Proceedings of the

4-7 july **2000** – Valencia Spain

These proceedings were printed as a special issue of WORLD RABBIT SCIENCE, the journal of the World Rabbit Science Association, Volume 8, supplement 1

ISSN reference of this on line version is 2308-1910
(ISSN for all the on-line versions of the proceedings of the successive World Rabbit Congresses)

PAPANTONAKIS K., XYLOURI –FRANGIADAKI E., SABATAKOU O.

DAILY COMPOSITION OF DIGESTA IN DIFFERENT PARTS OF THE LARGE INTESTINE IN NORMAL AND BULBECTOMIZED BUCKS

Volume C, pages 365-369

DAILY COMPOSITION OF DIGESTA IN DIFFERENT PARTS OF THE LARGE INTESTINE IN NORMAL AND BULBECTOMIZED BUCKS

PAPANTONAKIS K.*, XYLOURI –FRANGIADAKI E.*, SABATAKOU O.**

*Department of Anatomy & Physiology of Farm Animals, Faculty of Animal Science, Agricultural University of Athens, 75 Iera Odos Str., Athens 118 55, Greece.
E-mail: efxil @ aua.gr
**National Agricultural Research Foundation, 25 Neapoleos Str., Athens 153 10 Greece.

ABSTRACT

The aim of this study was to examine the influence of bulbectomy on the chemical composition of digesta during its daily passage through the large intestine of rabbits. For this reason 80 New Zealand White male adult rabbits were assigned to two groups: 40 treated and 40 control animals. The diet was the same during the entire experimental period for both experimental groups. The olfactory bulb was removed in the group of the treated animals only, by incision after trepanation of the frontal bones. Twenty days after the operation, the treated and control animals were slaughtered and samples from caecum, colon (proximal and distal) and rectum were collected and analyzed according to the AOAC method. No significant differences were found in nutrient elements between the caecum contents of the two groups, which were homogenous. Also, there were no significant differences between the two groups for the nutrient elements determinated in the whole digesta, but there were significant differences within the same group of animals in regard to elements sampled from different parts of the intestine at various hours during daily passage. The digesta of the treated animals had higher Na and K concentrations in all parts of the intestine examined, in comparison with that of the control animals. So it is concluded that bulbectomy affected the mineral concentration of the treated animals.

INTRODUCTION

The rabbit stimulating mechanisms responsible for the beginning and ending of caecotrophy and the faeces differentiation remain unknown.

After the first scientific announcement about caecotrophy (Charles Morot, 1882), researchers have studied many different ways of approaching the phenomenon, but only tiny steps have been taken towards a reasonable explanation (Bonnafous and Raynaud, 1966, Gallouin, 1984).

The colon is the intestinal part where the digesta is differentiated and the highest absorption of water takes place. This phenomenon is in close relation to the structure of its mucosa. The lumen surface of the colon consists of cylindrical absorptive epithelium (Sabatakou et al., 1999) whereas the crypts consist of non differentiated cells (Ross et al., 1989). The histological structure of the proximal colon presents great similarities with that of the ruminant duodenum while the caecum and the distal colon are similar to the large intestine of the ruminants (Gallouin and Demaux, 1980).

It was suggested that rabbit had an internal or external information mechanism to differentiate digesta and stimulate caecotrophy (Gallouin, 1984).

Particularly, it was believed that the soft faeces contain volative substances, which attract or stimulate caecotrophy (Yoshida et al., 1968). The olfactory substances can act not only on the olfactory epithelium but also on the mitral cells, changing their function, in relation to the change of the feed olfactory sense (Watanabe et al., 1986, Chaput and Holley, 1976).

The aim of the present study was to examine the influence of bulbectomy on the chemical composition of digesta during its daily passage through the large intestine of rabbits.

MATERIAL AND METHODS

Eighty New Zealand White adult male rabbits, about six months of age, were used. They were bred under daylight in the same housing conditions. Feed and water were offered ad libitum. The animals were kept individually in wire cages and were fed with a starter ration of pellets consisted of: Dry matter (DM): 89.76%, Crude protein (CP): 15.35%, Ash: 5.88%, Fat: 1.82%, Crude fiber (CF): 7.54%, Nitrogen free extract (NFE): 69.71%.

The animals were randomly distributed into two groups, control and treated, after a three-week period of rest. The treated animals were subjected surgically to the removal of their olfactory bulb under general anaesthesia. They were slaughtered, according to the schedule (Table 1) twenty days after bulbectomy.

Our pre-experimental observations indicate that caecotrophy takes place between 07.00 and 15.00 hours, under local conditions.

The samples of digesta were taken from 1) the middle of the caecum, 2) the colon area: a. from the first parts of proximal colon (PC) and b. from the distal colon (DC) and 3) the rectum. The samples of the colon area (2 and 3) were pooled for inorganic substance analysis. Analysis of digesta was performed regarding the AOAC.

The results were statistically analyzed based on the model $Y_{ijk} = \mu+E_i+X_j+e_{ijk}$, where Y_{ijk} = the observation, μ = the general mean average, E_i= treatment variable (i=1,2), X_j= time variable (j=1-6), and (1-4) and finally e_{ijk} = random error, N ($0.0\sigma^2e$).

Table 1. Slaughter timetable and number of slaughtered animals.

Slaughter timetable	7:30	10:30	12:00	13:30	16:30	24:00	Animals
Control group	7	7	6	7	7	6	40
Treated group	7	7	6	7	7	6	40

RESULTS AND DISCUSSION

Studying the results of Tables 2-5, it is shown that the transit of digesta through the large intestine begins with a homogenous composition of nutrient elements in the caecum.

The composition of the intestinal content changes according to the digesta position passing through the large intestine, the hour of the day and the secretion type (soft and hard faeces) that follows.

Table 2. Concentration of nutrients (% DM) and minerals (g/kg DM) in Caecum

	Treatment		Time						
	Cont.	Bulb.	7:30	10:30	12:00	13:30	16:30	24:00	RSD
Water	77.7	77.8	78.5	77.6	77.0	78.3	78.0	77.1	2.24
CF	23.8	22.9	24.5	26.4	23.8	21.5	22.9	21.2	5.33
CP	38.8	40.4	39.9	40.7	35.9	38.7	42.7	39.4	7.14
NFE	24.2	23.1	22.6^{ab}	19.5^{a}	27.0^{b}	26.1^{ab}	20.5^{ab}	26.2^{ab}	5.96
Fat	0.9	0.7	0.7	0.9	0.7	0.8	1.1	0.7	1.03
Ash	12.3^{a}	12.9^{b}	12.3	12.4	12.6	13.0	12.8	12.6	1.03
Na	6.9^{a}	11.3^{b}	9.4^{ab}	9.7^{ab}	7.8^{ab}	9.6^{ab}	10.5^{a}	7.4^{b}	2.47
K	6.0^{a}	9.6^{b}	7.3^{ab}	9.0^{ab}	6.3^{a}	7.2^{ab}	9.4^{b}	7.6^{ab}	2.54
P	8.5	8.7	8.9	8.5	8.6	8.3	8.4	8.8	1.19
Ca	23.5	23.7	21.8	25.9	24.6	24.8	22.0	22.4	0.75
Mg	3.3^{a}	4.0^{b}	3.3^{ab}	4.7^{a}	3.1^{ab}	2.9^{b}	3.8^{ab}	4.2^{ab}	1.52

Mean values with different superscript in colons are significantly different ($P \leq 0.05$).

Our results are in accordance to that of other studies, which concluded that the differentiation of both types of faeces occurs in the second half of the proximal colon (Bonnafous and Reynaud, 1963, 1966, Garcia, 1995). These changes are mainly the result of absorption and inner wall secretions, as it is shown in Tables 2-5. The changes referred as the results of exchange Na^+/H^+ and K^+/H^+ in the brush border membrane are in accordance with those of previous studies (Vernay, 1984, 1986). Our results were in accordance with the findings of other researchers as are shown in Table 6 (Bonnafous, 1973, Carabaño et al., 1988, Hörnicke & Batsch, 1977, Fekete & Bokori, 1985, Proto & Gioffre, 1986).

Table 3.Concentration of nutrients (% DM) and minerals (g/kg DM) in Proximal colon

	Treatment		Time						
	Cont.	Bulb.	7:30	10:30	12:00	13:30	16:30	24:00	RSD
Water	76.9	77.3	76.7^{ab}	76.1^{a}	73.7^{a}	75.9^{a}	80.0^{bc}	80.3^{c}	3.00
CF	21.6	19.7	21.0	23.0	20.6	18.4	22.7	18.0	4.55
CP	37.9	38.7	39.4	37.7	36.1	40.4	42.1	34.3	7.05
NFE	25.7	25.0	25.2^{abc}	21.7^{ac}	30.2^{b}	26.4^{ab}	19.9^{c}	28.8^{b}	5.05
Ash	12.2^{a}	12.8^{b}	12.3	12.4	12.2	12.7	12.7	12.8	1.07
Fat	0.8	0.7	0.7^{ab}	1.0^{a}	0.6^{ab}	0.6^{b}	1.0^{ab}	0.7^{ab}	0.40
Colon (proximal + distal)									
Na	6.4^{a}	10.1^{b}	8.6^{ab}	8.0^{ab}	7.4^{a}	8.1^{ab}	10.2^{b}	7.9^{a}	2.03
K	8.0^{a}	11.0^{b}	10.2^{ab}	10.9^{a}	7.5^{b}	9.7^{ab}	9.2^{ab}	9.6^{ab}	2.71
P	9.7	10.1	9.4	9.0	11.1	9.8	9.4	10.8	3.12
Ca	23.7	24.0	21.5	24.8	24.7	23.3	24.7	23.9	0.79
Mg	3.9	4.4	3.8	4.8	4.1	4.1	3.8	4.4	1.75

Mean values with different superscript in colons are significantly different (P≤0.05)

Table 4. Concentration of nutrients (% DM) and minerals (g/kg DM) in Distal colon

	Treatment		Time						
	Cont.	Bulb.	7:30	10:30	12:00	13:30	16:30	24:00	RSD
Water	75.4	75.4	75.6^{a}	75.0^{a}	72.0^{b}	75.2^{a}	78.6^{c}	75.9^{ac}	2.42
CF	20.1	19.6	17.9^{ac}	23.7^{ab}	17.4^{ac}	16.3^{c}	25.6^{b}	18.4^{ac}	6.09
CP	38.5	38.7	39.9	38.1	35.3	42.3	40.8	35.2	6.40
NFE	28.3	27.9	29.0^{abc}	23.9^{bc}	34.6^{acd}	28.0^{cd}	19.9^{b}	33.0^{b}	6.69
Ash	12.1^{a}	13.0^{b}	12.6	13.0	12.0	12.5	12.6	12.8	1.62
Fat	1.0	0.8	0.7^{a}	1.3^{b}	0.8^{ab}	0.9^{ab}	1.1^{ab}	0.8^{ab}	0.49

Mean values with different superscript in colons are significantly different (P≤0.05)

Table 5. Concentration of nutrients (% DM) and minerals (g/kg DM) in Rectum

	Treatment		Time						
	Cont.	Bulb.	7:30	10:30	12:00	13:30	16:30	24:00	RSD
Water	66.2	65.9	69.0^{a}	64.9^{a}	69.5a	69.7^{a}	64.5^{a}	57.1^{b}	5.11
CF	18.9^{a}	21.7^{b}	19.6^{a}	25.5^{b}	17.4^{a}	16.6^{a}	20.3^{a}	22.4^{b}	4.20
CP	33.9	36.0	36.3^{a}	34.3^{a}	39.2^{a}	43.4^{a}	37.6^{a}	19.1^{b}	9.29
NFE	35.4^{a}	29.6^{b}	32.7^{a}	27.6^{a}	31.3^{a}	27.8^{ab}	29.7^{a}	46.0^{b}	8.48
Ash	11.2^{a}	11.9^{b}	10.9	11.8	11.5	11.8	11.7	11.7	1.38
Fat	0.6	0.7	0.5	0.8	0.6	0.5	0.7	0.8	0.50
Na	4.3^{a}	6.2^{b}	5.3^{a}	6.0^{a}	6.1^{a}	6.2^{a}	5.3^{a}	2.3^{b}	1.78
K	7.0^{a}	9.1^{b}	9.0^{a}	10.4^{a}	8.1^{a}	8.5^{a}	7.9^{a}	4.5^{b}	2.78
P	9.9	9.5	10.2^{ab}	9.5^{ab}	11.6^{a}	9.2^{ab}	9.0^{b}	8.5^{b}	2.29
Ca	34.8	33.6	25.5^{a}	37.2^{ab}	25.7^{a}	36.9^{a}	36.9^{ab}	52.9^{b}	1.46
Mg	3.8	3.9	3.8	4.5	3.9	3.6	4.0	3.2	1.58

Mean values with different superscript in colons are significantly different (P≤0.05)

Table 6. Chemical composition (%DM) of digesta and faeces.

	Caecum		Soft faeces		Hard faeces		References
DM %	22.3	-	33.9	34.9	42.9	60.3	Carabano et al., 1988, Fekete & Bokori, 1985, Hörnicke & Batsch, 1977, Proto & Gioffre, 1986
CF	23.3	13.4-	20.3	14.3-34.9	22.4	10.9-46.6	
CP	39.6	36.4-	34.9	28.5-44	19.1	9.2-18.7	
NFE	23.6	-	32.5	30.3	46.0	35.8	
Ash	12.6	11.2-	11.5	8.2-15.7	11.7	3.9-14.8	
Fat	0.8	1.6-1.8	0.65	0.9-3.5	0.8	1.7-4.3	
Na^+ mmol/kg	395.7	-	226	40	100	120	Bonnafous, 1973
K^+ mmol/kg	200	-	205.1	95	115.4	280	Bonnafous, 1973
P mmol/kg	277.4	-	313	110 PO^{2-}_4	274.2	10 PO^{2-}_4 mmol/kg	Bonnafous, 1973

On the left column are shown our results and on the right those of other authors (mmol/kg).

It was proved from our experiment that the bulbectomy did not influence the organic substance Nitrogen-Free Extracts (NFE) and Crude Fiber (CF) in both experimental groups. However in the same animals NFE and CF are differentiated according to the parts of the colon and the daily time.
We found that the proximal colon does not change its content of total nitrogen, during 24 hours period, which means no nitrogen absorption occurs. This may be due to the fact that the diet fed to our animals was low in CF content. On the contrary, other authors have found that the second half of the proximal colon has the largest absorption of nitrogen (Bonnafous and Reynaud, 1966).
According to others, bulbectomy in rabbits depress the behavior of the kits from searching and suckling the mammary gland (Distel and Hudson, 1985). Bulbectomy in other kinds of animals provokes: cannibalism of rats (Flemming, 1973), delay of the body development of mice (Cooper and Cowley, 1976) and disturbance of the maternal behavior of sheep (Baldwin et al., 1977).

It is concluded that bulbectomy according to our results influences only the mineral concentration of the chemical composition of digesta.

REFERENCES

BALDWIN B.A., McLAUGHLIN C.L., BAILE C.A. 1977: The effect of ablation of the olfactory bulbs on feeding behavior in sheep. *Applied Animal Ethology,* 3:151-161.

BONNAFOUS R. 1973: Quelques aspects de la physiologie colique en relation avec la dualité de l' excrétion fécale chez le lapin. *Thèse Doctorat es Sciences.* Toulouse. France.

BONNAFOUS R., RAYNAUD P. 1963: Recherches sur le rythme nycthéméral de l' éxcretion de l'azote fecal chez le lapin domestique (Oryctolagus cuniculus): influences des glandes surrénales. *Comp. Biochem. Physiol.* 8: 321-326.

BONNAFOUS R., RAYNAUD P. 1966: Recherche sur le rôle du colon dans la dualité de l' excrétion fecale du lapin. *Arch. Sc. Physiol.* 21:261.

CARABANO R., FRAGA M.J., SANTOMA G., and de BLAS J.C. 1988: Effect of diet on composition of cecal contents and on excretion and composition of soft and hard feces of rabbits. *J. Anim. Sci.,* 66: 901-910.

CHAPUT M., HOLLEY A. 1976: Olfactory bulb responsiveness to food odor during stomach distention in the rat. *Chemical senses and Flavor*. 2:189-201.

COOPER A.J., COWLEY J.J. 1976: The effect of litter size on the growth, survival and behavior of neonatal bulbectomised mice. *Biology of the Neonate,* 29:56-65.

DISTEL H., HUDSON R. 1985: The contribution of the olfactory and tactile modalities to the nipple-search behavior of newborn Rabbits. *J. Comp. Physiol. A Sens Neural. Behav. Physiol.,* 157: 599-606.

FEKETE S., BOKORI J. 1985: The effects of the fiber and protein level of the ration upon the caecotrophy of rabbit. *Journal of Applied Rabbit Research* 8:68-71.

FLEMING A.S. 1973: Olfactory and experimental factors under lying maternal behavior in he lactating and cycling female rat. *Dissertation Abstracts International* B; 34 (1) 436: 73-15671.

GALLOUIN F., DEMAUX G. 1980: Rôle du mucus dans la production de caecotrophes du Lapin. *IIème Congrès International de Cuniculture. Barcelone* [2nd World Rabbit Congress, Baecelona] 15-18 Avril 1980. Vol I, 61.

GALLOUIN F., 1984: Le comportement de caecotrophie chez le lapin. *III World Rabbit Congress, Rome*, vol. II, 363-406.

GARCIA J., de BLAS J.C., CARABANO R., GARCIA P. 1995: Contribution through caecotrophy in rabbits. *Reproduction, Nutrition, Development,* 35:267-75.

HÖRNICKE H., BATSCH F. 1977: Caecotrophy in rabbits. A circadian function. *J. Mammalogy,* 58:240-242.

MOROT C. 1882: Mémoire relatif aux pelotes stomacales des léporidés. *Rec. Med. Vet.,* 59:635-646

PROTO V, GIOFFRE F. 1986. La ciecotrofia nel coniglio con particolare riferimento al significato nutrizionlae proteico del ciecotrofo. *Coniglicoltura.* **23 (5):** 41-43.

ROSS J.A., SCOTT A., GARDNER I.G. 1989: Ultrastructural observations on the caecum of the Rabbit. *J. Anat.,* 164:165-173.

SABATAKOU O., XYLOURI-FRANGIADAKI E., PARASKEVAKOU E., PAPANTONAKIS K. 1999: Scanning electron microscopy of large intestine (caecum and colon) of rabbit during foetal and postal - natal life. *J. Submicrosc. Cytol. Pathol.,* **31 (2),** 231- 236.

VERNAY M. 1986: Colonic absorption of inorganic ions and volatile fatty acids in the rabbit. *Comparative Biochemistry and Physiology. A*: *Comparative Physiology,* 83: 775-84.

VERNAY M., MARTY J., MOATTI J.P. 1984: Absorption of electrolytes and volatile fatty acids in the hind-gut of the rabbit. Circadian rhythm of hind-gut electrolytes and plasma aldosterone. *British Journal of Nutrition,* 52: 419-28.

WATANABE Y., MORI K. IMAMURA K., TAKAGI S.F., HAYAISHI O. 1986: Modulation by prostaglandin D-2 of mitral cell responses to odor stimulation in Rabbit olfactory bulb. *Brain Res.,* 378, 216-222.

YOSHIDA T., PLEASANTS J.R., REDDY B.S., WOSTMANN B.S. 1968: Efficiency of digestion in germ-free and conventional Rabbits. *Br. J. Nutr.,* 22:723-737.
