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DIGESTIVE EFFICIENCY BEFORE AND AFTER WEANING, ACCORDING TO THE DIETARY STARCH/FIBRE RATIO

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ABSTRACT

Thirteen litters (group C "control") have been fed a high starch/fibre (S/ADF) ratio diet (diet C) and 13 others (group E "experimental") a low S/ADF ratio diet (diet E) from 18 to 42 days of age (weaning at 32 days). After Day 42, both groups were fed the same finishing diet. Live weight, feed intake and apparent digestibility of organic matter (OM), crude protein (CP), neutral detergent fibre (NDF), fat and starch were recorded during 4 periods: 25 to 27 days (Period 1), 28 to 31 days (Period 2), 35 to 38 days (Period 3) and 49 to 52 days of age (Period 4). Before weaning, the feed intake was significantly lower in E group ($P<0.01$). From Day 25 to Day 38, digestibility decreased significantly for OM (-23%), CP (-14%), NDF (-54%) and fat (-6%), while starch digestibility increased with age in group E (+0.3% ; Period 2 vs Period 3, $P<0.01$) and remained steady in group C. A better digestive efficiency for nutrients was observed in rabbits fed the diet C (OM: +9% ; $P<0.01$; CP: +8%, NDF: +17%, Fat: +6% ; $P<0.0001$), except for starch. For finishing rabbit (Day 42 to 52), there was no difference of digestive efficiency between group E and C.

INTRODUCTION

A high frequency of digestive disorders, main cause of mortality, is observed in rabbit after weaning. MAERTENS and DE GROOTE (1990) observed a higher post-weaning mortality when start of solid feed intake was delayed before weaning. A shift in digestive capacities of the young is also observed with the beginning of intake. Therefore, adjusting the feed composition to the digestive capacities of the young is essential. Dietary effects on digestive efficiency have to be determined before weaning to enlarge knowledge on digestion of the young rabbit.
Consequently, our study aimed to evaluate: i) the development of digestive efficiency in rabbits before and after weaning, according to the dietary starch/fibre ratio ; and ii) the effect of a weaning diet on digestive capacity in fattening rabbits.

MATERIALS AND METHODS

Animals and feeding
Twenty-six does (strain INRA A1067) and their litter have been divided in two equal groups at 18 days of lactation (experimental "E" and control group "C"). Litters were equalised to 9 young at birth (Day 0), and were weaned at Day 32. To maintain the litter size, each rabbit dead before 18 days of lactation, was replaced. Three diets were used during the experiment (Table 1). From Day 18 to Day 42, growing rabbits of group C were fed a "female" feed with a high starch/fibre ratio “S/ADF” (151 Starch/154 ADF g/kg, diet C), while those of group E received a "weaning" feed with a low S/ADF ratio (125 Starch/184 ADF g/kg, diet E). Females were fed the same diet than their litter. At Day 21, does and young were caged separately, to determinate feed intake and digestive efficiency of young before weaning. Until Day 32 (weaning), does were placed few minutes every day with pups for nursing. From Day 42 to 70, rabbits were kept in the same cage and both groups were fed the same "fattening" diet.

In-vivo measurements

Apparent faecal digestibility of organic matter (dOM), crude proteins (dCP), neutral detergent fibre (dNDF), fat (dFat) and starch (dStarch) was measured before weaning: between Day 25 and 27 (Period 1=3days) and between Day 28 and 31 (Period 2=4 days) ; and after weaning: between Day 35 and 38 (Period 3) and between Day 49 and 52 (Period 4), according to the European reference method (PEREZ *et al*., 1995). For these 4 periods, daily weight gain (DWG) and solid feed intake were measured. Milk intake was determined by the weight difference of does before and after suckling.

Table 1: Chemical composition of feeds given to females and litters of the groups C and E, and to "finishing" rabbits after weaning.

Chemical Composition (% air dry basis)	C "Control"	E "Experimental"	Finishing
Organic matter	79.5	81.8	79.7
Crude protein	17.5	16.9	16.7
NDF	30.1	34.2	30.2
Fat	2.7	2.9	1.9
Starch	15.1	12.5	17.8
ED * (kcal/kg air dry basis)	2680*	2510*	2670

*: measured in Period 3

Biochemical analyses

Dry matter was determined on duplicate samples by heating at 103°C for 24h, organic matter (OM) after ashing at 550°C for 5h, and nitrogen by Dumas procedure. Starch was determined enzymatically. Neutral detergent fibre (NDF) and acid detergent fibre (ADF) was determined according to the sequential procedures of VAN SOEST (1991) and with an amylolytic pre-treatment using thermostable amylase (AFNOR, 1997) for feed samples. Fat determination on faeces and feed was performed using the Soxtec system H^+.

Table 2: Daily weight gain and live weight of rabbits, during different periods (1-4).

	Groups			
	Experimental	Control	Root-MSE	P level
Periods (days)	DWG (g/day/rabbit)			
← (25-27)	30	33	9	NS
↑ (28-31)	37	41	10	NS
→ (35-38)	33	38	13	*
↓ (49-52)	36	25	27	*
Age (day)	Live weight (g)			
25	373	372	51	NS
53	1418	1439	185	NS

Root-MSE: root-mean square error ; *: P<0.05 ; NS: not significant.

Statistical analyses

The results were submitted to analysis of variance according to the general linear model procedure of the Statistical Analysis System (SAS, 1988), including the effects of age, group and interaction between age and group as fixed effects. For the 3 first periods, interactions between age and group were not significant. Considering data of periods 3 and 4, interaction between the effect of age and group was significant, and results were presented within each age or group.

RESULTS

Intake and growth before and after weaning

At 25 and 53 days of age, live weight of rabbits (Table 2) was similar in both groups (372±59 g and 1428±225 g respectively). Before weaning, there was no significant difference in DWG between the two groups (32±12 g and 39±12 g/d/rabbit, during Period 1 and 2, respectively). During the Period 3, DWG was 13% lower in group E than in group C (33±13 *vs*. 38±12 g/d/rabbit, P<0.05). After feed change (Day 42), DWG was 31% higher in the group E than in the group C (36±23 *vs.* 25±31 g/d/rabbit, P<0.05).

During the first 3 periods (e.g. from Day 25 to Day 38), while rabbits of the 2 groups are fed different diets, feed intake (Figure 1) of the E group was 18% lower than of C group (respectively 708±92 *vs.* 870±154 g/rabbit, P<0.01). During the 4th period, while rabbits were fed the same diet, feed intake was equivalent in both groups (99±22 g/d/rabbit). Milk intake during the Period 1, was 27% lower in group E than in group C (17±7 vs. 24±5 g/d/rabbit, P<0.01), while no significant difference was found in Period 2 (17±5 g/d/rabbit).

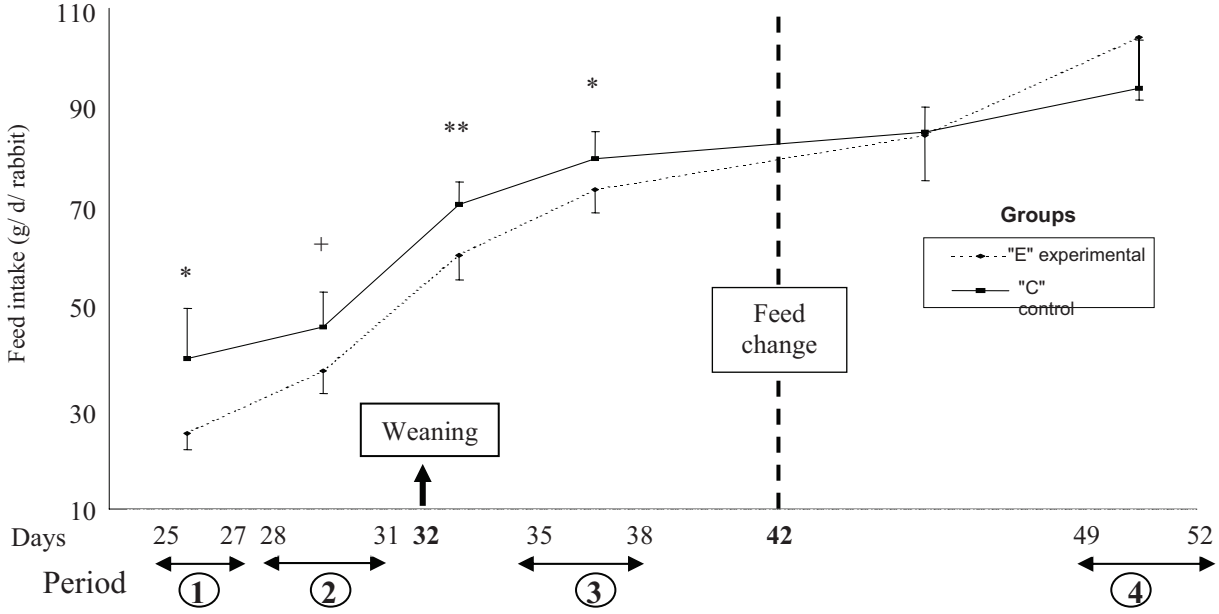


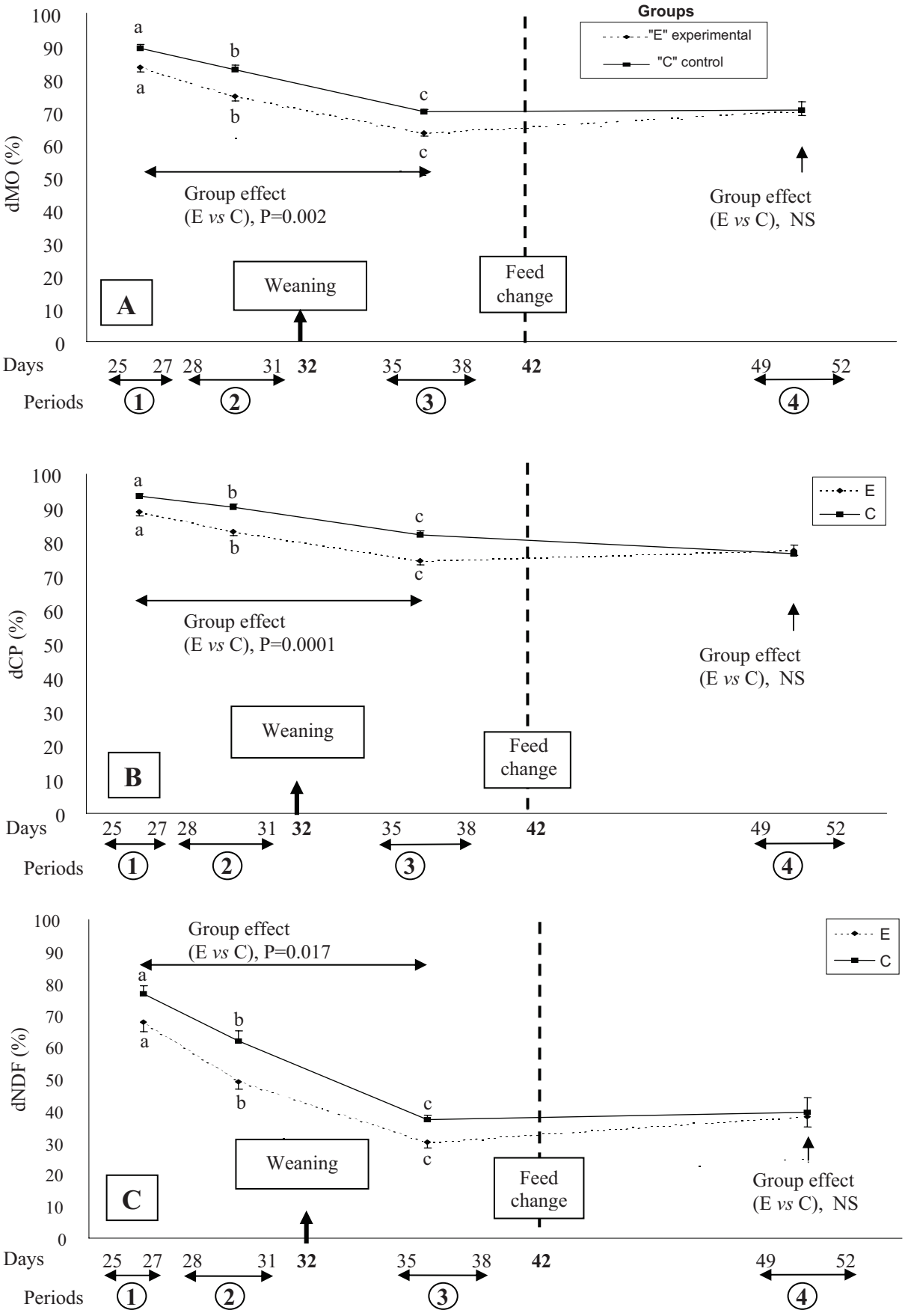
Figure 1: Daily feed intake of rabbit, during different periods (1-4), from Day 25 to Day 53.
(Within age, means differ at the level: +: P<0.1 ; *: P<0.05 ; **: P<0.001).

Digestive efficiency before and after weaning

Before the feed change (Day 42), apparent digestibility coefficient (ADC %) of OM (Figure 2A), crude protein (CP, Figure 2B) and NDF (Figure 2C) decreased with age in the 2 groups (P<0.0001). Fat ADC (Figure 3A) did not evolve during the 3 first periods in group E, while it decreased significantly after weaning (Period 3) in group C (P<0.0001). ADC of starch (Figure 3B) was very high (99.5±0.4 %). It remained constant during the 3 first periods in group C, while it increased in group E after weaning (Period 3 *vs*. Period 2).

During the first 3 periods, significant differences were observed for all the nutrients, according to the feeding group. Faecal digestibility was lower in group E compared to group C for OM (- 9 % ; P<0.01), CP (-8% ; P<0.0001), NDF (-17% ; P<0.0001), and fat (-6% ; P<0.0001). On the opposite, starch apparent digestibility was higher in group E than in the group C (+0.5% ; P<0.0001).

After feed change, there was no group effect on digestibility of nutrients, except for apparent digestibility of starch, which tended to be higher in group E than in group C (P<0.08).



<u>Figure 2:</u> Apparent faecal digestibility of: A) organic matter (OM), B) crude protein (CP), C) Neutral Detergent Fibre (NDF), during different periods (1-4), from Day 25 to Day 52 in experimental (E) or control (C) group.

Within group and for Periods 1, 2 and 3: means with a same superscript did not differ at level P=0.05.

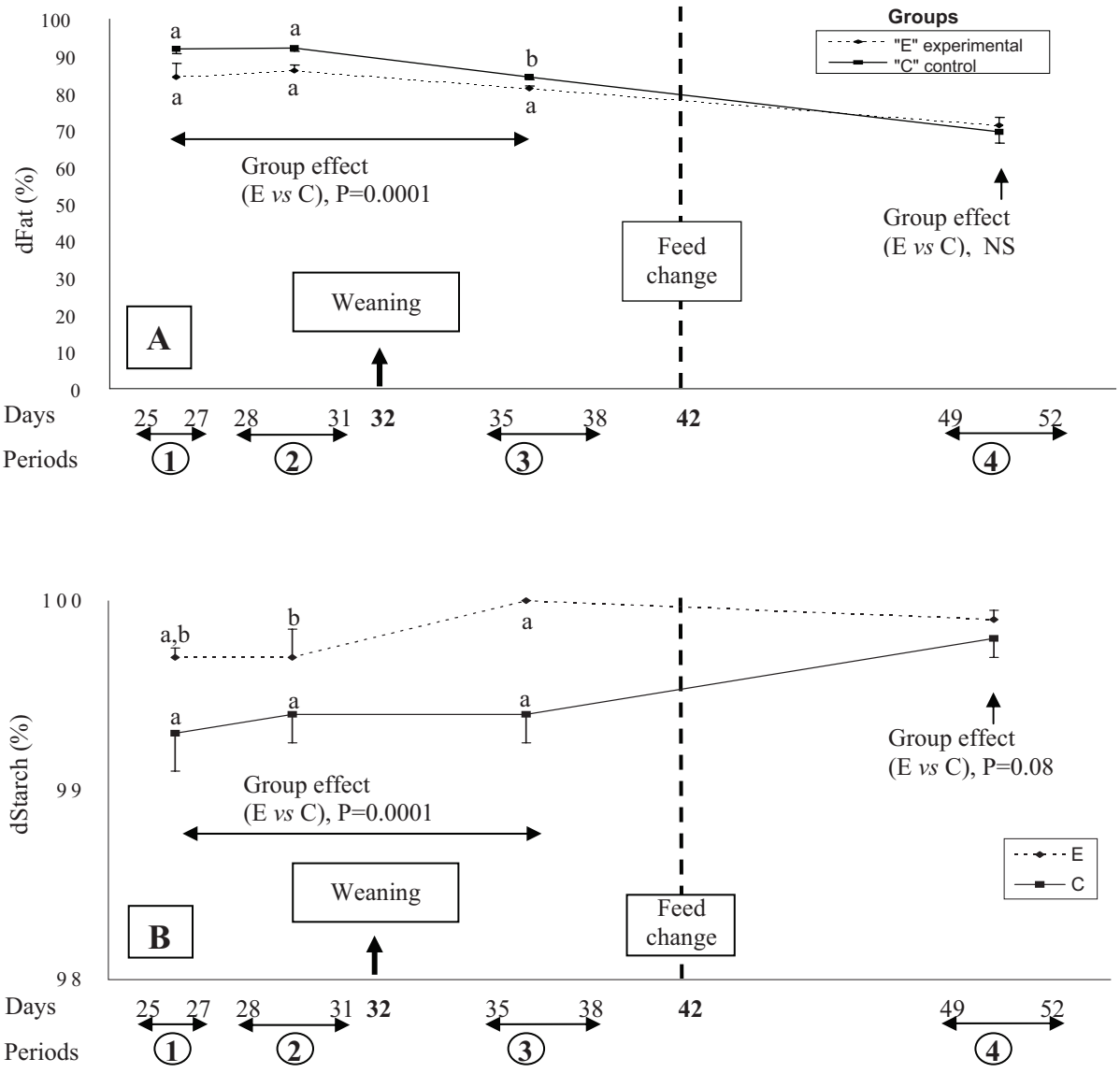


Figure 3: Apparent faecal digestibility of: A) fat, B) starch, during different periods (1-4), from Day 25 to Day 52 in Experimental (E) or Control (C) group.

Within group and for Periods 1, 2 and 3: means with a same superscrit did not differ at level P=0.05.

DISCUSSION

Intake and digestive efficiency before and after weaning

MAERTENS and DE GROOTE (1990) observed that solid feed intake began on day 22-23. Present data confirmed that at Day 25, solid feed intake was already important (>20 g/d/rabbit) and increased rapidly with age, in agreement with PARIGI-BINI *et al.* (1991). Feed digestion appeared globally very high (over 75%) before weaning and decreased with age for most of the nutrients, except for starch, in agreement with GIDENNE *et al.*(1990) or MAERTENS and DE GROOTE (1982).

Nevertheless, our high digestion results for young rabbits were 15 units higher compared to those of PARIGI-BINI *et al.* (1995). Besides, efficiency of digestion before weaning could be

overestimated, since during this period the digesta volume is increasing (particularly in cæcum), which could lead to an underestimation of nutrients excreted. Before weaning, fat digestion was high (87%) and only slightly decreased after weaning. On the opposite, EVANS and JEBELIAN (1982) showed that after weaning fat digestion was improved.

Effect of the dietary starch/fibre level, on intake and digestive efficiency.
It is acknowledged that after weaning, rabbit increases its voluntary feed intake, when dietary fibre level increases, to regulate its digestible energy intake. Inversely, before weaning we found that feed intake was lower for rabbits fed a high starch/low fibre diet. Similarly, DE BLAS *et al.* (1995) found that before weaning the feed intake of young was higher with high starch but also low fat isoenergetic diets.
Previous results showed that suckling rabbits compensate a low milk intake with a higher feed intake (SZENDRÖ *et al.*, 1985 ; SCAPINELLO et al., 1999). In the present study, young rabbits consumed less milk and less solid feed with the low starch/fibre ratio diet, while we expected a higher feed intake.
CARREGAL *et al.* (1980) and DE BLAS *et al.* (1986) showed in weaned rabbits that an increase in dietary fibre level lead to a decrease in digestibility coefficient for organic matter, protein and fibres. This is in agreement with the lower digestive efficiency observed, before and after weaning, in rabbits fed the low S/ADF diet for all nutrients excepted starch. The digestibility of this later, great in both group (> 99%), was higher in rabbit fed the low S/ADF ratio diet.
The diet given before and just after weaning has no influence on the digestive capacity of rabbits during later fattening period. This is in agreement with PEREZ *et al.* (1996) who showed that rabbit digestion is adapted within seven days after a feed change.
In conclusion, the rabbit digestive efficiency was high before weaning and then decrease (except for starch). Feed efficiency was reduced with low starch/high fibre level, either before or after weaning. Rabbits previously fed or not a "weaning" diet digest similarly a "finishing" feed. Effect of dietary starch/fibre ratio on feed intake regulation before weaning needs to be more deeply studied.

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