Meat Science 132 (2017) 59–71

Contents lists available at ScienceDirect

Meat Science

journal homepage: www.elsevier.com/locate/meatsci

Review

The diversity of beef safety: A global reason to strengthen our current systems

Mindy M. Brashears*, Byron D. Chaves

International Center for Food Industry Excellence, Department of Animal and Food Sciences, Texas Tech University, Lubbock, TX 79409, USA

ARTICLE INFO

Keywords:
Food safety
Meat industry
Beef
Farm-to-table

ABSTRACT

The purpose of this paper is to propose a more integrated and more aggressive system approach to food safety rather than focusing on one segment of the industry, or on one approach as described by or constrained by one set of regulations. We focus on the prevalence and control measures for *Salmonella* and pathogenic *Escherichia coli*, particularly, Shiga toxin-producing *E. coli* (STEC) in live cattle on the farm and in the final raw beef product at retail. We describe the antimicrobial and process control strategies most commonly used during slaughter and processing to prevent and reduce the frequency and concentration of these pathogens in the final product, and we propose points along the food chain where more interventions can be applied to ultimately reduce the prevalence of foodborne pathogens associated with beef and beef products, and to protect public health as well the global food supply.

1. Introduction

Over the past several decades, the meat industry around the world has made significant efforts to improve food safety. The beef industry has seen multiple advances in pathogen-reducing interventions, best practices during production and processing, and improvements in testing methods that have resulted in reduced prevalence of pathogens in beef. When an outbreak or even a product recall occurs, the endpoint confirmation is very specific – a bacterial colony observed on a petri dish that is ultimately confirmed through biochemical, serological, and genetic testing to be the culprit. However, the path that bacterium took to get into the product is very complex, and preventing the incident from re-occurring requires a more global view of our food production systems.

While it is important to identify the source of the pathogen in any outbreak or recall and any failures in process control that may lead to a contamination event, the overall control of pathogens in our beef supply must take a global farm-to-table approach. Whereas this concept is often discussed, the comparison of pathogen prevalence in cattle systems across different continents and the ultimate pathogen prevalence in the final products the corresponding locations has not been previously published.

In the beef industry, most current food safety efforts originate on the harvest floor. There is a great emphasis on good dressing procedures to prevent contamination of the carcass combined with antimicrobial interventions, when allowed by regulatory guidelines, to treat the carcass and kill any surface pathogens that may have been transferred from the hide or from the gastrointestinal tract to the carcass. This segment of the beef production chain deservingly receives the most attention in preventing food safety hazards from occurring. While the product most likely becomes contaminated at this stage, there is a need for a more comprehensive approach to controlling pathogens in beef products. Little emphasis is put on the conditions on the farm or at the feedyard where pathogen control can begin. There are even fewer interventions and process control measures in processing steps beyond the abattoir, such as fabrication and grinding. Additionally, there is little consideration given across different regulatory systems and the impact this has on the final pathogen prevalence.

The objective of this paper is to propose a more integrated and more aggressive systems approach to food safety rather than focusing on one segment of the industry or on one approach as described by or constrained by one set of regulations. A review of the origin of the pathogens on the farm as well as of the occurrence in final products will help us illustrate that control can take place across the entire beef production chain. Additionally, application of various interventions and process control methods in a specific environment in Mexico is described as an example to improve the overall final safety of beef products.

2. Presence of pathogens along the beef production chain

Production of beef begins with a live bovine animal, referred to as

* Corresponding author.
E-mail address: mindy.brashears@ttu.edu (M.M. Brashears).

http://dx.doi.org/10.1016/j.meatsci.2017.03.015
Received 16 February 2017; Received in revised form 20 March 2017; Accepted 30 March 2017
Available online 05 April 2017

Table 1
Fecal shedding of *E. coli* O157 and non-O157 STEC by beef cattle.

Source	Target	Type of sample	Sample origin	No. positive	No. samples	% positive	Location	Sampling period	Method
Alam & Zurek, 2006	O157:H7	Fecal	Feedlot	82	891	9.2	Kansas, USA	Aug. 2004–Feb. 2005	Culture/PCR
Al-Saigh et al., 2004	O157	Fecal	Healthy cattle	47	2930	1.6	Switzerland	Jan. 2002–June 2003	Culture/PCR
Baltasar, Milton, Swecker, Elvinger, & Ponder, 2014	Virulence genes	Fecal	Dams	84	90	93.3	Virginia, USA	July–Sept. 2011	Culture/PCR
Baltasar et al., 2014	*E. coli* virulence genes	Fecal	Calves	86	90	95.6	Virginia, USA	July–Sept 2011	Culture/PCR
Barham et al., 2002	O157	Fecal	Feedlot steers/ heifers	19	200	9.5	West TX, USA	April 2000	Culture
Barkocy-Gallagher et al., 2003	*stx* genes	Fecal	Beef cattle	408	1189	34.3	Midwestern USA	2001–2002	PCR
Bibbal et al., 2015	STEC	Fecal	Beef cattle	11	6901	1.6	France	Oct. 2010–June 2011	Culture/PCR
Callaway et al., 2006	O157:H7	Fecal	Feedlot	28	240	11.7	Southern Great Plains, USA	May 2004	Culture
Cerqueira, Guth, Joaquim, & Andrade, 1999	*stx* genes	Fecal	Beef cattle	40	76	53	Rio de Janeiro, Brazil	April 1996–Sept. 1997	Culture/PCR
Ezawa, Gocho, Kawata, Tahakashi, & Kikushi, 2004	O157	Fecal	Beef cattle	6	22	27.2	Hokkaido, Japan	1997–1998	Culture/PCR
Fegan, Vanderlinde, Higgs, & Desmarchelier, 2004	O157	Fecal	Beef cattle	39	310	13.0	Western/Southern Australia	NS	IMS/MPN
Karama, Johnson, Holtslander, McEwen, & Gyles, 2008	STEC	Fecal	Beef cattle	31	500	6.2	Ontario, Canada	April–Oct. 2004	PCR
Madden, Murray, & Gilmour, 2007	O157:H7	Fecal	Beef cattle	2	220	0.9	Northern Ireland	9-Month	Culture
Meichtri et al., 2004	*stx* sequences	Fecal/Rectal swabs	Beef steers	138	200	69	Across Argentina	July 1999–Dec. 2000	PCR
Milnes et al., 2008	O157	Fecal	Harvest	362	7703	4.7	UK	2003	Culture/PCR
Narvaez-Bravo et al., 2013	O157:H7	Fecal	Feedlot/Harvest	13	250	5.2	Veracruz, Mexico	2009–2010	Culture/PCR
Oporto, Esteban, Aduriz, Juste, & Hurtado, 2008	O157:H7	Fecal	Cattle hers	0	106	0	Northern Spain	Oct. 2003–May 2005	PCR
Renter et al., 2005	*stx* genes	Fecal	Cattle operations	431	1565	27.5	Nebraska, USA	11 months	PCR
Riley, Loneragan, Phillips, Gray, & Fedorka-Cray, 2008	O157:H7	Fecal	Steers and Heifers	0	10,982	0	Florida/Oklahoma, USA	2002–2004	Culture
Sasaki et al., 2013	O157	Fecal swabs	Healthy beef cattle	16	250	6.4	Eastern Japan	Sept. 2011	Culture/PCR
Schurman, Hariharan, Heaney, & Rahn, 2000	STEC	Fecal swabs	Beef steers	4	1000	4	Prince Edward Island, Canada	Jan.–Dec. 1994	Vero cell assay
Stephens et al., 2007	O157	Fecal grab	Feedlot cattle	15	64	23.0	West TX, USA	NS	Culture
Van Donkersgoed, Graham, & Gannon, 1999	O157:H7	Fecal	Cattle at processing	93	1247	7.5	Canada	Sept 1995–Aug 1996	Culture

NS = not specified.