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M. Ivan, M. Lamand, C.A. Kelleher, J. Mason. EXCHANGE OF DIGESTA VIA DUODENAL CANNULA IN SHEEP, A TECHNIQUE USEFUL FOR ABSORPTION STUDIES WITH LABELLED COMPOUNDS. *Annales de Recherches Vétérinaires*, 1981, 12 (4), pp.379-383. hal-00901346

HAL Id: hal-00901346

<https://hal.science/hal-00901346>

Submitted on 11 May 2020

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EXCHANGE OF DIGESTA VIA DUODENAL CANNULA IN SHEEP, A TECHNIQUE USEFUL FOR ABSORPTION STUDIES WITH LABELLED COMPOUNDS

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Résumé

ÉCHANGE DE DIGESTA PAR CANULE DUODÉNALE RÉENTRANTE CHEZ LE MOUTON, UNE TECHNIQUE UTILE POUR MESURER L'ABSORPTION DE NUTRIMENTS MARQUÉS. — Une technique pour mesurer séparément l'absorption et le métabolisme de nutriments marqués dans les estomacs ou l'intestin a été mise au point chez le mouton. La technique peut mettre en jeu deux ou trois moutons porteurs d'une canule duodénale réentrante. Les contenus digestifs sont échangés au niveau du duodénum entre les deux ou trois moutons. Le transfert de digesta est assuré en conditions anaérobies. La technique permet de quantifier l'absorption et le métabolisme du radioélément respectivement avant et après le duodénum.

Simple cannulation of the small intestine in sheep is a technique widely employed for metabolic studies. However, in experiments where radioisotopically labelled compounds have been introduced into the rumen it is often difficult to differentiate between changes which arise as a result of absorption and metabolism in the rumen and those which occur elsewhere. For this it is necessary to avoid further modifications due to the passage of the digesta into the rest of the digestive tract. This is particularly important where metabolism is monitored by means of plasma parameters. To

allow study of absorption and metabolism of digesta components independently, that is initially in the rumen, omasum and abomasum and subsequently in the remainder of the intestinal tract, a technique involving an exchange of digesta between two or even three sheep equipped with re-entrant cannula at the level of the proximal duodenum has been developed and is described here.

Materials and Methods

Two sheep system

Two wethers, each fitted with a duodenal re-entrant cannula in the proximal duodenum (Ivan and Johnston, 1981) were tethered in two metabolism cages placed in head to tail

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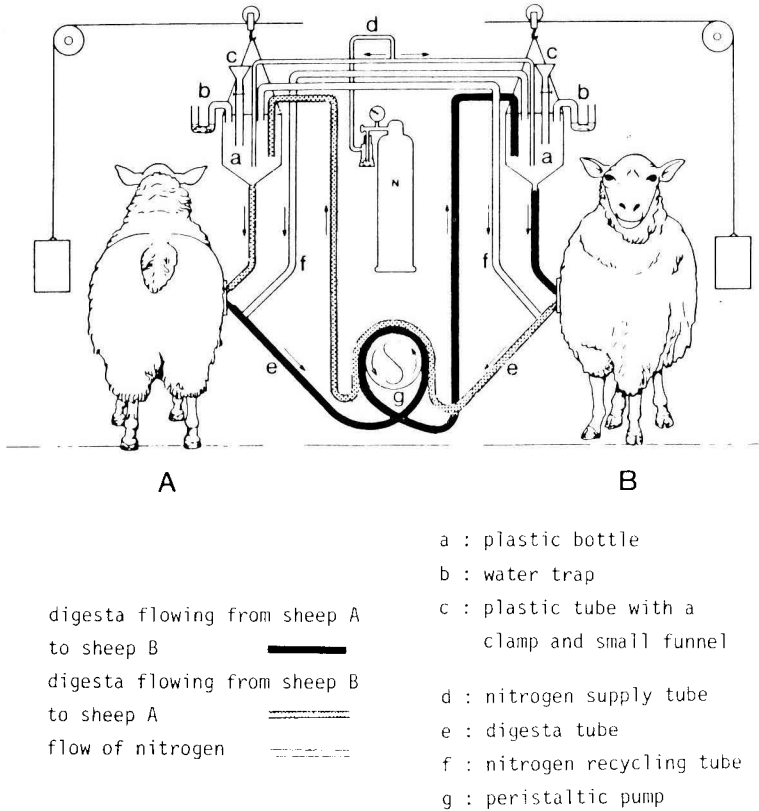


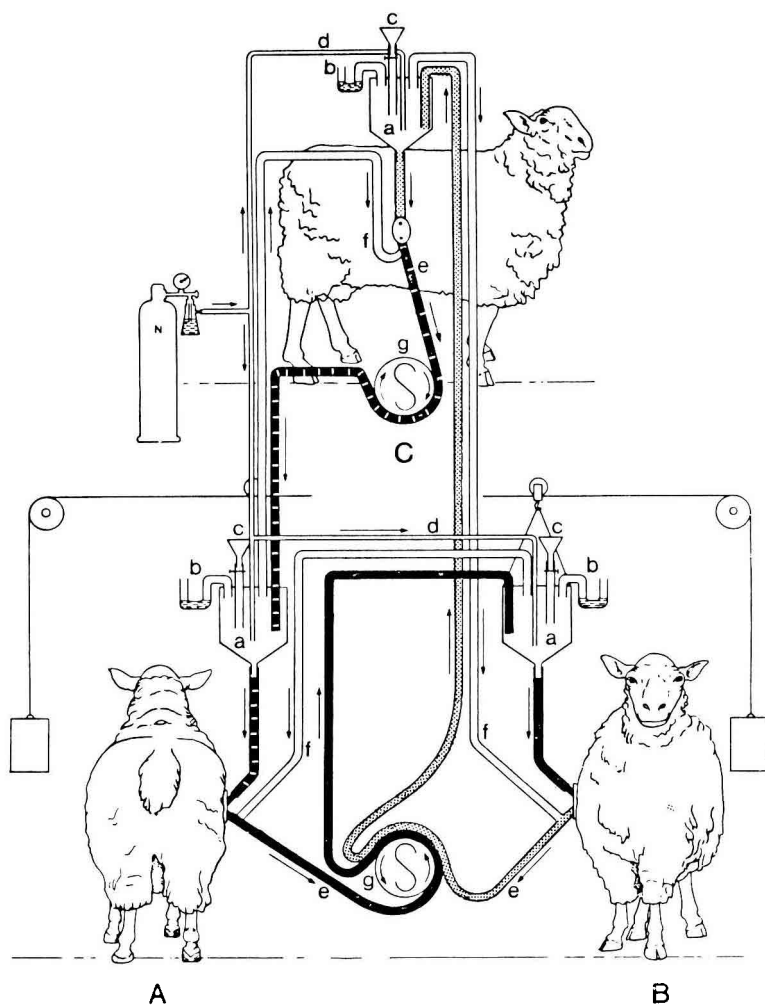
Fig. 1. — Diagram of exchange of duodenal digesta between two cannulated sheep.

juxtaposition 40 cm apart. A peristaltic pump (Gilson minipuls 2 with a 8-channel head supplied by Lyon-Labo, 69003 Lyon) used for pumping duodenal digesta from animal to animal was installed on a platform between the two cages ; the top of the pump slightly below the level of the cannula of a recumbant sheep. The interior sides of both cages were removed to facilitate the interconnection of the cannula via the peristaltic pump. The cages were equipped with urine collection trays and feces were collected from the sheep by means of a harness.

For the digesta exchange systems, the upper parts of 2 L plastic bottles were cut off and replaced by plastic funnels attached to the bottles by plastic tape. A reservoir bottle of this type was positioned over each sheep by means of a counterweight pulley system linked to the animal's harness at the shoulder. Each

bottle was thus able to move up and down with the movement of the sheep. Both bottles were connected to a nitrogen gas cylinder (fig. 1) by a plastic tube (8 mm diameter) inserted into a 7 mm hole at the base of each bottle. Gas flow from the cylinder was assessed by attaching a monitor (bubbling) flask to each cylinder. Four 13 mm holes at the base of each bottle (fig. 1) were utilized for the insertion of a water trap, a 5 cm long plastic tube equipped with a small funnel and a clamp, the digesta tube and a nitrogen recycling tube, all 14 mm in diameter. The traps equalize pressure and also serve as a safety mechanism to avoid excessive pressure in the system. The small funnel is used for duodenal saline infusion.

Digesta from the outflow channel of the cannula in sheep B was received via the pump through the tube inserted into the bottle of sheep A. Similarly, digesta from the outflow



- | | | |
|---|-----------|--|
| digesta flowing from dosed sheep A to sheep B | ————— | a : plastic bottle |
| digesta flowing from sheep B to sheep C | - - - - - | b : water trap |
| digesta flowing from sheep C to sheep A | | c : plastic tube with a clamp and small funnel |
| flow of nitrogen | ==== | d : nitrogen supply tube |
| | | e : digesta tube |
| | | f : nitrogen recycling tube |
| | | g : peristaltic pump |

Fig. 2. — Diagram of exchange of duodenal digesta among three cannulated sheep.

channel of sheep A passed via the pump into the digesta reservoir bottle of sheep B. A nitrogen recycling tube inserted 4 cm from the cannula in the digesta exit tube of sheep B was connected to the reservoir bottle of sheep A. An analogous nitrogen recycling tube from the bottle of sheep B joined the digesta exit tube near the cannula of sheep A. While the digesta tube between the outflow channel and the pump was long enough for reasonable movement of the sheep within the cage, the digesta tube between the pump and reservoir bottle was kept as short as possible and was jacketed by a tube heated with running warm water. The digesta outlet of each reservoir was connected to the entry channel of the corresponding cannula by 17 mm diameter plastic tubing.

Three sheep system

The system utilizing three sheep with duodenal re-entrant cannula was basically the same as that described for the two sheep system (fig. 1). In the three sheep system (fig. 2), the outflow channel of the cannula in sheep A was connected to the reservoir bottle of sheep B, that of sheep B with the bottle attached to sheep C, and that of sheep C with the bottle belonging to sheep A. Obviously an additional modified metabolism cage, place diagonally at the ends of the previous two cages, and an additional peristaltic pump are necessary with this system.

Results and Discussion

The technique described was developed for studies of absorption and metabolism of labelled compounds in the rumen and intestinal tract of sheep. It has been utilized in experiments on the absorption of ^{99}Mo -labelled thiomolybdates. Nitrogen gas was introduced into the system to avoid the oxidation demonstrable when the system was used aerobically. The gas was allowed to flow continuously at a very low rate so that a slightly positive pressure was maintained in the system. The gas was circulated in the system by the peristaltic pump pumping digesta from one sheep to another.

It is important to match the animals carefully, that is to use sheep of similar live weight and to feed equal quantities of the same ration

so that as far as possible the digesta inflow into the duodenum matches the outflow from the stomach. Water intake by each animal was measured and balanced at least twice daily. This is important since otherwise an animal may rapidly become dehydrated. An empty duodenum is a physiological signal for increased outflow of rumen digesta, this of course passes to the animal's partner. The recipient responds by decreasing rumen outflow, that is of digesta which should have been transferred to the initial animal. Thus any imbalance is rapidly exacerbated.

A fluid balance is achieved by infusing the appropriate quantity of warm saline directly into the duodenum of the sheep with the higher water intake. Since there is very little absorption of water pre-duodenum, any water consumed is mainly transferred with the digesta to the other sheep. The volume of saline infused was the difference between the respective water intakes. The rate of infusion must be slow to avoid perturbation of digesta flow from the stomach.

There is inevitably a slight delay in passage of digesta from one sheep to another. The delay is dependant on the diameter and length of plastic tubes between the peristaltic pump and the bottle over the sheep. This delay can be taken into consideration when evaluating data collected from the sheep receiving the radioactive digesta into the duodenum from the stomach of the dosed sheep. There may also be some contribution of the radioisotope into the dosed sheep from recycling in the other sheep. However, any effect of recycling is minimized by use of the three sheep system described in figure 2.

However, the system clearly separates digestion and absorption into two phases, pre-duodenal and post-duodenal; these can then be examined separately.

Accepted for publication, November 20 th, 1981.

Acknowledgements

This work was carried out at the Laboratoire des Maladies Nutritionnelles, INRA, Theix, during the senior author's study leave from the Animal Research Centre, Ottawa, Canada.

Summary

A technique for absorption and metabolism studies of labelled compounds in the stomach and intestinal tract of sheep has been developed and systems utilizing two or three sheep, each equipped with a duodenal re-entrant cannula, described. The technique involves exchanges of digesta between two or three sheep at the level of the proximal duodenum. The system was kept anaerobic with nitrogen. The technique allows the separate study of pre- and post-duodenal digestion metabolism and absorption.

Reference

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