 2).

Table 1. Regression correlations between the mean log reductions of desiccation-adapted *S.* Senftenberg and indigenous enterococci or total aerobic bacteria in aged broiler litter with 20, 30, 40, and 50% moisture contents at 75 and 85°C

Temperature (°C)	Microorganism	Correlation (R^2) with moisture content (%)			
		20	30	40	50
75	Enterococci	0.91	0.91	0.93	0.94
	Total aerobic bacteria	0.84	0.75	0.62	0.86
85	Enterococci	0.98	0.87	0.98	N.A.[b]
	Total aerobic bacteria	0.91	0.80	0.91	N.A.

[a]Population data during come-up time was used.
[b]N.A., not applicable.

Figure 1. Survival of desiccation-adapted S. Senftenberg, indigenous enterococci, and total aerobic bacteria in aged broiler litter with (A) 20 and (B) 30% moisture contents at 85°C.

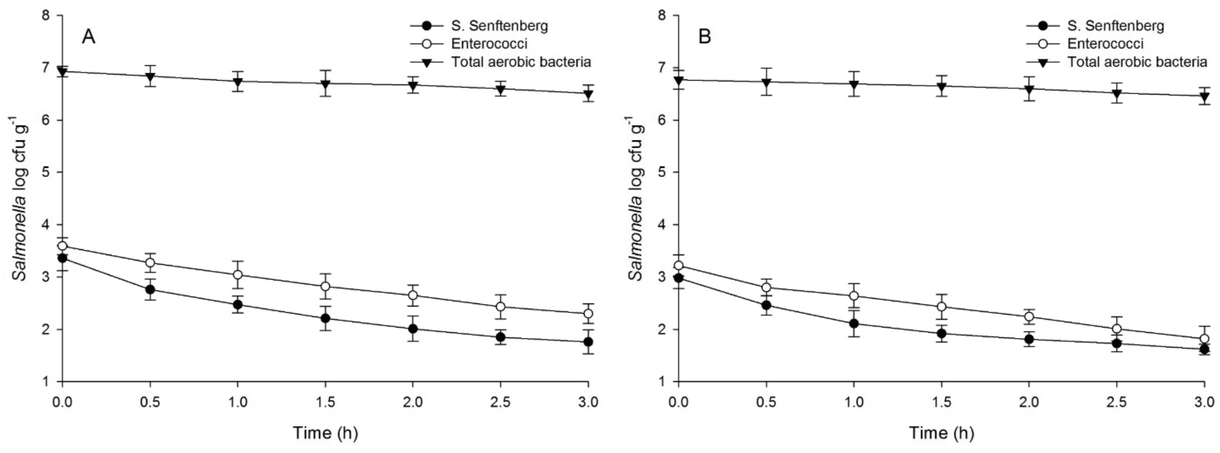

Figure 2. Developed colors on filter papers using color-coded MicroTracers (From left to right: Red, Blue, Violet, Yellow)

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