Effect of energy level in doe diet on intake and performances of young rabbits before and after weaning

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ABSTRACT

The aim of this study was to determine the influence of the energy content in the feed distributed to does on the intake of milk and solid feed, growth performances and the health of rabbit kits from birth (0 d) to 70 days of age (70 d). A total of 2322 kits from 236 litters, by 120 females followed for 3 reproductive cycles, were divided into 3 experimental groups that differ only by the diet offered to their mothers. Three experimental feeds were used: feed R (10.97 MJ DE/kg, 24.0 g lipids/kg and 161 g starch/kg), feed L (11.21 MJ DE/kg, 49.0 g lipids/kg and 161 g starch/kg) and feed F (9.70 MJ DE/kg, 23.0 g lipids/kg and 70 g starch/kg). In the RR group, the does received feed R throughout the study. In the RF group, the does received feed R from 0 to 25 d, and between weaning (35 d) and 42 d, and feed F from 25 to 35 d. In the LR group, the does received feed L from 0 to 25 d, and feed R from 25 to 42 d. Kits in the three groups were fed feed F from 18 to 70 d, where feed intake was restricted from 35 to 63 d, and distributed *ad libitum* outside of this period. Milk intake/kit was higher in the LR group compared to the other two groups at 17 d (+14.5%; $P<0.001$) and 23 d (+14.9%; $P<0.05$), but similar in the 3 groups at 3, 10 and 29 d (11.8, 24.2 and 13.8g/d/kit, respectively; NS). Kit weight was higher in the LR group than the other two groups at 18 and 25 d (+10.1%, and +8.2% respectively; $P<0.01$). No difference in live weight was observed at 35 or at 70 d ($P=0.239$ and $P=0.172$, respectively). Feed intake/kit from 18 to 25 d was higher in the groups RR and RF compared to the LR group (+26%; $P<0.001$), and higher in the RF group compared to the LR group from 25 to 35 d (+8%; $P<0.05$). Feed intake, when fed again *ad libitum* between 63 and 70 d, was similar in all groups ($P=0.292$). Kit mortality before weaning was similar in all groups (8.1%; NS), but was lower in the RF group after weaning compared to groups RR and LR (1.7 vs 4.8 and 5.8% respectively; $P<0.001$). Our results suggest that the incorporation of fat in the diet of the female increases milk intake of kits, which decreases their feed intake before weaning. The high milk intake before weaning was found to have a negative effect on the health of young rabbits after weaning, where all animals followed the same feeding program.

Key words: milk intake, feed intake, health, rabbit, weaning

INTRODUCTION

During the first three weeks of life, rabbit kits are entirely nutritionally dependent on the milk produced by their mother. Previous studies have linked kit viability and growth performances to the quantity and quality of the milk ingested (Szendro et al., 2002). With an increase in productivity, notably prolificacy and reproductive rates, the nutritional demands of rabbit does have drastically changed in recent years. The competing demands of gestation and lactation have been found to have a negative effect on milk yield (Maertens et al., 2006). In order to minimize this negative effect on milk production, the incorporation of dietary fat has been found to improve the utilization of dietary energy for milk production (Pascual et al., 2003). Previous works studying the effects of milk production on kit performances focused on the period before weaning, but the effects after weaning need to be studied.

The aim of this study was to determine the influence of the energy content of feed, due to the inclusion of fat, distributed to does on the intake of milk and solid feed intake, growth performances and the health of rabbit kits from birth (0 d) to 70 days of age (70 d).

MATERIALS AND METHODS

Animals, diet and experimental design

The experiment was designed and carried out according to the European Union recommendations on the protection of animals used for scientific purposes (2010) at the PECTOUL Experimental Unit (INRA, Toulouse, France), and was approved by the French government (n°2015100817517471).

Three experimental feeds were used during the experiment (Table 1). The R (reproduction) diet was formulated to meet the nutrient needs of reproductive does (DE; 10.97 MJ DE/kg, DP; 128 g DP/kg, starch 161 g/kg). The L (lactation) diet was also formulated for reproductive does (11.21 MJ DE/kg), rich in lipids to promote milk production. The F (fattening) diet was formulated to meet the nutrient needs of fattening rabbits (9.70 MJ DE/kg, starch 70 g/kg, 95 g DP/kg, and DF; 269 g DF/kg).

Table 1: Analyzed chemical composition of experimental diets (g/kg)

	Diet R	Diet L	Diet F
Fat	24	49	23
Starch	161	161	70
Acid detergent fibre (ADF)	198	169	240
Neutral detergent fibre (NDF)	343	302	421
Acid detergent lignin (ADL)	89	63	125
Digestible fibre	212	190	269
Digestible energy (MJ/kg)	10.97	11.21	9.70
Digestible protein	128	134	95

A total of 2322 kits, from 236 litters, issued from 120 does during three successive reproductive cycles were used in this study. Cages were equipped to feed kits independently from their mother (Fortun-Lamothe et al., 2000). Kits had access to the mothers' area in order to suckle. The separated feeding system was put in place at 18 d. Does were distributed at parturition into one of three experimental groups depending on the does' weight at parturition (4170±30g) and parity (1.4±0.1), as well as the litter size (12±1 kits) and weight (731±20g). The litters were equalized at 10 kits 3 days after birth by cross-fostering or culling. After weaning (35 d), the litters were split into cages (5 kits/cage) from the same litter. Experimental groups differed only by the diet of the reproducing does. In the RR group, the does received feed R throughout the study. In the RF group, the does received feed R from 0 to 25 d, and from weaning (35 d) and 42 d, and feed F from 25 to 35 d. In the LR group, the does received feed L from 0 to 25 d, and feed R from 25 to 42 d. Kits in the three groups were fed feed F from 18 to 70 d, where feed intake was restricted from 35 to 63 d, and distributed *ad libitum* outside of this period. During the restriction period, the quantity of feed distributed was 70 g/d/rabbit from 35 – 42 d, 90 g/d/rabbit from 42 – 49 d, 110 g/d/rabbit from 49 – 56 d and 130 g/d/rabbit from 56 – 63 d. During this period of restricted feeding, the feed was distributed daily. Antibiotics were not used, in either feed or water, throughout this study.

Growth, intake and health status measurements

Individual animal weight was recorded weekly from 18 to 70 d of age. Milk intake was measured once per week from 3 d to weaning (3, 10, 17, 23 and 29 d) by weighing the litter before and after nursing.

Feed intake per litter or cage, before or after weaning respectively, was measured weekly until 70 d. Health status of rabbits was monitored at each weighing. Mortality of kits was recorded daily from three to 70 d.

Statistical Analysis

All statistical analyses were performed with version 3.0.3 of the software R. Growth performances, feed and milk intake were evaluated by a linear mixed model, where the experimental group, the reproductive cycle, the parity and the reproductive success for the previous cycle (n-1) were fixed effects, and the doe was a random effect. Interactions between group and cycle were noted in the results when significant. The percentage of mortality was compared by a Chi^2 test.

RESULTS AND DISCUSSION

Milk intake of kits at 3 and 10 d was on average 11.8 and 24.2 g/kit, respectively, and was similar between the three groups (Table 2; P>0.05). At 17 and 23 d, milk intake was highest in the LR group, ranging from 14 to 21% higher compared to the other two groups (P<0.05; Table 2). This can be caused by the high fat content in the L diet. Pascual et al. (2003) showed that dietary fat improves milk yield. At 29 d, no differences of milk intake between groups were observed (13.8 g/kit; P=0.876).

The feed intake of kits at the onset of solid feed intake (18 – 25 d) was lowest in the LR group compared to groups RR and RF (7 vs. 9 and 10 g/d, respectively; Table 2; P<0.001). From 25 – 35 d, the feed intake of kits in the LR group was lower compared to the RF group, with the RR group as intermediary (P<0.05). This is similar to previous studies which demonstrated that litters of does offered fat rich diets consumed less feed compared to litters of control diets (Pascual et al., 2003). During the period of feed restriction (from 35 to 63 d), no feed remained in the feeder, therefore feed intake corresponded to feed offered. Feed intake from 63 – 70 d was on average 215 g/d/kit, and was similar between groups (P=0.292). The feed conversion ratio after weaning was similar for all groups (3.01; P=0.301).

Kit weight at birth was 59 g, and no difference was observed between the groups (Table 2; P=0.973). At 3 d, the kits in the LR group tended to be heavier than the kits in the other two groups (P=0.095). A difference in weight was observed at 18 d, where the kits in the LR group were heavier (+10.2% on average) than in the other two groups (P<0.001). As rabbit kits did not have access to solid feed before 18 d, this difference is strictly due to the milk intake. An increase in kit weight gain from +3 to +16 g/day with the incorporation of fat in the doe diet has been observed in a large number of previous studies (Pascual et al., 2003). At weaning, the weight of young rabbits was similar between the groups (P=0.371). This is due to the higher feed intake between 25 and 35 d in the RF group compared to the LR group (+8%; P<0.05), with group RR as intermediary. At 70 d, live weight was similar between groups (2322 g; P=0.172).

Kit mortality from equalization (3 d) to weaning (35 d) was similar between groups (8.1% on average for each group; P=0.754). On the contrary, De Blas and Mateos (1998) showed that kit survival before weaning was improved when doe diets were enriched with fat. Between weaning and 70 d, the mortality in the group RF was lower compared to the other two groups (1.7% compared to 4.8% and 5.8% for the groups RR and LR, respectively; P=0.001). This result could be caused by the higher solid feed intake before weaning in the RF group, which allowed for a faster maturation of the cecal microbiota.

Table 2: Effect of the feeding strategy on growth performances, milk and feed intake of young rabbits.

	Group			SEM	Prob.
	RR	RF	LR		
Rabbits, no.	720	681	716		
Milk intake 3 d (g/kit)	11.6	11.5	12.4	0.5	0.728
Milk intake 10 d (g/kit)	23.3	23.3	26.1	0.9	0.218
Milk intake 17 d (g/kit)	25.8^{b}	27.2^{b}	32.5^{a}	1.3	<0.001
Milk intake 23 d (g/kit)	26.7^{b}	26.6^{b}	31.0^{a}	1.1	0.044
Milk intake 29 d (g/kit)	14.2	13.5	13.7	0.7	0.846
Feed intake 18 d – 25 d (g/d/kit)	10^{a}	9^{a}	7^{b}	0.1	<0.001
Feed intake 25 d – 35 d (g/d/kit)	48^{ab}	50^{a}	46^{b}	0.1	0.013
Feed intake 63 d – 70 d (g/d/kit)	214	213	219	0.4	0.292
Live weight birth (g)	59	59	59	1.1	0.973
Live weight 3 d (g)	81	81	85	1.3	0.095
Live weight 18 d (g)*	276^{b}	274^{b}	306^{a}	1.1	<0.001
Live weight 25 d (g)*	385^{b}	384^{b}	419^{a}	1.5	0.006
Live weight 35 d (g)	784	780	806	2.2	0.371
Live weight 63 d (g)	1849	1845	1880	4.0	0.228
Live weight 70 d (g)	2312	2302	2344	4.0	0.172
Feed conversion 35 d – 70 d	3.06	3.00	2.97	0.1	0.301

* Interaction group x cycle (P=0.011 and P=0.028 for live weight at 18 and 28d, respectively)

CONCLUSIONS

In conclusion, our results suggest that the addition of fat in the doe diet increases the milk intake of kits, which in turn decreases their solid feed intake before weaning. The high milk intake before weaning was found to have a negative effect on the health of young rabbits after weaning when under the same feeding conditions, suggesting an effect on cecal microbiota maturation. Further experiments before weaning to better define dietary preference in suckling rabbits are needed.

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