

Salmonella and the Market Dairy Cow: Transport Contamination – Risk for Farm Biosecurity

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Abstract

Floors of trucks or trailers were sampled for *Salmonella* before culled dairy cows were loaded from cooperating farms and auction markets in New York (East) and California (West) prior to transport to slaughter establishments. Sampling occurred during two periods, winter and summer. These vehicles were sampled again after cattle were unloaded at slaughter establishments. Four of six vehicles picking up cattle from dairy farms were positive for *Salmonella* spp before cattle were loaded at East locations during winter, while five of seven were positive during the summer. One of five vehicles picking up cattle from auction markets was positive for *Salmonella* spp at an East location during winter, while all four sampled during the summer period were positive. During winter at the West location all trucks or trailers were positive for *Salmonella*. During the summer sampling, nine of 13 vehicles that arrived at dairy farms and four of six that arrived at auction markets to pick up cattle were positive for *Salmonella* before cattle were loaded. Biosecurity procedures need to address the risk of *Salmonella* contamination from cattle transport.

Keywords: bovine, dairy, salmonella, food safety, biosecurity, transportation

Résumé

Le plancher de camions ou de remorques a été échantillonné pour la présence de *Salmonella* avant que des vaches laitières réformées provenant de fermes coopératives ou de l'encan à New York (est) et en Californie (ouest) soient embarquées pour l'abattoir. L'échantillonnage a eu lieu pendant l'hiver et l'été. Les véhicules ont été échantillonnés à nouveau après que les vaches soient arrivées à l'abattoir. La présence de *Salmonella* spp. a été détectée avant le départ dans quatre des six véhicules transportant les vaches provenant des fermes laitières de l'est l'hiver alors que cinq des sept véhicules utilisés l'été étaient positifs. Un véhicule sur cinq transportant les vaches provenant de l'encan à l'est était contaminé avec *Salmonella* spp. l'hiver alors que les quatre véhicules échantillonnés étaient tous contaminés l'été. À l'ouest durant l'hiver, tous les camions ou les remorques étaient contaminés avec *Salmonella*. Durant l'échantillonnage estival, neuf des 13 véhicules qui arrivaient aux fermes laitières et quatre des six qui arrivaient à l'encan étaient contaminés avec *Salmonella* spp. avant le transport des vaches. Les protocoles de biosécurité doivent prendre en ligne de compte le risque de contamination à *Salmonella* engendré par le transport du bétail.

Introduction

Salmonella spp pose a risk to both dairy cattle health and public health. In the United States a significant amount of meat is obtained from market dairy cows,²¹ and these animals can account for approximately 17% of US ground beef production.¹⁹ Consumption of undercooked ground beef is a cause of salmonellosis in humans.⁵ The association of *Salmonella* with clinical disease in dairy cattle is well established¹¹ and has been compounded by the emergence of multi-drug resistant strains of the organism.⁷ *Salmonella* are prevalent on dairy farms in the United States.^{6,12,14,16} The ecology on dairy farms is likely complex and the basis for expression of clinical salmonellosis in dairy cattle multifactorial. A fundamental biosecurity strategy is to prevent the introduction of an infectious, contagious organism into a susceptible population.^{2,22}

Cattle trucks and trailers were sampled during two periods of the year (winter and summer) at East (New York) and West (California) dairy farms, auction markets and slaughter establishments. Sampling for *Salmonella* spp was performed before cattle were loaded at cooperating farms and auction markets, and again after delivery to slaughter establishments.

Materials and Methods

Sampling Sites

During the winter period at the East location (south central New York), livestock trucks and trailers were sampled before loading slaughter-bound dairy cattle at nine farms and two auction markets. During the summer, sampling occurred at 12 farms and four auction markets. At the East locations, cows were unloaded to one slaughter establishment and conveyances were sampled again. For the winter period at the West location (California's central San Joaquin Valley), livestock trailers were sampled before loading market cows at eight farms and two auction markets. During the summer, transport vehicles picking up cattle at 11 farms and a single auction market were sampled. As in the East, conveyances were sampled at a single slaughter establishment after cows were unloaded.

Sampling of Livestock Conveyances

Samples were collected for *Salmonella* culture from cattle trucks and trailers before cattle were loaded at either dairy farms or auction markets, and again when cattle were unloaded at slaughter establishments. Two sterile gauze sponges (4 in²), pre-moistened with sterile phosphate buffered saline and attached to alligator clips fixed to the two ends of a three-foot horizontal member of a T-shaped device made from 1-inch PVC pipe, were used to collect swab samples from several sites (front and

rear) of the floor(s) of the transport vehicles. Between samplings, each alligator clip and associated PVC pipe was rinsed in running water, scrubbed with a brush in a solution of chlorhexidine diacetate^a per label directions and then dipped in chlorhexidine diacetate directly from the bottle and air dried. No attempt was made to sample from a predetermined standardized area of the truck or trailer, but in general, an attempt was made to swab across the width of a truck or trailer to obtain manure-laden gauze samples.

Also, because of the need to accommodate truck and delivery schedules, it was not possible to standardize the number of swabs obtained per truck or trailer.

Handling of Drag Samples

After sampling, each gauze sample was placed in an individually identified sterile plastic bag^b in a cooler chest with frozen ice packs and later maintained in the slaughter facility's walk-in cooler (37°F; 2.8°C). After all samples were collected for the day, frozen ice packs were added to the cooler chest and it was shipped by overnight delivery to a microbiology laboratory at Kansas State University where culturing was accomplished the day of arrival or the following morning.

Salmonella Isolation and Identification

All *Salmonella* isolations were conducted at a microbiology laboratory at Kansas State University using procedures described^{4,8,9,10} with minor modifications: sterile phosphate buffered saline (10 mL) was added to the gauze samples, and each was placed in a Stomacher for 30 seconds. After mixing, 1.0 mL of suspension was placed in a sterile tube with 9.0 mL tetrathionate broth and incubated at 107.6°F (42°C) for 48 hours. Subsequent isolation procedures for *Salmonella* were as previously described, including enrichment in Rappaport Vassiladai broth and plating on XLT4 agar.²⁰

Salmonella were identified biochemically and serologically (O and H antigens) using specific antisera and standard procedures.³ Phage typing of *S* Typhimurium definitive type (DT) 104 was accomplished at the Diagnostic Bacteriology Laboratory, National Veterinary Services Laboratories, Ames, Iowa.

Data Analysis

The percentage of gauze samples that tested positive for *Salmonella* spp from each conveyance was tabulated. A trailer or truck was classified as *Salmonella* positive if at least one of the gauze samples was positive.

Results

East Dairy Farms

In the East during winter, 67% (4/6) of trailers were positive for *Salmonella* spp before market dairy

cattle were loaded at dairy farms, and approximately the same percentage (71%; 5/7) were positive during the summer sampling period (Table 1). After unloading cattle transported from dairy farms at the East slaughter establishment, 83% (5/6) of the trailers were positive during winter and 71% (5/7) were positive during summer. *Salmonella* spp were not detected after unloading one trailer (Trailer 2, Table 1) even though it had been detected in that trailer before loading.

East Auction Markets

At auction markets, 20% (1/5) of the livestock trucks were contaminated with *Salmonella* spp before loading during the winter, while 100% (4/4) of those sampled during the summer period were positive. Three trucks or trailers at auction markets could not be sampled during the summer period because of issues involving safety of personnel or because of timing conflicts. After unloading cattle from auction markets at the East slaughter establishment, 60% (3/5) of the trailers sampled were positive during winter and 71% (5/7) were positive during summer.

West Dairy Farms

In the West, 100% (9/9) of trailers were positive for *Salmonella* spp before loading cows at the dairy farms during winter and 69% (9/13) were positive in the summer (Table 2). After transport and unloading at the slaughter establishment 83% (5/6) of the trailers sampled were contaminated during winter (three trailers were not sampled because of safety issues or timing conflicts) and 77% (10/13) during summer. In two circumstances (Trailers 12 and 14, Table 2), *Salmonella* spp were not detected after unloading even though *Salmonella* had been cultured from the respective trailer before loading.

West Auction Markets

In the West during winter, both trailers (100%) tested positive for *Salmonella* spp at auction markets. In the summer, 67% of the six trailers sampled tested positive for *Salmonella* spp; two trailers could not be sampled. At the slaughter establishment, only one trailer was sampled out of two that arrived with cows from auction markets during winter. The trailer tested

Table 1. Percent (%) of drag samples that were *Salmonella*-positive from each truck or trailer (vehicle) before loading market dairy cows from dairy farms and auction markets and after transport to slaughter establishments in the East during winter and summer. The number of samples collected from each vehicle is in parenthesis and used as the denominator for calculating the percent.

Type of Site	East Winter			East Summer		
	Vehicle	Before	After	Vehicle	Before	After
Dairy Farms	1	25% (8)	20% (10)	7	25% (8)	50% (8)
	2	50% (8)	0% (8)	8	12.5% (8)	37.5% (8)
	3	100% (4)	75% (8)	9	12.5% (8)	50% (8)
	4	50% (8)	50% (8)	10	0% (8)	0% (8)
	5	0% (8)	12.5% (8)	11	25% (8)	37.5% (8)
	6	0% (8)	12.5% (8)	12	0% (8)	0% (4)
				13	12.5% (8)	12.5% (8)
Auction Markets	14	0% (8)	0% (8)	19	25% (8)	12.5% (8)
	15	100% (8)	100% (8)	20	12.5% (8)	37.5% (8)
	16	0% (8)	0% (8)	21	12.5% (8)	100% (8)
	17	0% (8)	25% (8)	22	50% (8)	0% (8)
	18	0% (8)	75% (8)	23	NS*	0% (8)
				24	NS*	50% (4)
				25	NS*	12.5% (8)

*NS - because of safety concerns or timing conflicts, not all vehicles involved were sampled before loading

Table 2. Percent (%) of drag samples that were *Salmonella*-positive from each trailer before loading market dairy cows from dairy farms and auction markets and after transport to slaughter establishments in the West during winter and summer. The number of samples collected from each trailer is in parenthesis and was used as the denominator for calculating the percent.

Type of Site	West Winter			West Summer		
	Trailer	Before	After	Trailer	Before	After
Dairy Farms	1	50% (4)	NS*	10	0% (4)	12.5% (8)
	2	25% (4)	NS*	11	75% (4)	25% (4)
	3	50% (2)	50% (4)	12	50% (4)	0% (4)
	4	50% (4)	37.5% (8)	13	0% (8)	12.5% (8)
	5	75% (4)	50% (4)	14	25% (4)	0% (4)
	6	100% (2)	25% (4)	15	100% (4)	50% (4)
	7	75% (4)	25% (4)	16	75% (4)	75% (4)
	8	75% (4)	0% (4)	17	75% (8)	87.5% (8)
	9	50% (2)	NS*	18	0% (4)	100% (8)
Auction Markets				19	0% (4)	0% (4)
				20	25% (4)	75% (4)
				21	75% (4)	100% (4)
				22	12.5% (8)	12.5% (8)
	23	75% (4)	NS*	25	0% (12)	25% (8)
	24	33.3% (6)	0% (2)	26	25% (8)	12.5% (8)
				27	0% (8)	37.5% (8)
				28	25% (8)	37.5% (8)
				29	75% (8)	62.5% (8)
				30	75% (8)	87.5% (8)
				31	NS*	50% (4)
				32	NS*	0% (8)

* NS – not sampled at that time

negative for *Salmonella* spp even though it had tested positive before cows were loaded at the auction market. During summer, 88% (7/8) of trailers that had unloaded cattle originating from the auction markets were positive for *Salmonella* species. After unloading at the slaughter establishment, drag samples from trailers 25 and 27 were positive for *Salmonella* spp although the organisms had not been identified from those trailers before loading at the auction market.

Serovar Results

Five of the 14 *Salmonella* serovars (*S* Muenster, *S* Anatum, *S* Kentucky, *S* Bergen and *S* Newport) isolated from trailers were found in both the East and West (Table 3). Overall, the serovar detected with the highest frequency was *S* Meleagridis. Two *S* Typhimurium isolates from trailers subsequently were identified as DT104; both were found in the West during summer in trailers from dairy farms.

Results Summary

Overall, for both the East and West (Tables 1 and 2), 77% (27/35) of trailers or trucks sampled before picking up market cows at dairy farms were positive for *Salmonella* spp, and more than 50% of those conveyances picking up slaughter cows at auction markets were positive.

Discussion

This report underscores the possibility of a high percentage of *Salmonella* spp contamination (up to 100%) in trailers or trucks before they were loaded with market dairy cows at either a dairy farm or auction market. The role of transport trailers or trucks as an environmental contaminant in the possible epidemiology of *Salmonella* spp infection in cattle is not a new concept. Reicks and co-workers¹⁵ reported a 43.8% prevalence of *Salmonella* spp in swab samples from “dirty” trail-

Table 3. *Salmonella* serovars (and frequency) isolated from swabs at West and East locations during winter and summer samplings.

West		East	
Winter	Summer	Winter	Summer
Montevideo (9)	Montevideo (27)	***	***
***	Meleagridis (29)	Meleagridis (25)	Meleagridis (4)
Muenster (4)	***	Muenster (8)	Muenster (15)
Kentucky (1)	Kentucky (17)	***	Kentucky (6)
***	Typhimurium (14) ⁺	Typhimurium (5)	Typhimurium (5)
Anatum (3)	***	Anatum (2)	***
Derby (1)	Derby (2)	***	***
Bergen (1)	***	***	Bergen (3)
***	Newport (1)	Newport (1)	***
Non-typable (1)	Non-typable (5)	Non-typable (14)	Non-typable (6)
***	Newbrunswick (10)	***	***
***	Dessau (3)	***	***
***	Give (1)	***	***
***	***	Infantis (4)	***
***	***	Minneapolis (1)	***

⁺ Includes var. Copenhagen
 *** Indicates serovar not identified at that location and season

ers picking up cattle at the feedyard for shipment to harvest facilities. More than a decade ago, Wray and colleagues²³ found that 20.6% (22/107) of trailers transporting market calves were positive for *Salmonella* spp before washing while 6.5% (4/62) of transport trailers were positive after cleaning and disinfection, and that most isolations were made from trailer floors. In this report we generally sampled across the width of only floors of trucks or trailers. In some circumstances, sampling had to be accomplished quickly or not at all because of concerns for personal safety or the need to maintain schedules of trucks.

We originally wanted to statistically compare the prevalence of *Salmonella* within zones of respective trucks before cattle were loaded and after delivery and between geographic regions. However, because of difficulties in standardizing sampling procedures (due to weather, truck schedules, safety) we simply ascertained whether or not trucks were positive for *Salmonella* spp and reported the outcomes as descriptive statistics.

A *Salmonella*-contaminated trailer or truck arriving at a farm can be considered a threat to the biosecurity of that farm. The potential public health implication also must be recognized because of the possibility of hide

contamination of cattle going to slaughter with risk of subsequent carcass contamination.^{1,15}

In two instances we were able to identify *S* Typhimurium DT104 as a contaminant in trailers that had hauled cattle from dairy farms. The significance of *S* Typhimurium DT104 as a risk to public health and a source of clinical disease in cattle is recognized.¹⁸

On several occasions we were unable to identify *Salmonella* spp from samples in trucks and trailers after delivery when we had identified *Salmonella* spp before pickup. This occurred at both East and West locations, and could have resulted from limitations in either sampling procedure or microbiological culture technique, or both.

The results reported here were acquired as an extension of an extensive project assessing the prevalence of *Salmonella* spp in market dairy cows at various points in their processing. Because it was outside the scope of the overall project and because of logistical limitations, we made no effort to record when or if trucks or trailers were washed, if disinfection was used, or where they stopped before loading or unloading dairy cows. However, the findings of this study are insightful and offer clues in the complexities of the epidemiology and practi-

cal control of *Salmonella* spp in dairy cattle. Samplings were conducted at two widely separated geographic locations that tended to contrast medium-sized farms to large dry-lot operations. In both locations, cattle trucks and trailers freely entered and left the farm. In some cases manure and bedding spilled from the trailers, and personnel moving between trailers and loading chutes or corrals possibly increased the potential for spread of *Salmonella* spp contamination. We observed that some trailers were rinsed with water on the premises, but at no time did we observe any disinfection procedures. Cleaning trucks and trailers on the premises could pose another risk of spreading contamination if trucks arrived contaminated with *Salmonella* spp unless cleaning was done in a designated area using appropriate cleaning and disinfection procedures.

A segment of the swine industry recognizes transport as an important element in the transmission of a serious viral disease of swine, and has instituted a trailer cleaning and thermal drying process to kill the virus.¹⁷ This approach also might be a cost-effective biosecurity procedure before hauling dairy cattle to and from markets or to slaughter establishments. However, intuitively at the least, trailers should be thoroughly cleaned and disinfected before loading with cattle for hauling off-site. If the sampling findings reported here can be extrapolated to other locations, livestock trailers constitute a potentially important risk of contamination for dairy farm premises and cattle by *Salmonella* spp. In addition, contamination of these conveyances could increase risk of carcass contamination because of the contamination of the hide, hair and hooves of pre-harvest cattle. As a component of any biosecurity program at dairy operations, the reduction of risk from contagious disease agents because of contaminated vehicles visiting the farms for a variety of reasons must be addressed.

We hope this information about trucks and trailers being contaminated with *Salmonella* spp at the time they were loaded with cattle from dairy farms in two very widely separated areas of the US increases the awareness of dairy veterinarians to what is possibly a common biosecurity threat.

Dairy veterinarians should work with their clients to first acknowledge the possible threat of premise contamination with *Salmonella* from trucks and trailers entering the farm to either pick up or deliver cattle. Villarroel *et al*²² have provided possible control points for biosecurity on dairy farms. The tables presented in this paper could be used as a simple visual documenting for clients the risk and diversity of *Salmonella* spp that can be present, also indicating that other fecal-borne pathogens could potentially be a threat. Indeed five of the *Salmonella* serovars listed in Table 3 (Anatum, Kentucky, Montevideo, Newport and Typhimurium) were among the most common serovars isolated from cattle

samples at the National Veterinary Services Laboratory for the period July 2005 through June 2006.¹³ Ideally, the dairy veterinarian and client should work together to develop a farm biosecurity protocol that includes well separated, dedicated and identified on-farm cattle pickup and delivery areas²² with concrete pads that can be appropriately washed and disinfected. Signage indicating a biosecurity area for, as an example, cattle pickup only and limiting access to the farm proper should be present.²² These areas should also contain strategically located foot/boot baths for use before personnel enter the production areas of the farm, and farm personnel should be assigned to clean, disinfect and maintain the foot/boot baths.

Conclusions

Contaminated trucks picking up or delivering cattle to dairy farms can pose a threat to the biosecurity of the farm. The dairy practitioner can be a very valuable resource in pointing out these biosecurity risks and in developing and facilitating procedures to prevent them.

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Endnotes

^aNolvasan Solution, Fort Dodge Animal Health, Overland Park, KS 66225

^bWhirl-Pak[®], Nasco, Fort Atkinson, WI 53538-0901

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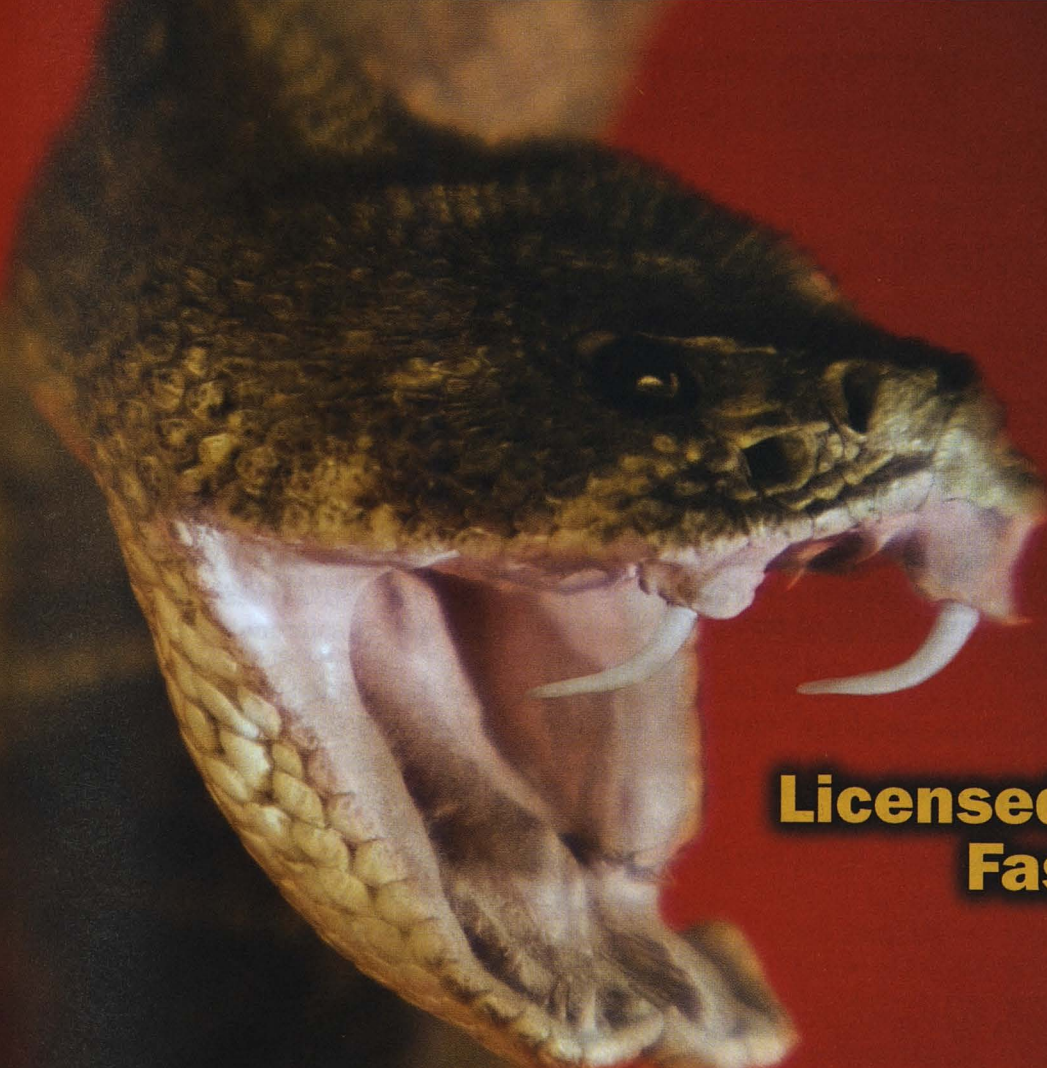
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