

CECUM-SEPARATION IN RABBITS AND ITS EFFECTS ON FECAL
COMPOSITION AND DIGESTIBILITY

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Introduction

A number of studies have been made on the functions of cecum of rabbits. Bergman and Hultgren(1903) reported that the cecectomy did not effect on digestibilities of nutrients. Herndon and Hove(1955) also reported that the digestibility of crude fiber was not depressed when cecum was removed. On the other hand, Ustjanzew(1907) found that cecectomy depressed the digestibilities of crude fiber and pentosan. Bacques and Perret(1971) and Herndon and Hove(1955) reported that coprophagy ceased when cecum was removed. Herndon and Hove(1955) found that the cecum-removed rabbits excreted both normal spherically-shaped and irregularly-shaped feces.

In this report, we wish to describe on a simple surgical method for separation of cecum and the effects of separation on the fecal production and digestibilities of nutrients.

Materials and Methods

Male Japanese White rabbits, weighing 2-3kg, were used. Their ceca were separated by the following method. After 16hr-fasting, they were fastened on a wooden plate on their backs. Under a deep anaesthesia with sodium pentobarbital injected through the marginal ear vein(25mg/kg body weight), abdominal wall was cut along the mid-line. Cecum and proximal colon were pulled out gently. Cecum was cut off at the point indicated in

(1)

Fig. 1. Veins and arteries surrounding cecum were not cut. Both cut-ends of cecum were stitched by the Parker-Kerr stitch. Proximal colon, remaining portion of cecum and isolated portion of cecum were returned into their abdominal cavity. Abdominal wall was stitched by a continuous stitch. After the operation, animals were injected penicillin to prevent suppuration. Mercurochrome solution was used as a disinfectant through the operation.

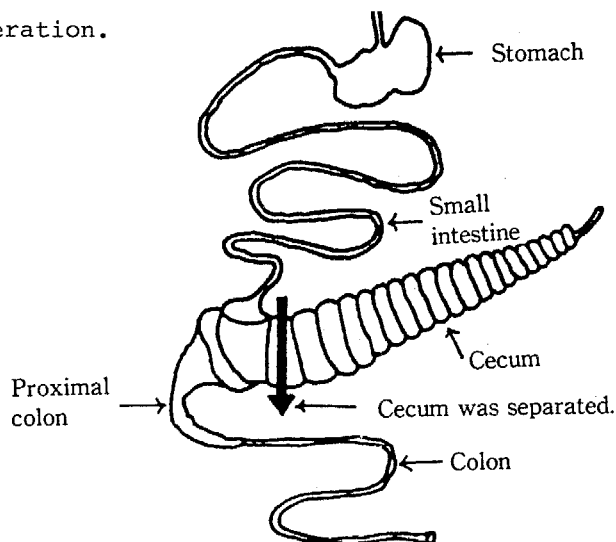


Fig. 1. Diagrammatic representation of the gastrointestinal tract of rabbits and the point where cecum was separated was indicated.

Rabbits were given a commercial pellets (Type, RC-4, Oriental Yeast Co., Tokyo, Japan) ad libitum all through the experiment. Composition of it is shown in Table 1.

Table 1. Composition of the experimental diet(% , dry basis)

Crude protein	22.3
Crude fat	3.4
Crude fiber	14.2
Ash	8.8
Nitrogen free extract (NFE)	51.3
Acid insoluble ash (AIA)*	2.65

* This component was used as a marker for measuring digestibilities.

To prevent coprophagy, they were fitted with a rigid plastic collar (Outer diameter, 30cm). Feces were dried in a forced-air oven at 60°C for 24 hr. Proximate analysis of diet and feces were carried out according to AOAC (1960). To determine apparent digestibility, animals were kept in metabolism cages to separate feces from urine. Digestibilities were determined by a marker ratio method using an acid-insoluble-ash (AIA) as a reference substance. AIA has been ascertained to be an excellent marker for digestion studies with rabbits by Furuichi and Takahashi (1981). The differences between the normal and cecum-separated groups were analyzed for significance by Student's t-test.

Results and Discussion

Cecum-separated rabbits began to consume diet and excrete feces about 20 days after the operation. Fig. 2 shows the daily intake of diet and the excretion of feces by the cecum-separated and normal rabbits. Two months after the operation, their daily food consumption was 120-150g. Their initial body weights were reached after about 3 months. Post-mortem examination after 1 year showed that the proximal colon had remarkably enlarged in compensation.

The excretion of feces of normal and cecum-separated rabbits was determined both with and without a collar to prevent practicing coprophagy. Amount of feces excreted and their chemical composition are shown in Table 2. Cecum-separated rabbits produced clearly distinguishable soft feces and their practice of coprophagy was not abolished. This result indicates that cecum does not necessarily play an important role in the production of soft and hard feces, but proximal colon does. Bonnafous and Raynaud (1967) found that rabbits produced hard feces and intermediate type of feces between hard and soft feces when proximal colon was removed. Gallouin et al (1979) also reported that rabbits stopped the production of soft feces when proximal colon was cut off. These observations support the view that proximal colon plays an important role in the production of hard and soft feces. In addition to hard and soft feces, cecum-separated rabbits excreted fairly large

amount of intermediate type of feces between these two types of feces (Table 2) and feces of this type were also found to be completely reingested. Further, this intermediate type of feces had a chemical composition between those of hard and soft feces. In both normal and cecum-separated rabbits the soft feces had a higher content of crude protein and a lower crude fiber content on a dry matter basis as shown in Table 2. However, Herndon and Hove (1955) reported that cecectomized rabbits excreted normal hard feces and irregularly shaped feces which were different from typical soft feces in appearance and those rabbits did not practice coprophagy. Bacques and Perret (1971) also reported that cecectomized rabbits did not consume their feces even when permitted to do so.

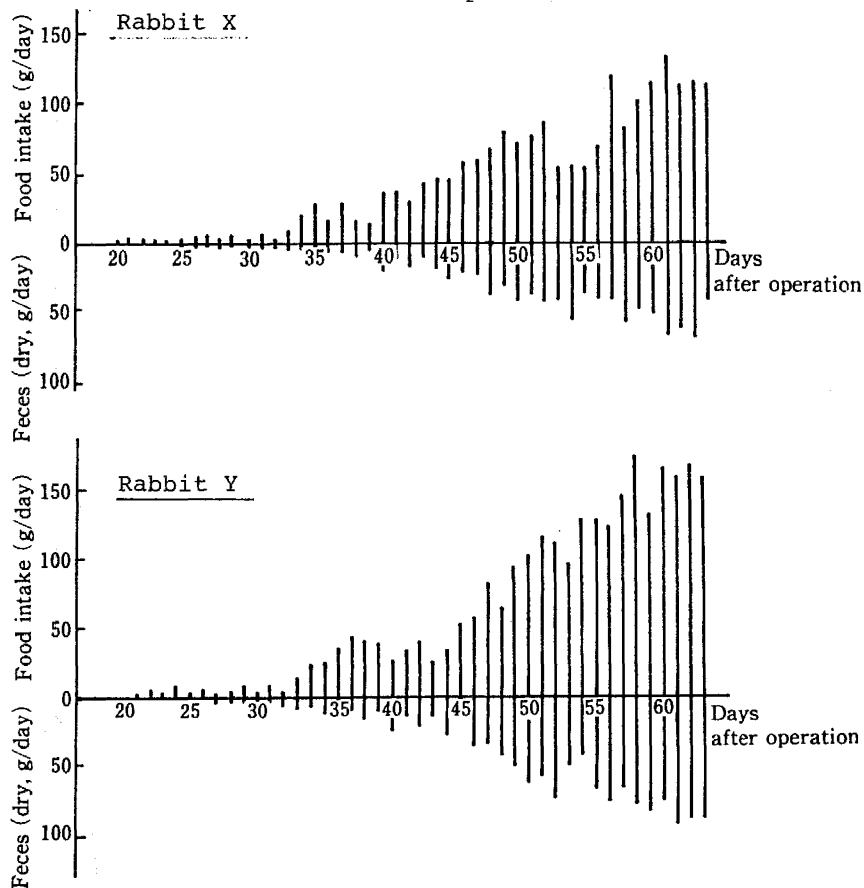


Fig. 2. Daily food intake and fecal production after cecum-separation.

Table 2. Composition of feces excreted by normal and cecum-separated rabbits

Treatment	Rabbit no.	Type of feces*	C.P.	C.Fib.	C.Fat	Ash	NFE	Daily production(g)**
Normal	A	H.F. (1)	16.0	28.4	2.1	7.3	46.2	62.1
		H.F. (2)	14.7	31.7	2.4	6.9	44.3	48.2
		S.F.	37.9	19.8	1.6	8.7	32.0	16.9
		I.F.	24.4	23.8	2.9	9.0	39.9	trace
	B	H.F. (1)	15.3	29.2	2.1	7.0	46.4	55.3
		H.F. (2)	18.0	31.3	2.9	7.9	39.9	43.5
		S.F.	32.4	19.0	2.7	8.9	37.0	17.4
		I.F.	27.1	23.1	2.3	9.4	38.1	trace
Cecum-separated	C	H.F. (1)	13.7	31.7	2.0	7.5	45.1	68.3
		H.F. (2)	12.5	32.7	2.3	7.3	45.2	50.3
		S.F.	19.1	25.3	1.8	9.6	44.2	15.5
		I.F.	16.9	27.6	2.1	8.5	44.9	9.6
	D	H.F. (1)	13.3	30.9	2.0	8.3	45.5	82.1
		H.F. (2)	12.0	31.7	1.9	7.7	46.7	63.8
		S.F.	21.8	21.3	1.7	10.4	44.8	18.1
		I.F.	18.2	28.0	1.9	9.6	42.3	7.6

* H.F. (1):Hard feces excreted when coprophagy was permitted.

H.F. (2):Hard feces excreted when coprophagy was prevented.

S.F.:Soft feces I.F.:Intermediate type feces

**Dry basis

Table 3. Apparent digestibilities by normal and cecum-separated rabbits

Treatment	Rabbit no.	D.M.	C.P.	C.Fat	C.Fib.	Ash	NFE
Normal	1	58.4	68.3	72.5	17.2	61.6	65.0
	2	56.8	65.3	68.6	19.4	57.2	53.5
	3	54.4	70.7	73.7	14.2	51.3	63.0
	4	59.7	77.3	75.0	21.1	56.5	67.5
	5	59.9	77.4	69.7	19.2	57.9	69.0
	Mean	57.84	71.80	71.90	18.22	56.90	63.60
	± SD	2.29	5.42	2.69	2.64	3.70	6.10
Cecum-separated	6	48.4	63.0	73.3	-10.3	55.1	55.4
	7	48.9	69.6	72.8	-10.7	54.0	53.9
	8	39.6	67.3	74.1	- 3.4	36.1	37.4
	9	42.8	64.7	71.9	- 9.8	35.3	46.7
	10	47.2	70.1	72.0	-12.8	44.1	50.4
	Mean	45.38	66.94	72.82	- 9.4	44.92	48.76
	± SD	4.03*	3.07	0.92	3.54*	9.45*	7.18*

*Significantly different from normal group ($p < 0.05$)
 Digestibilities were determined by marker ratio method using acid-insoluble ash.

Coefficients of apparent digestibility in normal and cecum-separated rabbits, in all of which coprophagy was permitted, are presented in Table 3. Apparent digestibilities of crude protein and crude fat did not reveal a statistically significant difference between normal and cecum-separated groups. However, a remarkably lower digestibility of crude fiber was found in cecum-separated group as compared with normal group. A slightly lower digestibilities of dry matter and NFE in cecum-separated group were observed. A marked depression in digestibility of crude fiber with cecum-separated rabbits indicates that cecum plays an important role in digestion of crude fiber. However, the reduction in passage time through the digestive tract due to the removal of cecum seems to be an important factor for the lower digestibility of crude fiber with cecum-separated rabbits.

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Summary

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The cecum was successfully separated in rabbits by a simple surgical method. Cecum-separated rabbits produced soft feces and their practice of coprophagy was not abolished. In addition to hard and soft feces, they excreted the intermediate type of feces between these two types and feces of this type were completely reingested. Further, the intermediate type of feces had a chemical composition between those of hard and soft feces. After the surgical operation, the rabbits lost weight for about 20 days and then began to eat diet and increased their body weights. Their initial body weights were reached after about 3 months. Post-mortem examination after 1 year showed the enlargement of the proximal colon. The digestibilities of dry matter, crude fiber, ash and NFE decreased with the cecum-separated rabbits.

