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ILEAL DIGESTIBILITY MEASURES ON CANULATED RABBIT

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INTRODUCTION

Only overall aspects of diet's digestion in rabbit are obtained by digestibility measures, using total feces collection. So, the relative importance of enzymic degradation of diets in the anterior part of the intestine (LEBAS et al., 1971) and the importance of fermentation of digestive residue in the cecum has not been clearly defined.

A convenient method for repeated sampling of ileal content, on canulated rabbits, has been reported in a previous paper (GIDENNE et al., 1988). The objective of the following experiment was to perform measures of flow on rabbits fistulated in terminal ileum, in order to determine apparent digestibility of a diet, before the fermentative digestion phase.

MATERIAL AND METHODS

Animals and feeding

Twelve adult female rabbits (New Zealand White x Californian), weighing 2.5 kg to 3.5 kg were alloted in two equal groups. Group "C" included rabbits fitted with single glass (Pyrex) cannula in terminal ileum, about 5 cm before ileocecal junction (GIDENNE et al., 1988). Group "N" include rabbits without cannula as control.

Animals were kept in individual metabolism cages, and submitted to a 12 h light 12 h dark schedule. Feeding was ad libitum with a pelleted diet based mainly on dehydrated lucerne. Chemical composition of the diet is given on table 1. According to the technique of UDEN (1978), chromium mordanced on lucerne hay was introduced in the diet (69 mg/kg) before pelleting, as a digesta flow marker.

Digestibility measures

Total apparent digestibility coefficients (ADC) were measured by total fecal collection during two periods of four days, on both C and N rabbits.

Ileal apparent digestibility (IAD) was calculated by the formula :

$$IAD = \left[\frac{TI - IF}{DI}\right] \times 100$$

TI or total intake = Diet intake (DI) + intake of soft feces.

IF or ileal flow was calculated by the method of the marker's dilution.

Ileal digestive contents were sampled along a 24 h period (8 collections, every 3 hours), as described by GIDENNE et al. (1988). Two or three collections per week were made (one hour each) to avoid stress or digestive disturbances. Then, a mean sample was made up for each rabbit (group C).

Soft feces excretion was measured on rabbits wearing a plastic collar, as described by GIDENNE and LEBAS (1987). For analyses, individual mean samples of soft feces were constituted after two separate periods of 24 hours collection.

Analyses

All samples were freeze-dried before analyses of crude protein (Kjeldhal method), gross energy (adiabatic calorimeter "PARR") and cell-walls (method of Van Soest and Wine, 1967 modified by GIGER et al., 1979). Chromium was analyzed by atomic absorption spectrophotometry.

TABLE 1

APPARENT DIGESTIBILITY COEFFICIENT MEASURED ON CANULATED AND NON-CANULATED RABBITS

	DM	CP	Energy kcal/kg	NDF	NDF-ADL	ADF-ADL	ADL
Diet composition % DM	91.7	17.5	4277	37.2	14.2	18.0	5.0
ADC %							
Non-canulated	59.4 ± 0.9	68.4 ± 1.9	59.2 ± 1.0	21.1 ± 1.4	30.9 ± 2.6	20.2 ± 2.0	- 3.8 ± 7.5
Canulated	59.1 ± 2.6	67.6 ± 4.5	58.7 ± 3.0	21.6 ± 4.3	30.8 ± 5.0	20.0 ± 5.2	1.5 ± 4.2
Residual SD	1.9	3.5	2.2	3.2	4.2	3.9	6.7

Mean values (n = 6) ± standard deviation (SD).

RESULTS

Apparent total digestibility of the diet

For any constituant of the diet, apparent digestibility coefficients were not significantly affected by canulation (table 1). Mean values measured for fistulated rabbits have higher standard deviation than in control group. This probably provide from greater variations in diet intake for group C (122.4 g ± 41.4 DM/d) than for group N (178.5 ± 28.8 g DM/d). Nevertheless, diet intake expressed relative to live weight, were not significantly different between the two groups : 35.6 ± 11.8 for group C, and 40.8 ± 6.8 g DM/kg live weight for group N.

Energy ADC was 59.2 %, conducting to a digestible energy content of the diet of 2532 kcal/DE/kg. More than twenty percent of NDF fraction appeared digestible, including better digestibility for hemicellulose (NDF-ADF) than for cellulose (ADF-ADL). Lignin fraction appeared undigested for this diet.

Digestibility of the diet in the small intestine

Fecal recovery rate of mordanced chromium was 96.8 ± 1.5 % (n = 6) for N group, and 100.8 ± 4.7 % for C group, indicating that chromium was unabsorbed during digestive transit.

For cell wall components, values for ileal apparent digestibility coefficient were very low (table 2), and thus standard deviation are high. But, more precision is obtained if using the term of ileum recovery rate (IRR), which is equal to :

$$\frac{\text{ileal flux}}{\text{total intake (diet and soft feces)}}$$

Thus, IRR for NDF and cellulose did'nt differ significantly from 100 %. But, corresponding values for hemicellulose indicated that approximatively 15 % of ingested hemicellulose disappeared before cecum. Inversely, more lignin was recovered in terminal ileum than total ingested quantities.

Ileal flow of DM, indicated that approximatively one third (37 %) of digestible dry matter and the two-third of crude protein apparently disappeared in the small intestine.

Moreover, soft feces for our adult rabbits correspond to 12 % of DM and to 21.5 % of crude protein ingested from the diet.

TABLE 2

INTAKE, ILEAL FLOW AND ILEAL DIGESTIBILITY OF DIET CONSTITUANT

	DM	Energy kcal/d	CP	NDF	HC	C	ADL
(1) Diet intake (g/d)	125,1 ±44,2	521,6 ±184,3	21,9 ±7,3	46,5 ±15,4	17,7 ±5,9	22,4 ± 7,4	6,3 ± 2,1
(2) Soft feces (g/d)	14,9 ± 7,1	67,8 ± 3,2	4,7 ±2,2	6,1 ± 3,1	2,2 ±1,3	2,3 ± 1,1	1,1 ± 0,5
(3) Ileal flow (g/d)	111,9 ±38,2	463,8 ±157,8	17,2 ±5,8	51,2 ±18,8	17,2 ±6,3	25,7 ± 9,3	8,3 ± 3,3
Recovery rate at ileum (%) (3)/(1+2)	80,5 ± 2,4	78,7 ± 2,4	65,4 ±4,4	97,9 ± 3,2	86,3 ±3,6	102,2 ± 3,9	111,6 ± 6,8
Ileal ADC (%) [(1+2)-(3)]/(1)	21,8 ± 3,1	23,4 ± 3,2	42,2 ±7,0	2,9 ± 3,5	15,4 ±3,8	- 2,4 ± 4,3	- 13,5 ± 7,8

Mean values (n = 6) ± standard deviation

DISCUSSION

According to results of the table 1, our technique of ileal canulation, using Pyrex cannula in adult rabbits, did'nt induce significative disturbance on digestive phenomenons. This was in agreement with results of KAMETAKA (1970), who observed any difference between canulated (PVC canula) and non canulated rabbits, for DM digestibility and fecal excretion pattern.

Ileal flow measures, with collection of digesta after slaughter, conducted to negative digestibility of crude protein (WOLTER et al., 1980) and to high digestibility for cell-walls (GIDENNE, 1987) in the small intestine.

Inversely, values of ileal flow obtained on the canulated rabbits are in a better agreement with "theoritical model", as the two-third of digestible CP disappeared before cecum. This confirmed hypothesis (GIDENNE, 1987), supporting that digesta samples obtained after slaughter were not representative of the content, because they did'nt account with differential transit time of the diet constituant. This was particularly true in the small intestine, where digesta content are very low, and thus where sampling errors could be very important.

For horses receiving a diet similar in chemical composition to our diet, DM and CP digestibility before cecum (HINTZ et al., 1971) were similar to those obtained for rabbits. Thus, for these two herbivorous species, digestion in small intestine would be quite similar.

According to the diet constituants, inter-individual variation coefficient for ileal flow varied between 32 and 37 %, as it was observed on canulated pigs by BRAUDE et al. (1976).

Ileal flow of cell walls constituants indicated that NDF fraction and cellulose (ADF-ADL) remained undigested before cecum. But, half of digestive hemicelluloses would be apparently absorbed in small intestine. In the same way, KEYS and DEBARTHE (1974) observed on pigs receiving a diet containing 30 % NDF that 20 % of digestible hemicellulose disappeared before hindgut. However, this results, supporting hemicelluloses digestibility without bacterial degradation in cecum or colon, could be affected by artefact in cell walls analyses on digesta with Van-Soest method.

This hypothesis was confirmed by lignin ileal flow (table 2) wich was superior to the intake, as previously observed in man (lignin ileal ADC = - 70 %) by HOLLOWAY et al. (1978). These overestimation of ADL ileal flow could be provide by overestimation in ADL fraction. In digestive contents, lignin residue obtained with Van-Soest technique, were probably contamined by other components, as protein-lignin or polysaccharides-lignin complexes. These complexes could contamined also ADF fraction, resulting in overestimation of ADF flow in ileum (IRR of ADF = 106.1 ± 5.2 %). So, assuming NDF fraction analyses was exact, concentration of hemicelluloses would be underestimated in ileum, corresponding to an apparent increased of hemicelluloses digestibility.

Soft feces excretion for DM and CP were similar to that observed by PROTO et al. (1968) or by GIDENNE et LEBAS (1987) and this confirmed the importance of caecotrophy for rabbit, especially for his protein requirement.

CONCLUSION

Ileal canulation are not significantly modified by diet intake or apparent total digestibility measures. This technique appear to be convenient for measurements of flow in terminal ileum. Now, studies on the relative importance of enzymic and fermentative degradation of the diet in rabbit could be performed.

These first measurement of digesta flow in the terminal ileum, give experimental confirmation that cell walls remains undigested in rabbit small intestine. But, ileal digestibility of hemicelluloses put forward the problem of fibre analyses in digestive contents.

Globaly, in the posterior parts of rabbit digestive tract (cecum and colon), the two-third of digestible DM and one third of digestible CP are apparently digested.

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Six adult female rabbits fitted in terminal ileum with single glass cannula and a further six non-cannulated rabbits were used. They received a pelleted diet, based on dehydrated lucerne, containing mordanced chromium as a marker of digesta flow. Intake and total apparent digestibility coefficient (table 1) were not significantly modified by ileal canulation.

The measurements of the flow of digesta in terminal ileum were realized on digesta samples collected in fistulated rabbits, according to the principle of the marker's dilution. According to ileal flow values, 21,8 % of dry matter and 42,2 % of crude protein was apparently digested in small intestine. For cell-wall constituants, NDF fraction and cellulose (ADF-ADL) are totally recovered in terminal ileum. But, about the half of digestible hemicellulose (NDF-ADF) would be hydrolysed before caecum, and ileal flow for ADL was superior to the total intake. This results could be caused by an overestimation in ADL analyses of digestive contents.

Independantly of these analytical problems, rabbit cannulated in terminal ileum is a convenient model for studying separately, enzymic degradation of a diet, and his fermentation by caecocolique flora.

MESURES DE DIGESTIBILITE ILEALE CHEZ LE LAPIN CANULE

Gidenne T.

Douze lapines adultes, dont 6 canulées à l'iléon terminal, ont reçu ad libitum un aliment à base de luzerne déshydratée, contenant un marqueur de transit : le chrome mordancé.

La canulation n'affecte pas significativement l'ingéré d'aliment ni les mesures de digestibilité (tableau 1).

Les mesures de flux de digesta à l'iléon terminal sont réalisées, à partir de prélèvements obtenus chez l'animal canulé, selon le principe de la dilution du marqueur. Les valeurs des flux iléaux (tableau 2) indiquent une digestibilité de la matière sèche de 21,8 % et une digestibilité des protéines brutes de 42,2 % avant le caecum. La fraction "NDF" et la cellulose (ADF-ADL) sont retrouvées en totalité dans l'iléon terminal. Par contre, environ la moitié des hémicelluloses (NDF-ADF) digestibles serait dégradées dans l'intestin grêle, tandis que le flux iléal de lignines (ADL) dépasse l'ingéré total. Une surestimation de la fraction lignine dans les digesta, par la technique de Van-Soest peut être à l'origine de ces résultats.

Indépendamment des problèmes d'analyse des constituants pariétaux dans les contenus digestifs, le lapin canulé à l'iléon terminal apparait comme un modèle adéquat pour étudier séparément la digestion enzymatique d'un régime et la fermentation par la flore caecocolique.