

Dry matter and nitrogen in the duodenal contents of growing pigs: a discrepancy explained

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1. Discrepancies between the results obtained from experiments on pigs with re-entrant duodenal cannulas have been investigated with reference to diet, cannula site and collection procedure.

2. The results obtained from a sealed automatic collection system were different from those obtained from an open manual method and it was concluded that the maintenance of gut intra-luminal pressure in the automatic system was the causative factor.

In several trials at the Institute of Animal Physiology and Nutrition, Jabłonna, Poland, 5–8 g/24 h more nitrogen passed through re-entrant duodenal cannulas, placed 50–70 cm from the pylorus of 40–60 kg pigs, than were ingested irrespective of the amount (between 1 and 50 g/24 h) or of the type of protein eaten (Zebrowska & Buraczewska, 1972; Zebrowska, 1973). By contrast, similar trials at the National Institute for Research in Dairying, Shinfield, Reading, showed that in 24 h about the same amount of N passed through cannulas placed 15 cm from the pylorus as was eaten (Low, unpublished); in this work the diets used were different from those used in Poland (Braude, Fulford & Low, 1976).

Exchange visits between the two Institutes enabled us to investigate whether (1) diet composition, (2) cannula location (at Jabłonna) and (3) digesta collection method (at Shinfield) could explain this discrepancy.

EXPERIMENTAL

Animals. Four castrated male Norwegian Landrace pigs and four castrated male Large White pigs were used at Jabłonna and Shinfield, respectively. The pigs weighed between 40 and 55 kg during the trials. They were housed continuously in metabolism cages and fed at a constant level (2.2 kg/d) at Jabłonna, or on a scale based on live weight at Shinfield (Barber, Braude, Mitchell & Pittman, 1972). Dry diet was mixed with water in the ratio of 1:2.5 (w/v).

Diets. At Jabłonna the diets contained (g/kg diet): wheat starch 600, cellulose 50, sucrose 100, soya-bean oil 30, casein 185, minerals and vitamins 35 (diet SSC); barley 895, white fish meal 70, minerals and vitamins 35 (diet BF). The diet used at Shinfield contained (g/kg diet): barley 712, fine wheat offal 200, white fish meal 70, minerals and vitamins 18 (diet BWF).

Surgery. At Jabłonna re-entrant cannulas were introduced into the duodenum either 15 cm ('proximal') or 70 cm ('distal') from the pylorus (2 pigs at each site) according to the method of Horszczaruk & Zebrowska (1973). At Shinfield all pigs had cannulas 15 cm from the pylorus and a similar surgical method was used (Markowitz, Archibald & Downie, 1954).

Digesta collection. At Jabłonna, digesta were collected by free drainage into a beaker; after 100–200 g had accumulated, a 5% sample was taken and the remainder returned

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Table 1. *Dietary intakes and average weights (g) of digesta, dry matter (DM) and nitrogen, passing duodenal cannulas at two sites in 24 h periods of manual collection at Jablonna*

(Nos of pigs completing collections in parentheses.
Pigs received 2200 g diet and 5500 ml water/24 h.)

Diet ...	SSC			BF		
	Digesta	DM	N	Digesta	DM	N
Intake	—	1998	53.6	—	1956	50.9
Proximal duodenum	14322	1978	63.9 (2)	26519	2131	61.9 (1)
Distal duodenum	15261	1902	60.8 (2)	29091	1952	59.2 (2)

Table 2. *Average dietary intakes and weights (g) of digesta, dry matter (DM) and nitrogen passing proximal duodenal cannulas in 24 h periods using manual, automatic or automatic unsealed collections at Shinfield*

(Number of pigs completing collections in parentheses.
On average pigs received 1674 g diet and 4185 ml water/24 h.)

Diet ...	BWF		
	Digesta	DM	N
Intake	—	1501	38.4
Manual collection	21572	1663	44.3 (4)
Automatic collection	20766	1391	38.4 (4)
Automatic collection unsealed	23156	1686	46.0 (4)
SED of 2 collection means (*)	848.8	42.2	1.13

* Pooled SED based on the interaction between collection methods with 5 d.f. due to adjustment for intakes.

through the entry cannula (called the 'manual method'). At Shinfield digesta were collected and returned by means of a sealed system (called the 'automatic method') which operated at gut lumen pressure and in which output and return of digesta occurred at approximately the same rate, temperature and pressure (Braude *et al.* 1976). In certain collections this system was used in an unsealed state (called the 'automatic unsealed' method). The 'manual method' was also used at Shinfield. There were usually three 24 h collections per pig per treatment.

Analysis. Dry matter was estimated by heating samples of the digesta at 102° for 18 h. N was estimated by the Kjeldahl method.

RESULTS AND DISCUSSION

The results obtained at Jablonna are shown in Table 1. Because two different cannula sites were studied, it was only possible to obtain results from one or two pigs for each site/diet combination, and this precluded statistical analysis of the results. However, it is notable that the average amounts of N which passed the cannulas, irrespective of site, were 13–22% above the intake levels. On the basis of this evidence it was considered that neither the nature of the diet nor the cannula location were factors which could adequately account for the discrepancy being investigated.

The results of collections at Shinfield are shown in Table 2. Pooled errors are presented but tests have been computed using individual errors.

For diet BWF there were significantly ($P < 0.05$) less digesta when the automatic collection method was used than when the automatic unsealed method was used, but the

automatic and manual methods did not give rise to significantly different amounts of digesta. However, it was found that there were significantly less ($P < 0.001$) dry matter and N flows when the automatic rather than the manual or automatic unsealed collection methods were used. From these results it was concluded that the discrepancy being investigated was the result of differences in the digesta collection methods being used at the two centres.

Results typical of the manual method were obtained from six of the early collections in which the automatic collection method was used. Subsequent examination of the automatic collection apparatus showed that intraluminal pressure could not have been maintained during these collections because of a defective bearing seal. Four further collections were therefore made, in which the apparatus was deliberately left open to the atmosphere and, again, results typical of the manual collection method were obtained. These indicated that correct intraluminal pressure was an important factor concerned in the regulation of digesta flow and composition. Which collection method gave results comparable to the normal physiological flow rates remains to be answered. We suggest that efforts should be continued to evolve a method of collection, sampling and returning digesta which involves less manipulation of re-entrant cannulas and digesta than those currently in use for studies of the duodenum, which is known to be a region highly sensitive to physical and chemical stimuli.

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