EFFECT OF ILEAL CANNULATION ON FEED INTAKE, SOFT AND HARD FECES EXCRETION THROUGHOUT THE DAY IN RABBITS

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Abstract - Eight adult female rabbits cannulated at terminal ileum (C) (2.65 ± 0.20 kg) and ten non-cannulated female rabbits (NC) (2.55 ± 0.06 kg) were used to study the effect of cannulation on the rhythms of soft and hard feces excretion and feed intake throughout 24 hours. A wooden collar was put on each animal to prevent cecotrophy. The collar was placed at 08:00, (light period 07:30 to 19:30) and was removed 24 h later. The animals were fed a commercial diet *ad libitum* (32.7 % NDF and 19.1% CP on DM) throughout the experimental period. Following the same procedure, 3 C and 4 NC animals were used to evaluate circadian rhythms of hard feces excretion and feed intake, when cecotrophy was or was not prevented. Cannulated animals showed smaller (P=0.10) soft feces excretion than NC animals (28.7 vs 33.7 g DM/d). However, C animals showed larger hard feces excretion (45.2 vs 34.2 g DM/d) (P<0.05) and feed intake (148.6 vs 106.7 g DM/d) (P<0.01) than NC animals. Sampling time had a significant effect (P<0.001) on all variables studied. Soft feces excretion took place mainly from 08:00 to 16:00 for both types of animals (84% and 64% of total excretion for NC and C animals, respectively). Ninety percent of total hard feces excretion and 86% of total feed intake occurred from 18:00 to 08:00, and from 16:00 to 08:00, respectively, for both types of animals. A significant interaction was found between the effect of cannulation and sampling time for soft (P<0.01) and hard (P<0.05) feces excretion. Cannulated animals showed smaller soft feces excretion (10 g DM) and larger hard feces excretion (10 g DM) than NC animals, 08:00 to 16:00 and 16:00 to 04:00 periods, respectively. The differences in hard feces excretion and feed intake among animals when cecotrophy was or was not prevented were not affected by cannulation or sampling time. From these results we may conclude that cannulation affects total feces excretion and feed intake but not their circadian rhythms.

INTRODUCTION

A prerequisite to validate an ileal cannulation technique is to confirm wether or not cannulation disturbs processes of digestion. GIDENNE and RUCKEBUSCH (1989) observed that cannulation do not affect neither the total digestibility nor transit time. However, the ileal cannulation reduces daily soft feces excretion (GIDENNE *et al.*, 1994). Soft feces are excreted according a circadian rhythm opposed to that of the hard feces excretion and feed intake (LEBAS and LAPLACE, 1974). A disturbance of that pattern might change the chemical composition of ileal digesta and, so the ileal sampling procedure. There is a lack of data about the effect of cannulation on those rhythms throughout the day. The aim of this work was to study the effect of cannulation on circadian rhythms of soft and hard feces excretion and feed intake.

MATERIAL AND METHODS

Animals and Diets

Eighteen adult female rabbits (New Zealand x California) were used to estimate the rhythms of soft and hard feces excretion and feed intake throughout 24 hours. These animals were divided in two groups, ten animals were used as a control group (NC), and eight animals (C) were cannulated at terminal ileum following the technique described by GIDENNE *et al.* (1988).

The animals were individually housed in metabolism cages that allowed separation of feces and urine.Environmental conditions were controlled. A 12/12 h light-dark schedule was used. The light period started at 07:30. Average temperature was 17 ± 3.1° C.

The animals were fed ad libitum with a commercial diet throughout the experimental period. The chemical composition of the diet, expressed on dry matter, was: 13.8% CF, 37.2% NDF, 16.8% ADF, 3.62% ADL, and 19.1% CP.

Trial 1

After a 14-d period of adaptation to the diet, the animals were weighed (average weight 2.55 ± 0.06 and 2.65 ± 0.20 kg, for NC and C animals, respectively), and a wooden collar (30 cm diameter) was put on each animal to prevent cecotrophy. The collar was placed at 08:00, (30 minutes after the beginning of light period) and was removed 24 h later. During that period, feed intake and soft and hard feces excretion were recorded every hour (06:00 to 18:00) or every two hours (18:00 to 06:00).
Feces collected were dried at 103° C to determine dry matter content. A sample of feed was also dried following the same procedure.
This trial was repeated seven days after, so the mean values of the two repetitions were used for the statistical analysis.

Trial 2

Following the previously described procedure, 3 C and 4 NC animals were use to evaluate the pattern of hard feces excretion and feed intake throughout 24 h period, when cecotrophy was or was not prevented.

Statistical analysis

Analyses of variance were performed using GLM procedure of SAS (1985). The main effects tested were cannulation (cannulated or non-cannulated), sampling time, and individual variation of rabbits. The interaction cannulation*sampling time was also considered.The mean square of intraindividual variation was used as a term of error to test the effect of cannulation. Differences in hard feces excretion and feed intake for the same animal with or without cecotrophy were analyzed using the same model described above, to evaluate influence of the prevention of cecotrophy on circadian rhythms.

RESULTS AND DISCUSSION

Trial 1

Figure 1 shows the variation of soft and hard feces excretion and feed intake for C and NC animals, throughout a 24 h period. According to the observed patterns, data from several hours were pooled in three periods: 04:00 to 08:00, 08:00 to 16:00, and 16:00 to 04:00 (Table 1).

Table 1 : Effect of cannulation and sampling time on soft and hard feces excretion (g DM) and dry matter intake (g DM) throughout 24 hours

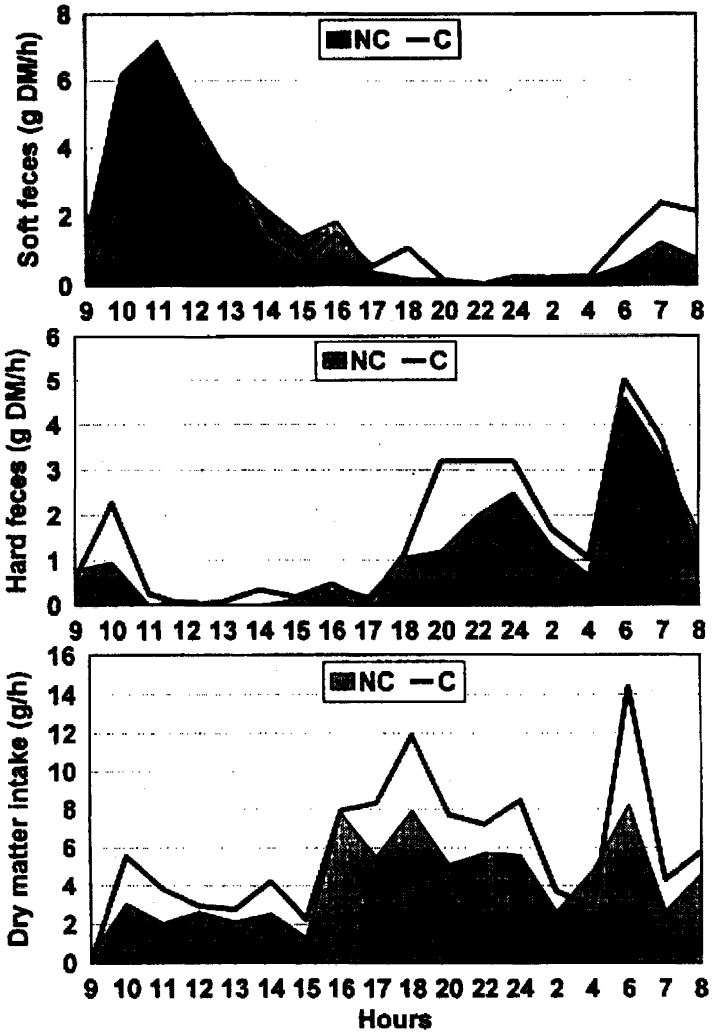
Time period	Soft feces		Hard feces		Intake	
	C	NC	C	NC	C	NC
04:00 to 08:00	7.4	3.2	14.6	14.1	38.9	23.5
08:00 to 16:00	18.4	28.4	4.2	2.4	29.5	21.8
16:00 to 04:00	3.2	2.1	26.0	16.8	80.2	61.2
SEM	1.9		1.8		4.1	
P < F						
Cannulation	0.10		0.05		0.01	
Time	0.001		0.001		0.001	
Interaction[d]	0.01		0.05		NS	
Animal	NS		NS		0.10	

C : Cannulated animals, n=8; NC:Non cannulated animals, n=10
SEM : Pooled standard error of the means
d : Cannulation*Time
NS : Not significant effect P>0.10

Sampling time had a significant effect (P<0.001) on all variables studied. Soft feces excretion took place mainly during light period (08:00 to 16:00) for both types of animals (84% and 64% of total excretion for NC and C animals, respectively). However, soft feces excretion began earlier for C animals. Seventy five percent of C showed soft feces excretion from 06:00 to 08:00, while, only 30% of NC animals showed soft feces excretion in

this period. Both type of animals showed a maximum at 11:00 (4.3 and 7.2 g DM, for C and NC animals) (Figure 1).

Figure 1 - Soft and hard feces excretion, and dry mater intake in non-cannulated (NC) and cannulated (c) animals throughout the day



Ninety percent of total hard feces excretion and 86% of total feed intake occurred during dark period (18:00 to 08:00, and 16:00 to 08:00, respectively) for both types of animals. As shown in Figure 1, hard feces excretion occurs along two periods (18:00 to 02:00 and 04:00 to 08:00), showing two maxima of excretion, 20:00 to 24:00 and at 06:00. Feed intake ocurred also along two periods (16:00 to 02:00 and 04:00 to 08:00), showing a maximun at 06:00. Our results are in agreement with those obtained by LEBAS and LAPLACE (1974) for non cannulated animals. These authors observed hard feces to be excreted 17:00 to 09:00, grouped in two periods 17:00 to 01:00 and 05:00 to 09:00. BELLIER *et al.* (1995) observed a longer period for adult animals (14:00 to 08:00) and they conclude that cecotrophy period was from 08:00 to 14:00. However, no data in cannulated animals about circadian rhythms of soft and hard feces excretion and feed intake are available.

Cannulated animals showed smaller (P=0.10) soft feces excretion than NC animals (28.7 vs 33.7 g DM/d) (Table 1). However, C animals showed larger hard feces excretion (45.2 vs 34.2 g DM/d) (P<0.05) and feed intake (148.6 vs 106.7 g DM/d) (P<0.01). GIDENNE *et al.* (1994) also observed smaller soft feces excretion for C animals than for NC animals (12 vs 16 g DM/d). However, no differences were obtained in hard feces excretion in that study.

A significant interaction was found between the effect of cannulation and sampling time for soft (P<0.01) and hard (P<0.05) feces excretion (Table 1). Cannulated animals showed smaller soft feces excretion (10 g DM) than to NC animals, from 08:00 to 16:00, but mainly during the maximum period of excretion 10:00 to 12:00 (Figure 1). On the contrary, C animals showed larger hard feces excretion (9 g DM) than NC ones from 16:00 to 04:00. These results suggest a lower recycling of cecal contents by cecotrophy, being excreted as hard feces for C animals. Taking into account the high content of protein of soft feces (CARABAÑO *et al.*, 1988), a reduction in protein

digestibility for C animals may be expected. GIDENNE *et al.* (1994) observed lower protein digestibility in C animals than in NC animals.
No interaction was found for dry matter intake pattern along the day.

Trial 2

Tables 2 and 3 show the hard feces excretion and dry matter intake, respectively, in C and NC animals with or without cecotrophy. To study main effects and interaction the data were pooled in the same three periods mentioned in the previous trial.

Table 2 : Effect of privation of cecotrophy on circadian variation of hard feces excretion (g DM) in cannulated (n=3) and non-cannulated animals (n=4)

Time period	Cannulated		Non-cannulated	
	A	B	A	B
04:00 to 08:00	18.1	12.2	12.6	11.4
08:00 to 16:00	6.8	4.9	1.3	1.8
16:00 to 04:00	25.1	27.9	20.6	18.0
SED	6.5			
P < F				
Cannulation	NS			
Time	NS			
Interaction[d]	NS			
Animal	NS			

A :control animals; B animals without cecotrophy
SED : Pooled standard error of the mean of differences (control - without cecotrophy)
d : Cannulation*Time
NS : Not significant effect P>0.10

When cecotrophy was prevented, a reduction of total hard feces excretion (10%) was observed for C and NC animals (table 2). However, the differences in hard feces excretion among animals with or without cecotrophy were not affected by cannulation, time period or their interaction. Hard feces excretion occurred from 16:00 to 08:00 when cecotrophy was or was not prevented (87.7 and 95 % asaverage of total hard feces excretion for C and NC animals, respectively).
Total dry matter intake (Table 3) was similar for C animals when cecotrophy was or not was prevented (132.2 g DM/d, as average). However, NC animals showed a smaller feed intake when cecotrophy was prevented (98.9 vs 111.3 d DM/d). The differences in feed intake among animals with or without cecotrophy were not affected by sampling time. The interaction cannulation*sampling time was not significant. Eighty two percent of total dry matter intake occurred from 16:00 to 08:00.

Table 3 : Effect of privation of cecotrophy on circadian variation of dry matter intake (g DM) in cannulated (n=3) and non-cannulated animals (n=4)

Time period	Cannulated		Non-cannulated	
	A	B	A	B
04:00 to 08:00	37.4	32.5	25.7	19.9
09:00 to 16:00	28.0	27.7	18.0	16.3
16:00 to 04:00	66.3	72.5	67.6	62.7
SED	11.0			
P Level				
Cannulation	0.05			
Time	NS			
Interaction[d]	NS			
Animal	NS			

A : control animals; B animals without cecotrophy
SED : Pooled standard error of the means of differences (control - without cecotrophy)
d : Cannulation*Time
NS : Not significant effect P>0.10

CONCLUSIONS

Cannulation reduced the recycling of cecal contents by cecotrophy, increasing the hard feces excretion. However, both cannulated and non-cannulated animals showed similar circadian rhythms of soft and hard feces excretion and feed intake. Prevention of cecotrophy did not affect circadian rhythms of soft and hard feces excretion and dry matter intake.

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Ejecto de la canulación ilial sobre los ritmos de ingestión de pienso y la excreción de heces duras y blandas a lo largo del día - Ocho conejas adultas canuladas (C) en ileon terminal (2.65 ± 0.20 kg) y diez no canuladas (NC) (2.55 ± 0.06 kg) fueron utilizadas para estudiar el efecto de la canulación sobre los ritmos de excreción de heces blandas y duras y los ritmos de ingestión de pienso a lo largo del dia. Para impedir la coprofagia, se colocó un collar de madera sobre cada animal a las 08:00 y se retiró 24 horas más tarde. El periodo de luz fue de las 07:30 a las 19:30. Los animales fueron alimentados ad libitum con un pienso comercial (32.7% FND y 19.1% PB sobre MS) a lo largo del periodo experimental. Siguiendo el mismo procedimento experimental, 3 animales C y 4 NC fueron utilizados para estudiar el efecto de la prevención de la coprofagia sobre los ritmos de excreción de heces duras y blandas y los ritmos de ingestión. Los animales C tuvieron menores (P=0.10) excreciones de heces blandas que los NC (28.7 vs 33.7 g MS/d). Sin embargo, los animales canulados tuvieron una excreción de heces duras (45.2 vs 34.2 g MS/d) y una ingestión de pienso (148.6 vs 106.7 g MS/d) mayor (P<0.05 y P<=0.01, respectivamente) que los animales no canulados. La hora de muestreo tuvo un efecto significativo (P<0.001) en todos los parámetros estudiados. La excreción de heces blandas tuvo lugar de 08:00 a 16:00 para ambos tipos de animales (90% and 64% de la excreción total para los animales NC y C, respectivamente). Para ambos tipos de animales, el 84% de la excreción total de heces duras y el 86% del total de la ingestión tuvo lugar de 18:00 a 08:00, y de 16:00 a 08:00, respectivamente. La interacción canulación*hora de muestreo fue significativa para la excreción de heces blandas (P<0.01) y duras (P<0.05). Los animales C tuvieron una excreción menor de heces blandas (10 g DM) y mayor de heces duras (10 g DM) que los animales NC, durante los periodos de 08:00 a 16:00 y de 16:00 a 04:00, respectivamente. Las diferencias individuales entre animales con o sin coprofagia para la excreción de heces duras e ingestión de pienso no se vieron afectadas por el efeto de la canulación o la hora de muestreo. En conclusión, la canulación afecta a las cantidades de heces excretadas y a la ingestión, pero no a su distribución a lo largo del día.