IN-PLANT VALIDATION STUDY OF HARVEST PROCESS CONTROLS IN TWO BEEF PROCESSING PLANTS IN HONDURAS

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Abstract – The objective of this study was to validate the beef harvest HACCP and food safety programs of two beef processing plants in Honduras operating under United States (US) Equivalency standards by evaluating the presence of *Salmonella* and Shiga toxin-producing *Escherichia coli* (STEC) on hides, their transfer from hide to carcass detected by pre-evisceration sampling, the mitigation of transferred pathogens by 2.5% lactic acid intervention and *Salmonella* prevalence in lymph nodes. In plant A, prevalence of *Salmonella* on hides (n=30/687; 4.4%) was significantly higher (*p<0.05*) than on carcasses swabbed at pre-evisceration (n=7/687; 1.0%) and post-intervention (n=13/678; 1.9%), and in lymph nodes (n=14/691; 2.0%). No significant difference in pathogen prevalence among the last three processing sites was found (*p* = 0.2751). In plant B, STEC prevalence on hides (n= 21/85; 24.7%) was higher (*p* < 0.05) than in carcasses at pre-evisceration (n=3/85; 3.5%) and post-intervention (n=1/85; 1.2%). Pathogen prevalence did not differ (*p* = 0.306) between carcasses in pre-evisceration and post-intervention but the initial presence was very low. The country equivalence was determined for both Honduran plants upon due validation of their respective harvest process controls.

I. INTRODUCTION

In 2016, beef and veal imports to the US totaled 1.5 million tons coming from 93 different countries [1]. Imported meat can become a food safety hazard if proper food safety programs are not fully implemented in foreign meat processing plants. Thus, exporting countries' food safety inspection systems must be equivalent to the US federal inspection system for becoming eligible to export meat to the USA [2]. As US beef imports from Honduras have rapidly resumed in recent years, 960.5 tons between 2016 to 2017 [1], there is an increased interest for country equivalency from Honduran plants. This study pursues the validation of harvest process controls in place by the two largest Honduran beef processing plants for supporting determination of US equivalency. Hence, the objective of the study was to validate the beef harvest HACCP and food safety programs implemented at these two facilities by assessing the transfer of *Salmonella* spp. and STECs from hide to carcass and the effective reduction of transferred pathogens after lactic acid anti-microbial intervention.

II. MATERIALS AND METHODS

The validation process was performed in the two largest Honduran beef processing plants. Swab samples of hides, carcasses (in pre-evisceration and post- intervention), and subiliac lymph nodes were taken. Samples were placed into coolers and transported to the Texas Tech food microbiology laboratory for microbiological analyses. Samples underwent detection and isolation protocols for STECs and *Salmonella,* according to USDA's Microbiology Laboratory Guide [3][4]. Prevalence data of STECs began to be recorded in 2017. Samples underwent BAX screening for STEC and *Salmonella* spp. Potential positive samples were subjected to immunomagnetic separation for pathogen isolation. The resulting cell suspension was plated onto selective media, and presumptive positive colonies were confirmed through latex agglutination. Molecular confirmation of isolated cells was not performed. The R(v3.3.4) statistical package was used to perform a chi square comparison and odd ratios of pathogens' presence among chosen sampling sites.

III. RESULTS AND DISCUSSION

In plant A, presence of *Salmonella* was evaluated during a three-year period (2015-2017). Presence of *Salmonella* varied by sampling site and sample date (Table 1).

Table 1. Prevalence of *Salmonella spp*. in hides, on carcasses in pre-evisceration and post-intervention, and in lymph nodes on different sampling dates at plant A.

Sampling Time	Hides	Carcasses at Pre-evisceration	Carcasses at Post-intervention	Lymph nodes
Feb-15	2.9% (1/34)	2.9% (1/34)	5.9% (2/34)	20.6% (7/34)

Apr-15	5.6% (7/125)	4.0% (5/125)	6.0% (7/116)	0.0% (0/124)
Jun-15	17.0% (8/47)	0.0% (0/47)	4.3% (2/47)	8.5% (4/47)
Aug-15	14.3% (5/35)	0.0% (0/35)	0.0% (0/35)	0.0% (0/40)
Nov-15	4.0%(8/210)	0.0% (0/210)	0.0 % (0/210)	0.5% (1/210)
Feb-3-16	0.0%(0/39)	0.0%(0/39)	0.0%(0/39)	0.0%(0/39)
Feb-29-16	0.0%(0/38)	0.0%(0/38)	0.0%(0/38)	0.0%(0/38)
Apr-16	0.0%(0/18)	0.0%(0/18)	0.0%(0/18)	0.0%(0/18)
Aug-16	0.0%(0/78)	0.0%(0/78)	0.0%(0/78)	1.3%(1/78)
Jan-17	1.6%(1/63)	1.6%(1/63)	3.2%(2/63)	1.6%(1/63)

Chi-square analysis detected a significantly higher presence of *Salmonella* ($p < 0.05$) on hides (4.4%), than in lymph nodes (2.0%), carcasses after the microbial intervention (1.9%) and in pre-evisceration (1.0%). No significant differences were found (p=0.2751) in the prevalence of *Salmonella* when comparing lymph nodes, carcasses in pre-evisceration and post-intervention. Most of the *Salmonella* isolates from carcasses after the intervention were found in three first sampling dates February, April and June 2015. Subsequently, the improvement of sanitary conditions and the application of effective concentrations of lactic acid for the intervention (2.5%) resulted in the reduction of the *Salmonella* prevalence in carcasses in pre-evisceration and post-intervention.

In plant B, *Salmonella* was not detected in hide samples. Because pathogen prevalence in hides is used as a baseline for pathogen transfer during harvest, *Salmonella* data could not be used for validation of the harvest HACCP plan in this plant. Conversely, STECs were found in hides sampled at this facility. Chi square analysis detected a higher prevalence of STECs in hides (24.7%), as compared to that found in carcasses in pre-evisceration (3.5%) and post-intervention (1.2%). No differences in STECs prevalence (p=0.306) was observed between carcass samples taken in pre-evisceration and post-intervention. Mitigation in hide-to-carcass pathogen transfer could be clearly assessed in this study. Process controls implemented at the harvest floor effectively reduced pathogen prevalence in the sampled beef carcasses.

IV. CONCLUSION

Salmonella spp. and STEC prevalence in beef carcasses can be mitigated by process controls implemented in Honduran plants. Overall sanitary conditions, good manufacturing practices and HACCP interventions on the harvest floor, effectively control and reduce pathogen prevalence on processed beef carcasses. Hide-to-carcass pathogen transfer is significantly mitigated and the resulting pathogen prevalence in carcasses after microbial intervention with lactic acid is substantially low. Upon due validation of their harvest HACCP programs, both plants were granted their respective US equivalency for beef exporting purposes. A follow-up validation study must be conducted during the following year to demonstrate that the HACCP program is still effective for reducing pathogen prevalence in beef carcasses.

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