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)

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Volume A, pages 591-598

EFFECT OF DOUBLE SUCKLING AND EARLY WEANING ON THE WEIGHT AND LENGTH OF THE GASTROINTESTINAL TRACT

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ABSTRACT

The authors examined young Pannon White rabbits reared by one of the following methods: suckled once a day in the traditional manner; nursed by two does until weaning (double suckling); suckled twice a day up to the age of 23 days, then once a day until weaning; or nursed twice a day up to weaning at the age of 23 days. The weight and length of the whole gastrointestinal tract and of certain parts of it (the stomach, small intestine, caecum, vermiform appendix and colon) were recorded at the ages of 3, 4, 5, 6 and 10 weeks. On the basis of the results obtained it was established that twice-daily suckling and the consumption of solid feed exert a stronger influence on the weight of the gastrointestinal tract than on its length.

INTRODUCTION

The literature contains a number of publications on the development of slaughter dressing percentage in rabbits, the dimensions of the individual body parts and the proportions of these to each other, and also the factors affecting these traits. Far fewer literature data are available on the dimensions of the digestive system, its growth and the factors influencing these characteristics. In the past few years an increasing number of articles have dealt with changes occurring with age in the construction and the functioning of the digestive system in rabbits (LATINER and SAWIN, 1963, 1967; LEBAS and LAPLACE, 1972, ALUS and EDWARDS, 1977; YU BI and CHIOU, 1977; PADILHA *et al*., 1996; PIATTONI *et al*., 1997)

The objective of the present study was to compare the size of the digestive organs (by measuring their weight and length) in young rabbits reared by either one doe or two (i.e., suckling once or twice daily) in relation to the length of the period of double suckling and at what age the young rabbits were weaned.

MATERIAL AND METHODS

Newborn Pannon White rabbits of average body weight were allocated into litters of eight; these litters were then divided at random into four groups.

- In group SS one doe reared the young in the traditional manner until they were weaned at 35 days of age.
- In group DD the suckling rabbits were nursed by two does which had produced litters on the same day; one doe suckled the litter at 8 a.m. and the other at 4 p.m. each day, up to the point of weaning at the age of 35 days.
- In group DS two does suckled the young, as above, up to the age of 23 days, after which only one nursed them until weaning at 35 days.

- In group D0 two does reared the young, as above, up to the age of 23 days, at which point they were weaned.

The procedure applied for suckling is described in greater detail in GYARMATI *et al*. (2000).
The young rabbits used in the experiment were fed an unmedicated rabbit feed (CP: 16.8%, CFat: 2.9%, CF: 14.1%, 10.3 DE MJ/kg), supplemented with barley and hay. The various feedstuffs provided were available in *ad libitum* quantities, and the rabbits also had free access to drinking water from weight-valve self-drinkers. As it was not possible to measure feed consumption in this experiment, data for daily intake were adopted from the previous experiment performed by the authors (GYARMATI *et al*., 2000).
At the ages of 3, 4, 5, 6 and 10 weeks between 2 and 8 rabbits, selected at random from each group, were slaughtered by means of anaesthetic overdose. The gastrointestinal tract was removed and the stomach, the small intestine, the caecum and the colon were separated, after which the empty weight and length of these parts were recorded. Findings on the quantities contained by these organs and on certain related parameters are reported in ZOMBORSZKY-KOVÁCS *et al.* (2000). The method developed by WOJTOWICZ *et al*. (1999) was applied in the recording of the data.
Statistical evaluation of the experimental data was performed by means of one-way analysis of variance, with SPSS 7.5 software.

RESULTS AND DISCUSSION

The data obtained for the weight and length of the small intestine, the caecum, the vermiform appendix and the colon are presented in tables 1 and 2.
In the case of group SS, the weight and length of them together with the changes occurring with age in these characteristics, were found to concur with most of the relevant data in the literature (LEBAS and LAPLACE, 1972, ALUS and EDWARDS, 1977, PIATTONI *et al*., 1997). The findings obtained in this study provide corroboration of the conclusions drawn by LEBAS and LAPLACE (1972) and by YU BI and CHION (1977), according to which change in the length and weight of the gastrointestinal tract follows an almost linear curve between the ages of 2 and 9 weeks. The *weight of the empty gastrointestinal tract* (table 1) proved similar in all four groups at the age of 3 weeks, which allows us to infer that up to this age twice-daily suckling exerted no substantial influence on the dimensions of the digestive system.
On the basis of the data obtained it seems that both twice-daily suckling and the subsequent higher consumption of solid feed affect the weight of the digestive system: the rabbits of group DD barely ate solid feed up to the age of 4 weeks, while those of group D0 switched abruptly to solid feed subsequent to early weaning, and their daily feed intake increased rapidly (GYARMATI *et al*., 2000). This accounts for the fact that at the age of 5 weeks the weight of the digestive system recorded in group D0 exceeded the values observed even in the rabbits of groups DD and DS. The digestive system of the rabbits which were suckled twice daily (DD, DS and D0) remained heavier than that of the rabbits of group SS up to the age of 10 weeks, although significant difference was ascertained only between groups SS and DD.

Table 1. Effect of double suckling and early weaning on weight of gastrointestinal tract (in g)

Age	SS		DD		DS		D0		s.e.
	n	mean	n	mean	n	mean	n	mean	
	Weight of empty digestive system, g								
3 weeks	8	34.4	3	43.3	3	35.9	2	33.7	3.95
4 weeks	8	49.2^{a}	8	67.3^{b}	8	70.3^{b}	8	64.2^{b}	2.69
5 weeks	8	79.7^{a}	8	93.1^{b}	8	92.9^{b}	8	110^{c}	2.61
6 weeks	8	103^{a}	8	121^{b}	8	115^{b}	4	124^{b}	2.08
10 weeks	7	219^{a}	8	259^{b}	8	235^{ab}	5	246^{ab}	5.11
	Weight of empty stomach, g								
3 weeks	8	15.4	3	11.0	3	7.60	2	8.50	3.87
4 weeks	8	11.7^{a}	8	13.5^{ab}	8	14.6^{b}	8	12.5^{ab}	0.51
5 weeks	8	15.2^{a}	8	18.5^{b}	8	19.0^{b}	8	18.4^{b}	0.55
6 weeks	8	17.6^{a}	8	21.9^{b}	8	20.0^{ab}	4	17.7^{a}	0.58
10 weeks	7	32.0	8	35.9	8	33.1	5	33.2	0.92
	Weight of empty small intestine, g								
3 weeks	8	10.2^{a}	3	16.0^{b}	3	12.7^{ab}	2	13.0^{ab}	0.71
4 weeks	8	15.8^{a}	8	22.4^{b}	8	20.6^{b}	8	19.2^{ab}	0.79
5 weeks	8	25.9^{a}	8	30.1^{ab}	8	27.3^{a}	8	36.6^{b}	1.23
6 weeks	8	32.8^{a}	8	39.2^{b}	8	37.2^{b}	4	38.0^{b}	0.70
10 weeks	7	62.8^{a}	8	73.1^{b}	8	66.0^{ab}	5	72.8^{b}	1.67
	Weight of empty caecum, g								
3 weeks	8	5.31^{a}	3	8.50^{b}	3	7.00^{c}	2	7.00^{c}	0.35
4 weeks	8	11.2^{a}	8	15.8^{b}	8	16.0^{b}	8	15.2^{b}	0.61
5 weeks	8	18.0^{a}	8	21.2^{a}	8	22.0^{ac}	8	27.2^{b}	0.87
6 weeks	8	22.8^{a}	8	25.9^{ab}	8	27.4^{b}	4	27.5^{b}	0.35
10 weeks	7	59.3	8	58.6	8	58.6	5	64.0	1.45
	Weight of colon, g								
3 weeks	8	3.50^{ac}	3	7.83^{bd}	3	8.67^{b}	2	5.25^{cd}	0.65
4 weeks	8	10.4^{a}	8	15.6^{ab}	8	19.1^{b}	8	17.2^{b}	1.15
5 weeks	8	20.6^{ac}	8	23.2^{cd}	8	24.6^{bd}	8	27.4^{b}	0.73
6 weeks	8	29.7^{a}	8	33.6^{a}	8	30.0^{a}	4	41.0^{b}	0.65
10 weeks	7	64.6^{a}	8	91.1^{b}	8	77.5^{ab}	5	76.2^{ab}	3.53

^{a,b,c,d} denote significant differences ($P < 0.05$) within a given row of data

A more precise explanation for the changes observed in the weight of the complete gastrointestinal tract may be provided by the development of the weight and length of the individual anatomical parts.

At the age of 3 weeks the *weight of the empty stomach*, although not significantly different (presumably due to the low number of animals involved), seemed lower in all three groups suckling twice daily than in the rabbits of group SS (table 1). On the basis of the data obtained it can be ascertained unequivocally that the stomach, referred to by LEBAS (1975) as an organ serving as a container, is no larger in young rabbits suckling twice daily than in those suckling only once a day, which gives grounds for the assumption that between morning and evening suckling the stomach empties almost completely, if not entirely. If this were not the case, it would be difficult to account for the finding that the stomach could accommodate an 89% higher quantity of milk than the milk intake characteristic of group SS (GYARMATI *et al*., 2000).

At the age of 4 weeks only the rabbits of group DS had stomach weight significantly exceeding that of the rabbits of group SS, but by 5 weeks this was true of all three groups which suckled twice daily. The probable explanation for this difference lies in the readiness with which the young rabbits switched to solid feed, and in their daily feed intake. In the

previous experiment performed by the authors (GYARMATI *et al*., 2000) it was found that the rabbits of group DS began to eat solid feed sooner than those of group DD, while the rabbits of group D0, due to early weaning, barely ate for several days; it was only after this transitional period that their feed intake began to increase. By the end of the fattening period there was no longer any significant difference between any of the groups, but the slight difference observed between the D groups and the rabbits of group SS was largely accounted for by the fact that, even at this age, the daily feed intake recorded in the rabbits which had suckled twice daily still slightly exceeded that of those which had suckled only once a day (GYARMATI *et al.*, 2000).

In all three groups which suckled twice daily the *weight of the empty small intestine* exceeded the values recorded for the rabbits of group SS, the differences proving significant in most instances (table 1). The effect exerted by twice-daily suckling only prevailed up to the age of 4 weeks, there being no substantial difference in the *length of the small intestine* from the 5th week onwards: only at the age of 4 weeks was a statistically verifiable difference between group SS and the D groups ascertained (table 2).

Table 2. Effect of double suckling and early weaning on the length of the gastrointestinal tract (in mm)

Age	SS		DD		DS		D0		
	n	mean	n	mean	n	mean	n	mean	s.e.
	Length of small intestine, mm								
3 weeks	8	1640	3	1840	3	1840	2	1870	50.8
4 weeks	8	2090^{a}	8	2470^{b}	8	2420^{b}	8	2440^{b}	42.0
5 weeks	8	2790	8	2880	8	2790	8	2790	53.6
6 weeks	8	3100	8	3130	8	3130	4	3040	58.3
10 weeks	7	3660	8	3900	8	3760	5	3900	54.1
	Length of caecum, mm								
3 weeks	8	173^{a}	3	188^{b}	3	177^{a}	2	185^{b}	5.00
4 weeks	8	249	8	271	8	280	8	285	5.90
5 weeks	8	324	8	349	8	356	8	347	6.90
6 weeks	8	380	8	372	8	341	4	375	5.00
10 weeks	7	467	8	450	8	440	5	446	7.70
	Length of vermiform appendix, mm								
3 weeks	8	49.7	3	68.3	3	55.0	2	65.0	2.30
4 weeks	8	77.3^{a}	8	90.6^{b}	8	83.7^{ab}	8	93.7^{b}	1.90
5 weeks	8	102	8	107	8	106	8	98.7	1.80
6 weeks	8	106^{ab}	8	112^{ab}	8	116^{a}	4	101^{ab}	2.30
10 weeks	7	141	8	150	8	140	5	149	2.30
	Length of colon, mm								
3 weeks	8	502^{a}	3	673^{b}	3	627^{ab}	2	635^{ab}	31.3
4 weeks	8	757^{a}	8	878^{b}	8	882^{b}	8	977^{c}	17.6
5 weeks	8	965^{a}	8	1140^{b}	8	1070^{ab}	8	1000^{ab}	25.5
6 weeks	8	1140	8	1160	8	1180	4	1230	31.4
10 weeks	7	1510	8	1510	8	1450	5	1590	28.1

^{a,b,} denote significant differences ($P < 0.05$) within a given row of data

In the light of the findings obtained it seems that the level of nutrition of the rabbits influenced the length of the small intestine less strongly than it influenced its weight. This difference may have been caused to a minor degree by higher milk intake due to twice-daily suckling, but to a greater degree by higher levels of solid feed consumption, since significant difference between group SS and the D groups with respect to the weight of the small

intestine was ascertained less frequently up to the age of 5 weeks than at the ages of 6 and 10 weeks (table 1).

At the ages of 3 and 4 weeks the *weight of the empty caecum* proved significantly higher in all three groups which suckled twice daily than in the rabbits of group SS (table 1). Although the same tendency could be observed up to the age of 6 weeks, the difference did not prove statistically verifiable in every instance. However, by the age of 10 weeks all four groups showed conformity in the weight of the caecum.

With respect to the *length of the caecum and of the vermiform appendix*, up to the age of 5 and 4 weeks, respectively, differences were detected between group SS and the D groups. In the case of the length of the caecum these differences proved significant only when the rabbits were 3 weeks old, and even then only between groups SS and DD or D0; significant differences in the length of the vermiform appendix were ascertained only at the age of 4 weeks, between groups SS and DD or D0 (table 2).

The findings outlined above indicate that the weight of the caecum and the length of the caecum and of the vermiform appendix were the characteristics primarily influenced by twice-daily suckling: up to the age of 4 weeks there developed more highly substantial and clear-cut differences between group SS and the D groups. The findings made in this study correspond to those reported by PADILHA *et al.* (1996), who found that in rabbits reared exclusively on milk up to the age of 42 days the weight of the caecum wall increased considerably between the ages of 29 and 42 days.

The effect of the forced, and rapidly rising, consumption of solid feed observed subsequent to early weaning is also illustrated by the fact that at the age of 5 weeks the weight of the caecum in the rabbits of group D0 proved significantly higher than that recorded in group DD. PIATTONI *et al*. (1997) also established that the development of the caecum is influenced by the level of solid feed consumption. Both very early weaning and a switch to solid feed at a later stage manifest themselves equally in the growth of the caecum: as the young begin to eat solid feed the caecum starts to increase in weight. ALUS and EDWARDS (1977) reported similar findings. They described relatively slow growth in the caecum (in terms of its wall and its capacity) from birth up to the age of 10 days; however, by the age of 40 days, with growth parallel to the increase in feed consumption, the caecum was found to grow to as much as ten times its original size.

The *weight of the colon* (table 1) showed a particularly characteristic pattern of development. At the age of 3 weeks in the rabbits of group DD, at 3, 4 and 5 weeks in those of group DS, and at 4, 5 and 6 weeks in those of group D0 significantly higher values were recorded than those observed in group SS. Although the weight of the colon in the rabbits of the D groups also proved higher than that measured in group SS at the other ages studied, these differences were not statistically verifiable. On the other hand, it was also ascertained that at the ages of 5 and 6 weeks the weight of the colon in group D0 significantly exceeded even that recorded in the rabbits of group DD. With respect to the *length of the colon* (table 2), significant difference was detected between groups SS and DD at the ages of 3, 4 and 5 weeks, and between groups SS and DS or D0 only at 4 weeks. It was also established in this respect that at the age of 4 weeks the colon in the rabbits of group D0 was significantly longer than in group DD. On the basis of the observation that differences in the weight of the colon between group SS and the D groups had already emerged by the age of 3 weeks, and also that there was significant difference between groups DD and D0 two weeks later, it can be concluded that twice-daily suckling and the intake of larger quantities of solid feed were equally instrumental in the development of the dimensions of the colon. Difference in length was observed less frequently; that is, twice-daily suckling was found to exert stronger influence on the weight of the colon than on its length. With respect to colon length, after the age of 5 weeks there was no longer any difference between the groups.

Conclusions

Twice-daily suckling and the subsequent higher level of solid feed intake were found to exert a stronger influence on the weight of the entire gastrointestinal tract and that of its individual parts (the stomach, small intestine, caecum and colon) than on its length.

Due to the higher levels of feed consumption which followed, the stomac reached greater weight.

The weights of the small intestine, the caecum and the colon were all found to be influenced by twice-daily suckling.

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