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COMPARISON OF THE CONTINUOUS AND SPOT SAMPLING METHODS FOR COLLECTING DIGESTA OF THE DUODENUM IN YOUNG CALVES FITTED WITH THE DUODENAL RE-ENTRANT CANNULAE

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Introduction

The duodenal cannulation has caused no permanent detrimental disturbances to digestion, feed intake and weight gain[4,7,9]. Thus, the method of measuring the flow of digesta from the stomach to the intestine has offered the best way to determine the changes occurred in the stomach and in the small and large intestine. HOGAN and PHILLIPSON[5] were the first to give detailed reports of digesta collection made from re-entrant cannulae in sheep. Yet, the procedure for collection of duodenal samples has required laborious works including 24-hour continuous collection of the digesta. The alternative procedure of obtaining post-ruminal digesta samples (spot sampling procedure) was deviced to reduce complicated and laborious works for the collection of samples. MACRAE and ULYATT[8] have observed no significant differences in duodenal digesta flow measured using spot and continuous sampling procedures. They, however, reported that spot sampling gave more variable results. MACRAE[7] has pointed out that spot sampling procedures adopted with T-shape cannulae were less accurate than continuous collections obtained from re-entrant cannulae.

The present study purposed to assess the sampling procedures with comparison of spot and 24-hr continuous sampling procedures for estimating duodenal digesta flow in young calves.

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Materials and Methods

Animals used were 2 Holstein castrated male calves weighing 100 kg fitted with the duodenal re-entrant cannulae[9]. Calves were fed such 2 different mixed rations as those with dry-heated soybean meal (HS) and with corn gluten meal (CG) as a main protein source. Table 1 shows the composition of rations used together with the contents of organic matter and crude protein. Daily allowance of the ration (4 kg/day) with two equal portions was fed twice daily (9 : 00 and 17 : 00 hour). The ration was expected to supply metabolizable energy to fulfil the requirement for daily gain of 0.5 kg (ARC[2]).

TABLE 1. Composition of rations used

	Ration	
	HS	CG
	%	
Orchardgrass hay, 1st cut	40.0	40.0
Rolled corn	42.7	48.0
Heated soybean meal[a)]	13.4	—
Linseed meal	1.8	—
Corn gluten meal	—	8.1
Fish meal, 60% CP	—	1.8
Vitamin and mineral mixtures	2.1	2.1
	% of DM	
Contents of		
Organic matter	94.4	95.2
Crude protein	15.5	14.3

a) Dry-heat treated at 130°C for 2 hours

The experiment was divided into two periods. In the first period, calves were fed HS ration and in the second, CG ration. After over 10 days of preliminary period, balance trials and measurements of duodenal digesta flow were conducted for 5 consecutive days. Of which period, feces and urine were collected by total collection method for the first 3 days. On the day when the fecal and urine collection started, spot sampling procedure also started for collecting 200 ml of duodenal digesta at 8-hour intervals for 3 day and samples were composited for a 24-hr sample. On the last day, duodenal digest were hourly collected from the abomasal side of cannulae for 24 hours with continuous sampling procedure. Aliquot samples were

retained in 10% of amounts of duodenal digesta collected hourly and composited for 24-hr samples. While the digesta collection proceeded, the digesta collected in a previous hour were infused into the jejunal side of cannulae using a rotary pump at a constant rate so as to complete the infusion within one hour. At the first collection term (9 : 00 to 10 : 00 hour), the infusion of digesta was done using the digesta collected in advance.

The preparation chromium inpregnated cell wall constituents (Cr-CWC)[10] was added to a ration at a rate of 0.5% on the air dry matter basis. Rations containing Cr-CWC were fed to calves during the periods of balance trials and measurements of duodenal digesta flow. Duodenal digesta flow was determined using chromium concentration in the digesta as an index for spot sampling procedure. The digesta flow determined by continuous sampling procedure and amounts of feces voided were also corrected with the chromium recovery.

The partitions of the digesta were determined using the coefficients of digestibility and the rates of nitrogen retention obtained by balance trials and the duodenal digesta flow determined.

Chemical analyses were done by the methods of A. O. A. C.[1] using fresh samples of duodenal digesta.

Results and Discussion

Table 2 shows the results of the partition of organic matter (OM) ingested, determined by continuous and spot sampling procedures. Duodenal OM flow determined by the continuous sampling procedure was greater than that by the spot sampling procedure, irrespective of the rations. Daily OM flow to the duodenum amounted to about 1.7 kg for the continuous sampling procedure and to about 1.5 kg for the spot sampling procedure.

TABLE 2. The partition of organic matter ingested, determined by continuous or spot sampling procedure

Ration	HS		CG	
Sampling procedure	Continuous	Spot	Continuous	Spot
	kg/day			
Ingested	3.28	3.28	3.32	3.32
Disappeared in the rumen	1.59	1.83	1.61	1.73
Entered in the duodenum	1.69	1.45	1.71	1.59
Disappeared in the lower gut	0.59	0.35	0.73	0.61
Excreted in feces	1.10	1.10	0.98	0.98
Digested in the whole tract	2.18	2.18	2.34	2.34

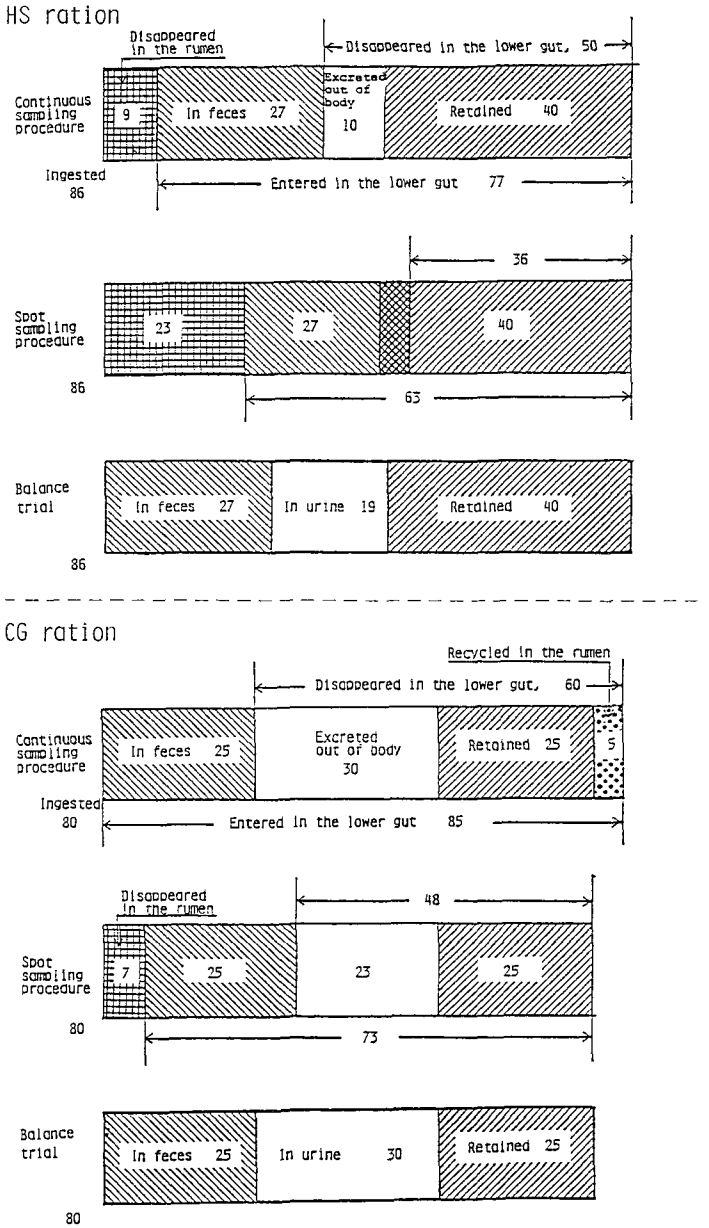

Fig. 1. Schematic illustrations of the partition of nitrogen ingested, determined by either continuous or spot sampling procedure and the balance trial for HS (upper half) and CG (lowere half) rations. Figures are expressed as g/day.

Amounts of OM apparently digested in the lower gut were greater in the continuous sampling procedure than the spot sampling procedure. Organic matter apparently digested in the lower gut amounted to 0.59 kg and 0.73 kg for HS and CG rations, respectively, as determined by the continuous sampling procedure and to 0.35 kg and 0.61 kg for HS and CG rations, respectively, as determined by the spot sampling procedure. Differences were found in amounts of OM digested in the lower gut and in the whole digestive tracts between HS and CG rations. Thus, the differences in the digestion of OM in the lower gut were responsible for the differences in the digestibility of OM between HS and CG rations.

Determinations by the spot sampling procedure appear to underestimate OM flow to the duodenum, when the results obtained were considered.

Figure 1 illustrates the partition of nitrogen (N) ingested, determined by either continuous or spot sampling procedure for HS and CG rations, together with results of N balance trial. Duodenal N flow determined by the continuous sampling procedure was greater than that by the spot sampling procedure, irrespective of the rations. Daily N flow to the duodenum amounted to 77 and 85 g for the continuous sampling procedure and to 63 and 73 g for the spot sampling procedure, for HS and CG rations, respectively.

In HS ration, amounts of N entered in the lower gut were less than the sum of N excreted in feces and retained in the animal body, when duodenal N flow was determined by the spot sampling procedure. Thus, amounts of N disappeared in the lower gut resulted in less than those retained in the animal body. Amounts of N disappeared in the rumen also exceeded over the urinary N (19 g/day) determined in N balance trial as a result of underestimation of duodenal N flow by the spot sampling procedure.

MACRAE and ULYATT[8] found no significant difference in duodenal digesta flow determined by spot and continuous sampling procedures. They used ^{103}Ru-phenanthroline and ^{51}Cr-EDTA as dual-phase markers for the spot sampling procedure, while chromium trioxide had been used to correct flow rates in the continuous sampling procedure. Yet, they pointed out the greater variability of the spot sampling results than continuous ones. Use of chromium trioxide appeared to be inappropriate as a marker in the spot sampling procedure[3,6,7].

Considering the results obtained in the present study and reported by several workers, the spot sampling procedure using chromium as a marker is concluded to underestimate the digesta flow to the duodenum. Thus, the continuous sampling procedure should be adopted to measure the doudenal

flow of digesta in young calves. When the spot sampling procedure is obliged to adopt, much attention should be stressed on the use of marker systems.

Summary

The sampling procedures were assessed between continuous and spot procedures for estimating duodenal digesta flow in young calves fed 2 different rations with heated soybean meal or corn gluten meal as a main source of protein. Flows of organic matter and nitrogen to the duodenum were greater in determinations by continuous sampling procedure than by spot sampling procedure, irrespective of rations. The continuous sampling procedure was concluded to be appropriate for collecting the duodenal digesta in young calves.

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