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Effect of waste milk pasteurization on fecal shedding of *Salmonella* in preweaned calves

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ABSTRACT

The objective of the current research was to determine if pasteurization of nonsaleable waste milk influences fecal *Salmonella* concentrations and prevalence, or antimicrobial susceptibility and serotype of the cultured isolates. Holstein dairy calves (n = 211) were housed on a single commercial dairy in the southwestern United States and randomly allotted to be fed either pasteurized (PWM; n = 128 calves) or nonpasteurized waste milk (NPWM; n = 83 calves). Fecal samples were collected via rectal palpation or from freshly voided, undisturbed fecal pats, weekly during the first 4 wk of the animal's life and then again at weaning. Eight total collections were made and 1,117 fecal samples cultured for *Salmonella*. One isolate from each culture-positive fecal sample was preserved for antimicrobial susceptibility screening and serotyping. Sixty-nine percent of the fecal samples were culture positive for *Salmonella* with no difference due to treatment (67.7 and 69% *Salmonella* positive for PWM and NPWM treatments, respectively). Few fecal samples (178/1,117; 15.9%) contained *Salmonella* concentrations above the limit of detection (~1 cfu/g of feces) with concentrations ranging from 1.0 to 6.46 cfu ($\log_{10}$)/g of feces. Concentration was not affected by treatment. Seventeen different serotypes were identified, the majority of which were Montevideo and Anatum. A greater percentage of Typhimurium (87 vs. 13%), Muenchen (88 vs. 12%), and Derby (91 vs. 9%) were recovered from calves fed PWM compared with NPWM-fed calves. Conversely, Newport (12.5 vs. 86%), Bredeney (22.2 vs. 77.8%), and Muenster (12.5 vs. 87.5%) were lower in PWM compared with NPWM treatments. The majority (66.7%) of isolates were susceptible to all of the antibiotics examined. Results from this one commercial dairy suggest that milkborne *Salmonella* is not an important vector of transmission in dairy neonates, nor does pasteurization of waste milk influence fecal shedding of this pathogen. Caution should be used, however, when extrapolating results to other farms as *Salmonella* contamination of milk on farm is well documented. The potential benefits of pasteurization in disease prevention outweigh the potential risks of feeding a nonpasteurized product and warrants incorporation into any calf-rearing program using nonsaleable waste milk for feeding young dairy neonates.
Key words: *Salmonella*, waste milk, pasteurization, calf

INTRODUCTION

Dairy producers use a variety of liquid feeds for their young calves including milk replacers, whole milk, and waste milk. Waste, or discard milk, is milk from cows treated with antibiotics for mastitis or other illnesses and cannot be sold for human consumption (Chardavoyne et al., 1979). A survey conducted in 2002 reported that 87.2% of dairy farms in the United States use waste milk to feed their calves (USDA National Agricultural Statistics Service, 2002). Several studies have reported that the incidence of scours and growth rates in calves fed waste milk are comparable to those fed whole milk (Chardavoyne et al., 1979; Keys et al., 1980; Kesler, 1981). This practice is not without its dangers, however, as feeding waste milk can expose young calves to diarrhea-causing pathogens and disease. *Escherichia coli*, *Salmonella*, *Streptococcus*, and *Staphylococcus* are bacteria that have been identified in waste milk (Selim and Cullor, 1997). In an effort to eliminate or reduce the transmission risk, many producers are incorporating pasteurization of the waste milk in

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their calf management program. Pasteurization, if done correctly, has been shown to kill important bacteria such as *Mycobacterium paratuberculosis* (responsible for Johne's disease), *Salmonella*, and *Mycoplasma* (Butler et al., 2000; Stabel et al., 2004). Additional benefits of on-farm pasteurization include reduced diarrhea and pneumonia and improved weight gains (Jamaluddin et al., 1996). Although bacterial counts can be significantly reduced by pasteurization, milk handling after pasteurization can increase bacterial contamination substantially to levels similar to those prepasteurization (Elizondo-Salazar et al., 2010).

Salmonella is commonly isolated from mature dairy cattle where it typically thrives in the gastrointestinal tract (**GIT**) as part of the commensal bacterial population without causing any harm to the animal (Fitzgerald et al., 2003; Edrington et al., 2004, 2008a; Loneragan et al., 2012). In preruminant (1–2 wk of age) dairy calves, however, *Salmonella* is a serious bacterial pathogen and a significant causative agent of neonatal calf scours (Moore et al., 1962; Rings, 1985). Numerous *Salmonella* serotypes have been isolated from young dairy calves, although those associated with increased virulence and multidrug resistance are often cultured (Edrington et al., 2008a). Due to the sensitivity of neonatal calves to *Salmonella* and the propensity for the more virulent strains to thrive in these young hosts, methods such as waste-milk pasteurization have been employed to combat this pathogen. Even so, published reports examining the effect of waste milk pasteurization specifically on *Salmonella* in dairy calves are scarce. Previously, we examined the colonic microflora (via pyrosequencing) of dairy calves from 1 wk to 6 mo of age (Edrington et al., 2012) fed either pasteurized (**PWM**) or nonpasteurized waste milk (**NPWM**). *Salmonella* was consistently detected in the younger animals fed NPWM, whereas total bacterial diversity was greater for those animals fed pasteurized milk. However, the study compared animals on 2 different farms, and although location, housing, and general management were the same or very similar, subtle differences could have affected these results. Indeed, differences in *Salmonella* prevalence have been reported for dairies located within the same region and managed similarly (Edrington et al., 2004, 2008a). Therefore, the current study was conducted to determine the effect of waste-milk pasteurization on fecal shedding of *Salmonella,* the distribution of *Salmonella* serotypes, and antimicrobial resistance of cultured *Salmonella* isolates in dairy calves on a single commercial dairy farm in the southwestern United States.

Tetracycline and β-lactam residues, 2 antibiotics used most commonly in lactating dairy cows (Sundlof et al., 1995), were detected in 63% of waste milk and milk-based fluids (Selim and Cullor, 1997). The β-lactam residues were more often associated with dairies utilizing waste milk, whereas the tetracycline residues were mostly associated with farms using milk replacers (Selim and Cullor, 1997). In recent years there has been considerable controversy over the inclusion of antibiotics in rations of farm animals because of the possible emergence of antibiotic resistant bacteria (Salisbury et al., 2002). Wray et al. (1990) reported no differences in the prevalence of antibiotic-resistant *Escherichia coli* in the feces of calves fed milk from antibiotic-treated cows versus those fed a milk replacer. Resistance to penicillin and ampicillin was reported in *Escherichia coli* cultured from calves fed waste milk; however, the authors' presentation of the data makes it difficult to determine how this differed from those fed milk replacer (Selim and Cullor, 1997). As previous research has reported antibiotic residues in waste milk and the potential exists for this to influence antimicrobial susceptibility of the microbial fauna of the calf, our second objective was to examine the antimicrobial susceptibility profiles of the cultured *Salmonella* isolates.

MATERIALS AND METHODS

Animals and Sample Collection

Holstein dairy calves were housed on a single commercial dairy in the southwestern United States throughout the sample collection period. Calves were either born on the dairy or born on other dairies and transported to this dairy at 1 or 2 d of age. Calves were housed in commercially available polyethylene hutches affixed with a 1 × 2 m outdoor pen made of welded wire panels. Soon after birth or at arrival to the farm, calves were randomly allotted to be fed either PWM (n = 128 calves) or NPWM (n = 83 calves). For convenience of the farm personnel, calves in each treatment were housed in separate rows. Animals were fed waste milk twice daily, approximately 2.0 L per feeding, until they would drink from a bucket (typically 1–3 d), after which they were provided 7.5 L of waste milk twice daily until weaning at approximately 2 mo of age. Batches of waste milk were split and pasteurized (flash pasteurization: 161°F, 15 s) or not pasteurized. In addition, calves received approximately 7.5 L water daily and were gradually introduced to solid feeds between 10 and 14 d of age. Calves were generally placed alternately in rows (treatments), and other than the type of waste milk fed, were all managed the same as per typical calf-rearing protocols for this region of the United States. Due to concerns with feeding NPWM, more calves were placed in the PWM treatment per the dairy owner's instructions.