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THE INFLUENCE OF CECOTOMY ON GROWTH AND DIGESTIBILITY IN WEANED RABBITS

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Abstract

The experiment was performed with New Zealand White rabbits weaned on day 31-32 day of life. The animals were cecotomized on day 20 day of life at 300-370 g body weight. The experiment lasted until 32 days post-weaning, during which body weight and feed intake were measured. Feces were collected and the digestibility of dry matter, organic matter, NDF, ADF and crude protein as well as live-weight gain and feed efficiency were calculated. Digestibility values for cecotomized rabbits were compared significantly lower ($P<0.05$) than for a control group.

Introduction

The rabbit, because of its high reproductive potential, growth rate comparable to that of the chicken broiler and ability to convert feeds not used for human consumption into high quality meat, has potential as an alternative source of protein in human nutrition. There still is not sufficient scientific information on the nutrient requirements of the rabbit, and many workers are researching this subject (Davidson and Spreadbury, 1975; Lang, 1981; Schulze et al., 1988; Partridge et al., 1989). The question of nutrient requirements is related to knowledge of digestive physiology. Cecotrophy is a special feature of the rabbit which is sometimes incorrectly identified as coprophagy, well known in other rodents. Both coprophagy and cecotrophy allow rodents to recycle digesta and acquire B-vitamins, vitamin K, essential amino acids and a buffer for gastric microflora. Additionally, cecotrophy supplies bacteria for gastric fermentation and allows better nutrient utilization (Hörnicke, 1981; Contera, 1985).

Materials and Methods

Four rabbits 22 days old from the same litter were cecotomized with an electric scalpel. Two of the animals died within two days of surgery. During necropsy, it was observed that the stomachs and small intestines were enormously enlarged due to gases, suggesting that there was no motility after surgery. A third animal died for unknown reasons three weeks later. This animal had completely healed, and necropsy did not confirm the observations made before. Meanwhile, another litter of rabbits 20 days old with body weights ranging from 300 to 370 g was cecotomized. The length of the excised cecum ranged from 14.5 to 16.5 cm. One of five rabbits died 20 minutes after surgery, probably due to anaesthetic shock, and a second animal starved to death after 10 days. Necropsy of both animals again showed nothing to explain cause of death. The surviving animals stayed with the dam, suckling until the beginning of experiment when they were 32 days old. A litter of five half brothers/sisters was used as a control group and it was weaned on day 31 day of life. Mean body weight of the animals was 483 $\pm$ 40 g in the experimental group and 596 $\pm$ 92 g in the control group on the first day of weaning.

During the 32 days post-weaning, the animals were kept in individual cages with a cycle of 24 h light provided. Rabbits were offered ad libitum granulated complete feed "Biocun" produced by Bioter, S.A., consisting of cereals, dried forages, industrial by-product meals, oil seed cakes, molasses and sugar, supplemented with minerals, vitamins, DL-methionine, methyl-chlorpindol 25 ppm and copper (copper pentahydrated sulfate 15 ppm). Dietary composition is presented in Table 1. Water was freely available throughout the trial.

Body weight of the animals was measured daily and feed intake every two days. Feces were collected every two days and then dried at 80° C. Chemical analyses of feed and feces were made according to AOAC (1981) methods.

For statistical evaluation, one way analysis of variance was used and means were compared with the Tukey range test at $P \leq 0.05$.

Results and Discussion

Average daily dry matter intake (DMI) was 113.3 $\pm$ 3.19 g and 76.3 $\pm$ 3.22 g, respectively, for the control (n = 80) and experimental (n = 48) groups and this difference was statistically significant. DMI in the cecotomized group was also lower than that of growing rabbits according to Partrige et al. (1989). When animals were offered ad libitum diets with different contents of fiber, DMI varied from 93.4 to 158.5 $g*day^{-1}$. Davidson and Spreadbury (1975) observed lower values of DMI in growing rabbits (81 - 114 $g*day^{-1}$). Values for DMI increased with increasing crude fiber content in the diet. Differences between groups were also observed when DMI was expressed on either a metabolic body weight or body weight basis. Mean values in the cecotomized group (n = 48) were significantly lower (83.1 $\pm$ 1.74 $g*kg^{-0.75}*day^{-1}$ and 93.5 $\pm$ 1.99 $g*kg^{-1}*day^{-1}$) than in the control rabbits (99.3 $\pm$ 1.41 $g*kg^{-0.75}*day^{-1}$ and 96.3 $\pm$ 1.29 $g*kg^{-1}*day^{-1}$; n = 80).

Table 1: The composition of complete feed ($\bar{x} \pm SD$).

Item	Composition
Dry matter, %	90.0 ± 0.20
Dry matter basis	
Organic matter (%)	83.3 ± 0.43
Crude protein (%)	15.6 ± 1.17
Crude fibre (%)	22.1 ± 1.26
NDF (%)	47.7 ± 2.11
ADF (%)	25.6 ± 0.98
Ash (%)	11.7 ± 0.43
Air matter basis*	
Cellulose (%)	17.0
Starch (%)	14.7
Ether extract (%)	2.0
Ca (%)	1.0
P (%)	0.4
Na (%)	0.29
Vitamin A ($IU*kg^{-1}$)	8000
Vitamin D_3 ($IU*kg^{-1}$)	1600
Vitamin E ($mg*kg^{-1}$)	9

* Producer's data.

The cecotomized rabbits excreted about 40 g daily more feces than the control animals, which was due to higher moisture content (Table 2). At the end of the experiment, cecotrophy, or more correctly coprophagy, was observed in the cecotomized animals. Because of the structure of the ileo-ceco-colic junction, complete removal of the cecum is not possible, so that after cecotomy, the rabbits can, sooner or later, excrete two types of fecal material (Lang, 1981). Lang as well as Hörnicke (1981) and Contera (1985) reported that the proximal colon has great importance in the formation of the two types of feces. Dry matter (DM) excretion ($g*day^{-1}$) was lower in the experimental group, a consequence of lower DMI. Despite a very small difference in dry matter composition (especially organic matter level), organic matter, NDF and ADF content of the feces was significantly higher in the control rabbits, while there was no significant difference between groups in crude protein content of feces (Table 2). The composition of hard and soft feces has been reported by Hörnicke (1981), Contera (1985) and Lorente et al. (1988). In the present study,

Table 2. The excretion and composition of feces ($\bar{x} \pm SD$).

Item	Control Group (n = 70)	Cecotomized Group (n = 42)
Fresh feces ($g*day^{-1}$)	73.6 ± 2.74^a	111.0 ± 3.83^b
Feces DM ($g*day^{-1}$)	48.3 ± 1.59^a	41.0 ± 1.53^b
DM content (%)	65.9 ± 0.87^a	37.7 ± 1.19^b
DM basis (%):		
Organic matter	87.2 ± 0.08^a	886.9 ± 0.10^b
Crude protein	9.7 ± 0.20	9.7 ± 0.16
NDF	762 ± 0.40^a	70.0 ± 0.51^b
ADF	51.4 ± 0.44^a	47.0 ± 0.30^b

[a,b] Means followed by different letters differ at $P \leq 0.05$.

cecotomized animals excreted an intermediate type of feces with only crude protein content similar to that of hard feces of the control group.

Dry matter digestibility (DMD) is presented in Fig. 1. Both curves are discontinued due to a lack of feces samples, as samples collected over four days were burned during an oven fire. For the same reason, a similar discontinuity appears in all figures of digestibility. DMD was higher in the control group (58.6 ± 0.32%) than in the experimental group (48.8 ± 0.64%) and was nearly exactly the same as organic matter digestibility (OMD) presented in Fig. 2 (59.0 ± 0.31% and 49.5 ± 0.60%, respectively). The difference between groups was statistically significant in both cases. Neutral detergent fiber digestibility (NDFD) shown in Fig. 3 was similar to that observed by Kennedy and Hershberger (1974) in immature rabbits (27.6 - 43.2%). This value was significantly higher in control rabbits (33.3 ± 0.52%) than in cecotomized animals (24.7 ± 0.76%), and in both groups at least two times higher than the acid detergent fiber digestibility (ADFD) presented in Fig. 4. Negative values for ADFD were observed in the cecotomized rabbits during the two weeks after weaning; thus the average for ADFD in this group was very low (4.7 ± 1.53 %) and, of course, statistically different from the mean value in control animals (16.0 ± 1.03%). Crude protein digestibility (CPD) was also higher in unoperated animals (74.0 ± 0.53% vs. 67.7 ± 0.76% for cecotomized animals). For rabbits fed different diets, Kennedy and Hershberger reported similar or even lower values of CPD than those obtained in the present study for the experimental group. In contrast to results of Lang (1981), a significant reduction of digestibility coefficients after cecotomy was observed in the present study, similar to the case of cecotrophy prevention (Kennedy and Hershberger, 1974). The cecum is continuously in motion, mixing contents and separating large particles from small particles. Small particles and fluids are retained for a considerable period in the cecum,

where fermentation occurs, while fiber is eliminated rapidly (Cheeke, 1987). This is why soft feces are characterized by high digestibility. Cecotomy should prevent such a process. On the other hand, according to Hörnicke (1981), usually one-third of the total (soft and hard) fecal dry matter is reingested. Reingested soft feces provide 5-18% of DMI and up to 30% of the daily nitrogen intake. Consequently, higher digestibility coefficients can be expected. The lack of particle separation in the hind gut of experimental animals could also explain the difference which occurs between groups in composition of feces (Table 2).

Because of the lower digestibility and lower DMI in cecotomized rabbits, decreased growth rate was expected and this was observed. Average total gain was 1253 $\pm$ 15.1 g in the control group and 761 $\pm$ 145.6 g in operated animals. Daily body gain was higher in control rabbits (37.7 $\pm$ 0.44 g) than in the experimental group (23.1 $\pm$ 4.41 g). The difference in this case, similar to that for total body gain, was statistically significant (Fig.6). Growth rate of rabbits from 0.8 to 2.0 kg body weight varies from 29.6 to 43.1 $g*day^{-1}$ (Partrige et al., 1989) or even up to 49.4 $g*day^{-1}$ (Davidson and Spreadbury, 1975). However, growth rate of cecotomized animals was even better than the 6.8 $g*day^{-1}$ observed by Kennedy and Hershberger (1974) in immature rabbits (2.0 kg body weight) for which cecotrophy was prevented. Schultze et al. (1988) observed that when crude protein levels in diets of growing rabbits were dropped from 140.4 to 97.1 $g*kg^{-1}$, live-weight gain decreased from 28.0 to 22.0 $g*day^{-1}$. Thus after cecotomy or when cecotrophy is prevented, animals may be insufficiently supplied with protein as well as other nutrients. Spreadbury (1978) found that protein produced in the cecum and eaten during cecotrophy by 4-8 week old rabbits supplied dietary protein by 2 g CP/day - a small proportion of normal dietary intake. In contrast, Davidson and Spreadbury (1975) reported that cecal activity can increase proportions of methionine, threonine and tyrosine in the digesta. These authors suggested that at least one-tenth of the basal energy requirements of the animal can be obtained by cecal fermentation, while Lang (1981) reported that cecotrophy appears to have no significant effect on digestibility of energy. It is noteworthy that the coefficient of variation in the experimental group was over 19%, while in control rabbits about 1%, indicating that there was a big difference among cecotomized animals. Feed efficiency is presented in Fig. 6. In the present study, control animals needed 2.92 $\pm$ 0.147 g of feed for 1 g of live-weight gain, while operated rabbits needed 3.28 $\pm$ 0.205 g. Schultze et al. (1988) presented a similar feed conversion ratio (3.26 $g*g^{-1}$ of live-weight gain) when a diet with 9.71% of crude protein was offered. Although the difference between groups was very low, it was statistically significant.

Conclusions

1. The mortality of rabbits after cecotomy was over 50%.

2. Daily dry matter intake in cecotomized rabbits was about 40% lower ($P \leq 0.05$) than in nonoperated animals.

3. Cecotomized rabbits excreted more feces daily than control animals but their feces were of an intermediate type, with dry matter, organic matter, NDF and ADF contents lower than in hard feces of the control group.

4. Digestibility of dry matter, organic matter, crude protein, NDF and ADF was shown to decrease significantly after cecotomy.

5. Live-weight gain and feed efficiency were statistically lower in cecotomized rabbits than in control animals.

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