Proceedings 5th World Rabbit Congress, 25-30 July 1992, Corvallis – USA, 931-937.

EFFECT OF TYPE OF FIBRE ON ILEAL AND FAECAL DIGESTIBILITIES

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Introduction

Previous studies have shown the importance of type of fibre on digestive physiology in rabbits (transit time, caecal activity, soft faeces excretion and faecal digestibility) (Fraga et al, 1991; Motta, 1990). However, for a proper feedstuff evaluation it is also necessary to know the amount of nutrient degradation and absortion in the different parts of digestive tract, because this could modify the net utilization of the absorbed nutrients.

The ileal fistulation of rabbits developed by Gidenne and Bouyssou (1987) can be a good method to have a better knowledge about the role of fibre sources in diet digestion.

The aim of this work was to study the effect of partial substitution of alfalfa by sugar beet pulp or grape marc on ileal and faecal digestibility.

Material and Methods

Animals and Feeding. Six adult female rabbits (New Zealand White x California) weighing 3.7 kg to 4.0 kg were fistulated with a glass cannula at the terminal ileum (Gidenne et al., 1988).

Animals were kept in individual metabolism cages and submitted to a cycle of 12 h light 12 h darkness.

To study the effect of type of fibre, three isofibrous (crude fibre) diets based on a partial substitution (60%) of alfalfa hay from diet A by grape marc (diet GM) or sugar beet pulp (diet BP) were formulated. The inclusion level of barley and soybean meal were varied in order to meet essential nutrients requirements (Lebas, 1980; de Blas et al., 1981). Raw materials and chemical composition of diets and chemical composition of fibre sources are shown in tables 1 and 2. All three diets included mordanted chromium on alfalfa hay (Uden et al, 1980) as a digesta marker.

Throughout the experiment, animals were fed the three experimental diets ad libitum according to a Latin square design.

Sampling Colletion. The sampling collection period from ileum was performed after animals had recovered from surgeon.

Ileal samples were collected to cover a period of 24 hours at 9.00, 13.00, 17.00, 21.00, 01.00 and 05.00 h.. Collections lasted 1 hour and were held along a period of two weeks (Gidenne,1987).

Soft faeces excretion was measured after the ileal collection period for each diet according to the methodology described by Carabaño et al. (1988).

The faecal digestibility trial was carried out at the end of the experimental period with three fistulated animals. Collection was done along four consecutive days.

Samples from ileum, soft and hard faeces were stored at -18 ºC up to their chemical analysis.

Analitical Methods. Before the chemical analysis, ileal samples and soft faeces were freeze-dried and hard faeces were dried for 48 h at 80 ºC for DM determination.

Chemical analysis of diets, hard faeces, soft faeces and ileal samples were made following the method of A.O.A.C. (1984) for DM, ash, CP and CF; Van Soest (1963) for ADF and ADL, and Robertson and Van Soest (1977) for NDF. Starch was determined according to procedures described by Longstaff and Mc Nab (1987). Chromium recovery was done following the method of Siddons et al (1985) and was analyzed by atomic absorption spectrophotometry.

Calculations and Statistical Analysis. Ileal apparent digestibility (IAD) was calculated as follows:

$$IAD = \frac{TI - IF}{FI}$$, where:

TI (total intake) = feed intake (FI) + soft faeces intake
IF (ileal flux) = calculated by the marker dilution method

At the end of the experimental period only 5 data for each diet were obtained because one animal died during the experimental period. Statistical analysis were made using the GLM procedure of SAS program (1985).

Results and Discussion

The effect of type of fibre on ileal and faecal digestibility is shown in tables 3 and 4 respectively.

The partial substitution of alfalfa hay by beet pulp did not show differences with respect to the alfalfa diet at ileal level. Dry matter and CP digestibility were as average 49% and 60% respectively for both diets. These values were similar to the obtained by Gidenne et al (1990) with a semipurified diet where alfalfa was included at 48.5% as the main fibre source. Yu et al (1987) obtained lower DM and CP ileal digestibilities (44.7% and 33.5% respectively) with a diet similar to diet A in chemical and raw materials composition. These differences could be due to that soft faeces excretion is not considered for ileal digestibility calculations.

Ileal fibre digestibilities for diets A and BP were much higher than expected. Several authors have observed partial digestion of fibre at ileum in rabbits and pigs (Gidenne et al., 1990; Yu et al., 1987; Longland et al., 1988; Just et al., 1985; Schulz et al., 1988). However, the low soft faeces excretion obtained in this work (6.6 and 8.8 g DM/d for diets A and BP, respectively) could have subestimated the ileal flux, increasing this effect.

Except for ADF, that showed lower ileal digestibility for diet BP than for

diet A, NDF and CF digestibilities did not show significant differences.

Starch was totally digested before caecum in both diets BP and A. The low starch level of ileal content (1.09% and 0.4% for diets A and BP respectively) is in agreement with the results obtained from slaughtered animals (Blas, 1986; Motta, 1990). So, the results of this work support that very small quantities of starch could reach the caecum.

Faecal digestibility of diet BP was higher than for diet A; however, there were not significant differences except for NDF digestibility. Motta (1990) using the same diets observed a similar, but significant, effect for all nutrients in growing rabbits. Since no differences in digestibility were found at ileal level, differences in caecal digestion could explain this tendency. When ileal and faecal digestibilities were compared (table 5), diet BP showed higher post-ileal digestibility than diet A, mainly for fibrous components (NDF, ADF and CF). Graham et al (1985) in pigs observed that the pectines (30% of total non-starch polysacharides) of sugar beet pulp are quite totally fermented at the post-ileal part of the intestinal tract.

As a result, the partial substitution of alfalfa by beet pulp increased the proportion of DM and OM digested after the ileum (40% and 33% vs 25% and 18% for diets BP and A respectively). However, these differences do not seem to be enough to change the efficiency of energy utilization in rabbits. Motta (1990) obtained that overall efficiency for digestible energy in growing rabbits was 21.5% and 21.9% for diet BP and A, respectively.

The partial substitution of alfalfa by grape marc significantly decreased ileal and faecal digestibility of all chemical components, except for starch that was totally digested at ileum. The starch level in the ileal content (1.29%) was as low as in diets BP and A.

Crude protein and fibre were the mainly affected chemical components by grape marc inclusion. Several authors have obtained low CP faecal digestibility of diets with increasing levels of grape marc (Paragi-Bini and Chiericato, 1980; Falcao e Cunha and Lebas, 1986; Motta, 1990). For most of them, the high proportion of protein bound to lignin and the tannin content of grape marc seem to be the main reasons to explain this effect.

The results of this work show that the impairment of CP digestion specially occurs at the ileal level where inclusion of grape marc reduces about 53% CP digestibility respect to diet A. Although caecal CP digestibility is low(17%), it is higher than the obtained for diet A (Table 5).

Fibre was poorly digested at both ilelal and faecal levels.

Consequently, the proportion of DM and OM digested in the caecum was higher for diet GM than for diet A (48 and 37% vs 33 and 18%, respectively). Motta (1990) did not observe changes in energy efficiency for diet GM (20.9%) respect to diet A, possibly due to the low caecal activity (volatile fatty acids production) associated with this diet.

As a conclusion, the type of fibre affects the site of nutrients digestion, however more studies at ileal level together with studies on net utilization of

nutrients are necessary to know the practical consequences of these results for feedstuff evalutation in rabbits.

On the other hand the importance of the caecotrophy on ileal digestibility estimations must be reviewed because this could explain some of the unexpected results obtained, specially for fibrous components.

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Table 1. Raw materials and chemical composition of diets

	A	GM	BP
Raw materials (%)			
Alfalfa hay	50	20	20
Sugar beet pulp	-	-	30
Grape marc	-	30	-
Barley	38	41	35
Soya bean meal	10	7	13
Bentonite	1.3	1.3	1.3
Salt	0.5	0.5	0.5
Mineral and vitamin supplement	0.2	0.2	0.2
Chemical composition (% DM)			
DM	91	91	91
OM	90	91	92
CP	18.92	15.07	17.61
NDF	31.75	36.23	37.36
ADF	19.26	28.09	18.14
CF	15.46	15.25	15.25
Starch	32.01	33.37	26.46
Cr (mg/g DM)	4.07	4.36	4.16
	0.102	0.109	0.104

DM = dry matter; OM = organic matter; CP = crude protein; ADF = acid detergent fiber; CF = crude fiber; Cr = chromium

Table 2. Chemical composition of alfalfa hay, grape marc and sugar beet pulp (% DM)

	Alfalfa hay	Grape marc	Beet pulp
DM	85.4	88.2	87.6
Ash	13.6	11.2	5.3
CP	20.3	12.0	9.2
NDF	43.5	63.2	53.9
ADF	31.2	57.0	27.6
ADL	7.7	37.4	4.2
CF	27.7	27.8	24.3

Table 3. Effect of type of fibre on ileal digestibility (g/g)

	Diets				
	A	GM	BP	rsd	Probability > F
DM	0.515 a	0.286 b	0.456 a	0.05	0.0001
OM	0.565 a	0.340 b	0.506 a	0.05	0.0001
Starch	0.980	0.973	0.993	0.01	0.2479
CP	0.608 a	0.284 b	0.596 a	0.08	0.0001
NDF	0.393 a	0.098 b	0.435 a	0.06	0.0001
ADF	0.365 a	0.105 b	0.263 b	0.05	0.0003
CF	0.223 a	-0.050 b	0.300 a	0.06	0.001

a, b Means in the same row without common superscript differ (P < 0.05)

Table 4. Effect of type of fibre on faecal digestibility (g/g)

	Diets				
	A	GM	BP	rsd	Probability > F
DM	0.687 a	0.547 b	0.750 a	0.035	0.0001
OM	0.693 a	0.543 b	0.757 a	0.034	0.0007
Starch	1.000	0.993	0.993	0.004	0.216
CP	0.667 a	0.457 b	0.703 a	0.024	0.0001
NDF	0.420 b	0.190 c	0.613 a	0.073	0.001
ADF	0.323 ab	0.097 b	0.573 a	0.117	0.020
CF	0.363 a	0.153 b	0.523 a	0.096	0.0095

a, b Means in the same row without common superscript differ (P < 0.05)

Table 5. Caecal digestibility (g/g) (1)

	Diets		
	A	GM	BP
DM	0.172	0.261	0.294
OM	0.128	0.203	0.251
Starch	0.020	0.020	0.000
CP	0.059	0.173	0.107
NDF	0.028	0.093	0.178
ADF	-0.041	-0.008	0.211
CF	0.140	0.206	0.223

(1) Caecal digestibility = mean faecal digestibility - mean ileal digestibility .