Approaches for Reduction of Shiga Toxin-Producing *Escherichia coli* and *Salmonella* on Hide of Cattle

Tong Zhao

Center for Food Safety, college of Agricultural and Environmental Sciences, University of Georgia, Griffin, Georgia, USA

*Corresponding author:* Tong Zhao, Center for Food Safety, college of Agricultural and Environmental Sciences, University of Georgia, Griffin, Georgia, USA, Tel: 770-228-7273; Fax: 770-229-3216; E-mail: tongzhao@uga.edu

Received date: Sep 10, 2015; Accepted date: Jan 11, 2016; Published date: Jan 14, 2016

Copyright: © 2016 Zhao T. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Isolates of Shiga toxin-producing *Escherichia coli* (STEC) were first recognized as human pathogens in 1982 when *E. coli* O157:H7 was identified as the source of two outbreaks of hemorrhagic colitis. Since then other outbreaks of STEC, such as O26, O45, O103, O104, O111, O121, and O145, also have been associated with cases of hemorrhagic colitis [1,7]. However, serotype O157:H7 still is the predominant cause of STEC-associated diseases in the United States and many other countries [2,8].

Epidemiological investigation and animal model studies have revealed that cattle are major reservoir for *E. coli* O157:H7 and other STEC [3,8,10,11]. Recent data indicated that isolation rate of *E. coli* O157:H7 in individual cattle were ranged from 5 to 20%, with enumeration rate in feces at <100 to >10⁶ CFU/g [3,8]. STEC can be excreted through feces at cell numbers of 10³ CFU/g in super-shedding cattle and survive on hides, in drinking troughs, in pens and bedding, on tools, and in the farm environment for several months. Animal hides are an important source of zoonotic pathogens which contaminate carcasses at beef slaughter.

Commercial beef processing plants currently employ several interventions (i.e., trimming, steam vacuuming, steam pasteurization, water washes, and organic acid washes) in combination to achieve great, ranging from 0 to 93% for *O157* and non-*O157* STEC; respectively [3]. However, pre-evisceration interventions (i.e., trimming, steam vacuuming, steam pasteurization, water washes, and organic acid washes) in combination to achieve effective (≥ 3 log/cm²) reduction and acetic and lactic acids at high concentrations (4 and 6%) were effective (≥ 3 log/cm²). However, chlorine, even at 400 ppm only reduced 1.3 log CFU/cm². Cattle washing studies on determination of the impact of various pre-harvest treatments (0.5% lactic acid and 50 ppm chlorine) on microbiological integrity on living animal indicated that the counts of aerobic plate counts, coliforms, *E. coli* had no statistical difference (P>0.05) between water wash groups and chemical wash groups.

A method at post-harvest stage was evaluated. Under cooperation between Water Management resources and Cargill, a hide-on-carcass wash machine, as a “car wash for cattle”, in which the hides of animals are scrubbed with spinning bristles and a mild bromine solution that kills bacteria at the beginning of the harvesting process was installed at the Fresno beef plant. This process helps better ensure removal of the dirt and debris while washing the animal’s exterior, thereby minimizing the potential for contamination from bacteria that potentially pose a health risk to humans. The cost for such a processing is high and it is fine at current high beef price. However it should have an alternative choice in case beef price may go down like oil price.

A food-grade and non-chlorine-based microbicide, containing just two chemicals, levulinic acid and sodium dodecyl sulfate, SDS was developed and thoroughly evaluated in our lab and other labs for effectively killing foodborne pathogens in poultry [12], meat [13], produce [12], and seeds; especially for removal of biofilms in processing plants [6]. This microbicide can also remove dental biofilm in vitro and is 10-fold better than *Listeria* and when applied in animal mucus for either short term or long term there were no pathological change when compared with water only [9]. Thus its safety for animal application is guaranteed.

Studies were performed to determine the efficacy of this commercial microbicide (Fit-L, HealthPro Inc.) to inactivate STEC and *Salmonella Typhimurium* on cattle hides as a surface spray treatment at different concentrations in vitro and in vivo. A mixture of six isolates of STEC, including serovars O26, O45, O103, O111, O121, and O157 (10⁷ CFU/ml) and a mixture of 5 strains of *S. Typhimurium (10⁸ CFU/ml)* were sprayed on the surface of 10 × 10 cm sections of cattle hide. The hides were treated by surface spray with this microbicide diluted at different concentrations at 45 psi for 15s. Water only was used as the negative control. For STEC-contaminated hides, 3% levulinic acid plus 0.5% SDS for 5 min reduced STEC populations by 2.3 log CFU/cm², compared to the water only treatment. For *S. Typhimurium*-contaminated hides, treatment with 2% levulinic acid plus 0.2% SDS reduced the *Salmonella* population by 3.2 log CFU/cm². Scrubbing hides with a brush processing for 30 s followed by the microbicide spray treatment further reduced *Salmonella* contamination by 0.5 log/cm². However, for wet hides, a spray treatment with 4% levulinic acid...
acid plus 2% SDS for 5 min reduced Salmonella by only 1.3log CFU/cm² when compared with the water-only treatment.

Based on the results obtained from hide studies, commercial "Fit-L" product diluted in tap water at 1:22 (v/v, 2% levulinic acid plus 0.2% SDS) was used for surface wash of live beef cattle. Results revealed the average E. coli count before washing (7 cattle with 26 samples) was 6.58log CFU ± 1.0/cm². For tap water only washed cattle (7 cattle with 28 samples) the average E. coli count was 6.0log CFU ± 1.10/cm² at 5 min and 6.06log CFU ± 1.48/cm² at 10 min. Whereas, for "Fit-L"-washed cattle (7 cattle with 28 samples) the average E. coli count was 2.6log CFU ± 0.95/cm² at 5 min and 2.25log CFU ± 0.89 CFU/cm² at 10 min. Following the "Fit-L" washing with a tap water wash resulted in 2.3log CFU E. coli ± 0.83/cm². These data revealed that a simple "Fit-L" wash could reduce E. coli population by 3.4log and 3.8log on the surface of cattle hide at 5 min and 10 min, respectively when compared with tap-water wash only. A tap water-only wash reduced E. coli by 0.5log CFU/cm² when compared with samples collected before the wash. Following "Fit-L" washing with one more tap water wash did not further reduce E. coli on the surface of cattle hides. These results suggested a simple "Fit-L" wash just before cattle entered the slaughter facility will substantially reduce the population of E. coli on cattle hides.

References