FEEDING STRATEGY FOR THE EARLY WEANED RABBIT: INTEREST OF A HIGH ENERGY AND PROTEIN STARTER DIET ON GROWTH AND HEALTH STATUS

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ABSTRACT

The performances and digestive health of early-weaned rabbits were compared according to two feeding strategies. 26 litters were fed a two-feeds program (group TF), with a "Starter" diet (crude fat=6.3%, CP=19.6%, ADF=12.4%) from 18d till 31d, with a “Control” diet (crude fat=2.4%, CP=16.5%, ADF=17.0%) from 31 till 70d of age. In the single-feed program (group SF) 16 litters were given only the control feed from 18 till 70d. Litters (9 pups at 18d) were bred with their mother, in specific cages adapted to distribute separately the experimental feeds to the litter from 18d of age, while females were fed a commercial feed (without access to the litter). At 23d of age, all litters were weaned but maintained in the same cage till 49d. Then, 5 rabbits from each litter were moved to the same collective fattening cage until 70d. Feed intake results, obtained from collective cages, were corrected for mortality. Between 18 and 23d of age, the live weight (at 23d = 410 g) were not significantly affected by the diet (Starter *vs* Control), while the feed intake was 64% higher for the most energetic diet (148 *vs* 90 g per litter, respectively for TF and SF groups). The intake was slightly lower (-7%) for TF group between 23 and 31d (36.5 *vs* 39.1 g/d/rab, P=0.11). The feed conversion between 23 and 31d was 16% lower in TF group (respectively 1.32 and 1.57 for TF and SF, P<0.001), with a slightly higher weight gain (33.1 *vs* 30.9 g/d, P=0.17), in relation to the higher energetic content (+35%) of the starter diet. Between 31and 49d the weight gain of litters were similar among the two groups. At 70d of age, the weight of rabbits were not affected by the feeding program, as the growth of SF group was 7% higher (P=0.012) between 49 and 70d. Till the feed change at 31d, the mortality and morbidity rates remained at a low level (<3%) and were not affected by the diet (Starter or Control feed). After 31d (shift of feed for TF group) the incidence of digestive troubles increased sharply and led to a significantly higher mortality in SF than in the TF group in the 31 to 49d period (24.6 *vs* 15.2%, P=0.021). After 49d the mortality and morbidity were again low (<7%), although the health risk index tended to be higher in the SF group (P=0.07). In conclusion, these results suggested that the distribution of a high energy and protein diet during the week following an early weaning improve the health status in subsequent fattening period.

Key words: weaning, feeding program, digestive health, performances, rabbit.

INTRODUCTION

Several authors suggest that nutritional requirement of lactating females and young rabbits are antagonistic. In this context, early weaning make possible to give to the young a specific diet which meet their nutritional requirements (PASCUAL, 2001; GIDENNE and FORTUN-LAMOTHE, 2002). Several studies recently explored the feeding and nutrition of the early-weaned rabbit (XICCATO *et al*., 2000; GUTIERREZ *et al.,* 2002 a, b; GIDENNE *et al., 2002, 2003*). The lipids and protein content of the doe milk is very high (PASCUAL *et al.*, 1999) suggesting that digestive capacities of young rabbits are adapted to digestion of highly energetic diet. In contrast, a high fibre/low energy feed improves the health status of the growing rabbit weaned after 4 weeks of age (GIDENNE, 2003). Therefore, the advantages of a highly energetic diet given to young rabbits could be counterbalanced by a negative effect on health following the feed change. Indeed, a brutal shift from a concentrate to a low energy feed would favour the post-weaning digestive troubles as reported for the young rabbit double-milked (ZOMBORSZKY-KOVÁCS *et al.,* 2000), or by breeders saving litters with a piglet feed. Moreover, the ability of the young to valorise a high lipid feed between 3 and 4 weeks of age is fewly documented, as well the consequences on its post-weaning digestive health.

Therefore, we aimed to compare the digestive health and performances of early weaned rabbits (at 23d old), submitted to two feeding strategies: a two-feeds (TF) program corresponded to a "Starter" diet (rich in lipids and protein) given from 18d till 31d, followed by a Control feed from 31 till 70d; and single-feed "SF" program where only the Control feed was given from 18 till 70d.

MATERIAL AND METHODS

Animals, feeds and experimental design

A total of 42 litters, maintained at 9 pups from birth (day 0) till 18d, were bred with their mother, in specific cages (FORTUN-LAMOTHE *et al.* 2000) adapted to distribute separately a feed to the litter from day 18 of age, while females were fed a commercial feed (without access to the litter). At 23d of age, all litters were weaned and maintained in the same cage till 49d (Figure 1). At 49d, 5 rabbits from each litter were moved to the same collective fattening cage until 70d of age. In the “two feeds” program (TF group, n=26 litters; Figure 1) rabbits were given a "Starter" diet from 18 till 31d, and next a "Control" diet from 31 till 70d (Table 1). In the “single feed” program (SF group, n=16 litters) rabbits received only the "Control" diet from 18 till 70d of age. The "Starter" diet had a high content of digestible protein and energy (with a high incorporation of vegetable fat and sucrose), but a low starch level. Addition of vegetable oil in the starter diet (3% copra oil + 2% sunflower oil) permitted to increase the level of medium chain fatty acids (C8 and C10). The "Control" diet was formulated to meet the nutritional requirements of fattening rabbits, and had a classical protein, energy, starch, fibre and fat content. The two diets were given *ad libitum* in pellet form (diam. 3.5 mm), and they contained only a coccidiostat, but no antibiotics. No prophylactic treatment was applied to rabbits throughout the experiment.

Growth, intake and health status measurements

Litters were weighed at 18, 23, 28, 31 d, then rabbits were individually weighed at 49 and 70d of age. Feed intake was precisely controlled at the same ages, including a control of food spillage. Cages having more than 2 rabbits dead within a period were discarded from statistical analysis of feed intake.

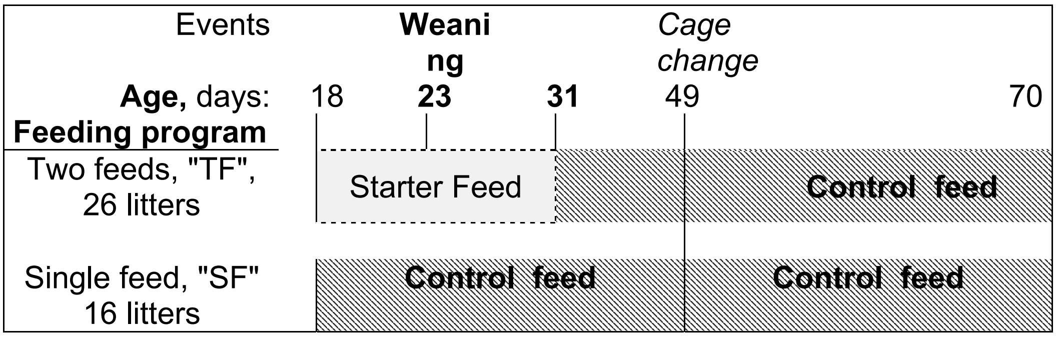

Figure 1 : Experimental design

Morbidity was measured individually at each weighing till 31d and thereafter weekly. It corresponds to ill rabbits (but still alive within a period), showing digestive troubles (diarrhoea), or severe loss of weight during a week, or an abnormally low growth. An animal was accounted morbid only one time (within a period), even if diarrhoea lasted several days. The Health Risk index was the sum of morbid and dead animals, knowing that each animal was accounted only once (classed either dead or morbid). Feeds were analysed for dry matter, ash, crude fat and fibres (EGRAN 2001), and nitrogen (Leco auto-analyser).

Statistical analyses

Results of growth and intake were analysed according to a monofactorial variance analysis (effect of group). Data of mortality and morbidity were analysed according to the method of K Pearson (distribution of χ^2, procedure CATMOD, SAS).

RESULTS AND DISCUSSION

The special model of cages allowing us to separate the feeding for young and doe, also permitted to exclude interactions with female, such a feed given to the litter that would affect the milk production (and litter growth) or body condition of the doe (FORTUN-LAMOTHE, 2003). Accordingly, the female weight at weaning (23d) was not affected by the litter feeding program (4317 *vs* 4343 g for TF and SF groups, P=0.85). The weight of kits at 23d (meanly 410 g) was consistent with previous studies using the same cages (GIDENNE *et al.*, 2003). The feed intake between 18 and 23 d of age was 64% higher for the Starter diet (148 *vs* 90 g per litter, respectively for TF and SF groups, P=0.012),

Table 1. Ingredients (%) and chemical composition of diets

Diets :	Starter	Control
Wheat	9.45	12.40
Wheat straw		6.00
Soya bean meal	19.00	10.00
Beet pulp	15.00	20.00
Wheat bran	15.00	20.00
Sunflower meal	10.00	
Alfalfa meal	12.00	30.00
Whole soya bean seeds	5.00	
Vegetable oil	5.00	
Sugar (sucrose)	5.00	
Minerals and vitamins	4.55	1.60
Composition *(g/kg air dry basis)*		
Organic matter	806	819
Neutral detergent fibre	240	328
Acid detergent fibre	124	170
Acid detergent lignin	27	35
Crude protein (Nx 6.25)	196	165
Crude fat	63	24
Starch*	67	120
Digestible energy*, MJ/kg	12.89	9.60
Digestible protein*, g/kg	166	119

*calculated values from tables (MAERTENS et al., 2002), devoted to 6-8wks old rabbits.

although the intake variability was very high at this age (CV > 45%). Next, the dry feed intake was slightly lower (-7%) for TF group between 23 and 31d (36.5 *vs* 39.1 g/d/rab, P=0.11). Consequently, no significant difference in feed intake was detected in the whole 18 to 31d period (Table 2). In fact, we potentially expected a much lower intake for the Starter diet, taking into account its very high energy level (+35% compared to Control diet). These results suggested that young rabbit did no entirely regulate its feed intake according to dietary energy content. Similar results were previously obtained by FORTUN-LAMOTHE *et al*. (2001) and DEBRAY *et al*. (2002).

Between 18d and 31d of age, the feed conversion ratio (milk intake not accounted from 18 to 23d) was logically lower in TF than in SF group, because of the high energy content of the starter diet (Table 2). The feed conversion between 23 and 31d (after weaning) was 16% lower in TF group (resp. 1.32 and 1.57 for TF and SF, P<0.001), since the feed intake was slightly lower for TF as mentioned above, and the weight gain slightly higher also for TF (33.1 *vs* 30.9 g/d, P=0.17). This suggested that young rabbits would be able to valorise a high energy and protein dry feed. XICCATO *et al*. (2000) also reported a higher live weight of early-weaned rabbits fed a starter diet, but containing 3.7% lipids (*vs* 6.3% here). Besides, the dietary digestible energy remains difficult to be precisely measured in the young (possible overestimation) as shown by DEBRAY *et al.* (2000). Between 18 and 31d the weight gain of litters was 9% higher in TF group

Table 2. Performances of early weaned rabbits, according to the feeding program

Feeding program : (from 18-49d)	Two feeds	Single feed	*CVr, %*	*P level*
Live weight, g				
at 18 days	320	324	*13.1*	*0.79*
at 31 days	681	652	*12.0*	*0.26*
at 49 days	1380	1359	*13.2*	*0.71*
at 70 days*	2337	2347	*10.4*	*0.77*
Period 18-31d old				
Weight gain, g/d	27.7	25.2	*16.1*	*0.073*
Feed intake, g/d	24.5	23.5	*13.4*	*0.28*
Feed conversion$	0.86	0.99	*10.3*	*<0.001*
Period 31-49d old				
Weight gain, g/d	38.8	39.3	*19.0*	*0.85*
Feed intake, g/d	90.3	88.0	*13.9*	*0.55*
Feed conversion	2.35	2.30	*13.3*	*0.62*
Period 49-70d old				
Weight gain*, g/d	42.9	45.9	*17.0*	*0.012*
Feed intake, g/d	142.0	142.6	*11.2*	*0.92*
Feed conversion	3.33	3.17	*7.1*	*0.040*

Data obtained on healthy rabbits raised collectively, except individual live-weight at 70d (*). CVr: residual variation coefficient. $: milk intake not accounted from 18 till 23d;

(P=0.07, Table 2), and between 31 and 49d it became similar among the two groups, as well the feed intake. At 70d of age, the weight of rabbits were not affected by the feeding program, as the growth of SF group was 7% higher (P=0.012) between 49 and 70d while their feed conversion was 5% lower.

From 18 to weaning (23d) only 4 rabbits (3 and 1 respectively for TF and SF groups) died by diarrhoea. Till the feed change at 31d, the mortality and morbidity rates remained at a low level (<3%, Table 3) and were not affected by the feeding program (Starter or Control feed). After 31d (shift of feed for TF group) the frequency of digestive troubles increased sharply and led to a significantly higher mortality in SF than in the TF group (Table 3). This episode of enteropathy was transitory since after 49d the mortality and morbidity were again low, although the health risk index tended to be higher in the SF group (P=0.07). Autopsy of some dead animals revealed no signs of inflammation on the small intestine, and no signs of Epizootic Rabbit Enteropathy. When the TF rabbits were fed the starter diet, their live weight at 31d was 7% higher than for SF animals, and this could favour the resistance to enteropathy. Although the high-fat starter diet was given till 31d only, a favourable role of dietary lipids on digestive immunity could also be hypothesised (FORTUN-LAMOTHE and DROUET-VIARD, 2001). The starter diet may also have a "health protective" action, through its high levels of medium chain fatty acid (C12, C10 and C8). Indeed, the bacteriostatic properties of these fatty acids were identified in the doe milk by CANAS-RODRIGUEZ and SMITH (1966), and its antimicrobial activity against some enteropathogenic agent was observed in-vitro by MAROUNEK *et al.* (2001).

Table 3. Health status of early weaned rabbits, according to the feeding program

Feeding program : (from 18-49d)	Two feeds	Single feed	*P level*
Period 23-31 d			
(Group size at 23d)	*(231)*	*(143)*	
Mortality, %	3.0	1.4	*0.32*
Morbidity, %	1.7	2.8	*0.48*
Health Risk Index, %	4.8	4.2	*0.80*
Period 31-49 d			
(Group size at 31d)	*(224)*	*(141)*	
Mortality, %	15.2	24.6	*0.021*
Morbidity, %	7.1	9.2	*0.46*
Health Risk Index, %	22.3	33.8	*0.013*
Period 49-70 d			
(Group size at 49d)	*(105)*	*(90)*	
Mortality, %	1.9	6.7	*0.12*
Morbidity, %	0	1.1	*0.82*
Health Risk Index, %	1.9	7.8	*0.072*

However, the protective effect of such medium chain fatty acid remained to be confirmed in-vivo. Besides, we initially hypothesised that an abrupt shift in feed composition would disturb the digestive tract. Our result did not support such assertion, therefore permitting the use of multi-feed program for the growing rabbit.

In conclusion, a high energy and protein starter feed was valorised by the early-weaned rabbit, but no residual beneficial effect on growth was found for the end-fattening period.

In return, face to an episode of non-specific enteropathy, a two-feed strategy (high then low energy) favoured the resistance of the young rabbit to digestive troubles. Contrary to initial hypotheses, an abrupt feed change during the post-weaning period seemed not detrimental for the digestive health of the young, thus allowing the use of multi-feeds strategy for the young rabbit.

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