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## Technical note: Infusion, sampling, and vacuum-assisted collection devices for use in ruminally cannulated calves

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### ABSTRACT

Calves can be ruminally cannulated at young ages, but equipment size limitations preclude use of an infusion and sampling device in these small animals. Likewise, a procedure to easily evacuate rumen contents in young calves has not been described. Overcoming these technical complications related to assessment of ruminal passage kinetics, nutrient digestion, and volatile fatty acid absorption would aid in future studies advancing our knowledge of dairy calf nutrition. The first objective was to design and fabricate 2 devices (one device for infusion and sampling, and another for vacuum-assisted collection) suitable for use in young ruminally cannulated dairy calves. The second objective was to test the utility of these tools when performing procedures commonly used in ruminant nutrition research. A single weaned 62-d-old ruminally cannulated calf was used to evaluate the ability to infuse a solution of LiCoEDTA and sample rumen contents through the cannula cap over a period of 2 h to assess the rumen liquid passage rate (procedure 1). The device was capable of infusing the LiCoEDTA and sampling the rumen fluid, as evidenced by the presence of elevated Co concentrations in the sampled rumen fluid. Using the fluid samples obtained, liquid passage rate within the calf was estimated to be 40.2% of ruminal fluid/h. The second procedure tested the vacuum-assisted collection device and consisted of evacuating and weighing the rumen contents, which is considered a key preparatory step in washed reticulorumen technique experiments that aim to measure nutrient absorption. In agreement with existing literature, evacuated rumen contents represented approximately 4% of the calf's body weight. In conclusion, custom-built devices for infusion, sampling, and vacuum-assisted collection were efficacious when tested in a 62-d-old ruminally cannulated calf fed a diet

of 100% texturized starter (18% crude protein, as-fed). Fellow scientists may employ and further modify these techniques to suit their needs when assessing passage kinetics, nutrient digestion, and volatile fatty acid absorption in calves.

**Key words:** calf rumen cannulation, rumen evacuation, washed rumen technique, calf nutrition, passage rate

### Technical Note

Ruminal passage kinetics (Azevedo et al., 2016), nutrient digestion, and VFA absorption (Conrad et al., 1956; Sutton et al., 1963; Khouri, 1969) are difficult to assess in young dairy calves. Overcoming technical complications related to assessment of ruminal passage kinetics, nutrient digestion, and VFA absorption are therefore essential steps toward improving our understanding of dairy calf nutrition.

In experiments that measure ruminal passage kinetics, nutrient digestion and VFA absorption in mature ruminants are often facilitated by use of ruminally cannulated animals. These animals are typically fitted with a specialized indwelling infusion and sampling device (Annison et al., 1974; Sutton et al., 2003) or a washed reticulorumen technique is employed, the latter requiring an evacuated rumen (Gaebel et al., 1987; Kristensen and Harmon, 2004; Storm et al., 2011). Calves can be ruminally cannulated at young ages (Lesmeister and Heinrichs, 2004; Kristensen et al., 2010; Suárez-Mena et al., 2015), but equipment size limitations preclude use of an infusion and sampling device in young calves. Likewise, an efficient means to easily evacuate rumen contents in young calves has not been described.

Our first objective was to design and fabricate an infusion and sampling device and a separate vacuum-assisted rumen contents collection device suitable for use in young ruminally cannulated dairy calves. The second objective was to test the effectiveness of these devices in a ruminally cannulated calf. Two procedures common in ruminant nutrition research were selected to evaluate the performance of our newly created de-

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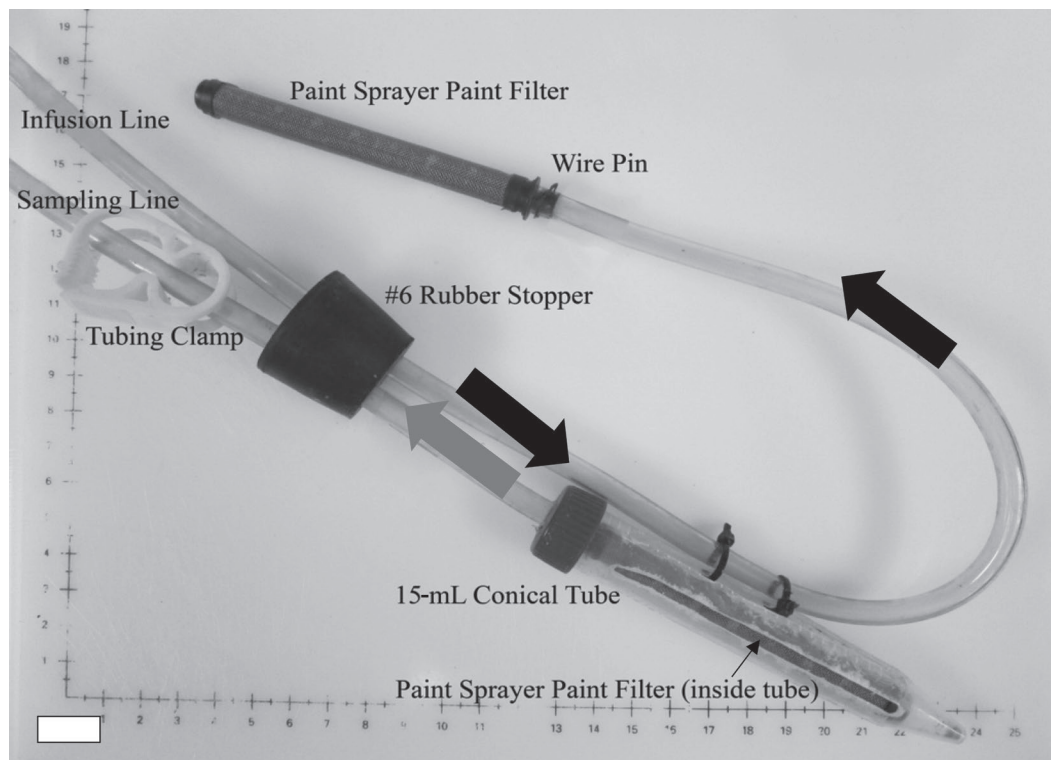
vices. The first procedure was to infuse a solution of LiCoEDTA into the rumen and sample rumen contents through the cannula cap over time to assess rumen liquid passage rate (Udén et al., 1980; Dijkstra et al., 1993; Krizsan et al., 2010). The second procedure was to remove and collect the content of the rumen, which is considered a key preparatory step in washed reticulo-rumen technique experiments that aim to measure nutrient absorption (Gaebel et al., 1987; Kristensen and Harmon, 2004; Storm et al., 2011).

Our device design approach for the infusion and sampling device was to identify important functional properties of systems used in mature animals and scale-down components using commercially available materials. Design elements of the vacuum-assisted rumen collection device feature an open-ended vacuum tube connected to a custom-built sanitary trap and commercial vacuum pump (Figures 1, 2, 3, and 4).

The design, manufacture, and evaluation of our 2 devices were conducted from September 2016 to November 2016. One Holstein bull calf born at Virginia Tech (VT) was used in the evaluation of the devices. It should be noted that only 1 calf was used due to the

pilot trial nature of this study to test devices and techniques that will be used in future studies. The following procedures were approved by the VT Animal Care and Use Committee (protocol #15-181). The bull calf was healthy (serum total protein 60 mg/mL after colostrum feeding) and underwent rumen cannulation surgery on d 5 of age. The rumen cannulation surgery was performed similarly to that described by Kristensen et al. (2010). The surgically placed rumen cannula (2.75 cm i.d.) was the same design used in Lesmeister and Heinrichs (2004) and Suárez-Mena et al. (2016). The cannula opening was plugged with a #6 rubber laboratory stopper.

The calf was fed twice daily at 0700 and 1900 h. Prior to weaning, the calf was fed a diet of milk replacer (Southern States Cooperative, Richmond, VA) containing 22% CP and 20% fat (as-fed basis) and texturized calf starter (Southern States Cooperative) containing 18% CP (as-fed). Water was available at all times. The calf was housed in an individual calf hutch bedded with sawdust. Hay was not offered. The calf's birth weight was 43 kg and the calf weighed 80 kg on d 62 of life, which coincided with the procedures described



**Figure 1.** Custom-made rumen infusion (upper line) and sampling (lower line) device built and used to administer infusate and sample rumen fluid, respectively, in the ruminally cannulated calf. Infusion line connects to distal end of IV set and sampling line connects to a 60-mL syringe. Infusion and sampling lines were 145 and 28 cm in length, respectively, and both were 0.64 cm o.d. × 0.48 cm i.d. plastic tubing. See text for further specifications. Black and gray (red) arrows denote direction of fluid through infusion and sampling lines, respectively. White scale bar represents 2 cm. Color version available online.

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