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REARING CONDITIONS IN RABBIT:
EFFECT OF LITTER SIZE BEFORE WEANING ON FEED INTAKE AND BODY DEVELOPMENT AND COMPOSITION OF YOUNG RABBIT DOES

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ABSTRACT

In two experiments, the effect of litter size before weaning on subsequent body development and feed intake was studied. Before weaning, kits were raised in a litter size (LS) of 6, 9 or 12. After weaning, 58 female kits per treatment were fed ad libitum to 14 ½ weeks of age. At this age, receptive does were inseminated. During reproduction, a semi-intensive breeding rhythm (10-12 days PP) was used. The experiments ended at weaning of the second litter. Feed intake and body weight were recorded. At the end of rearing and at end of the experiment, does were sacrificed to determine body composition.
During rearing, LS-12 had a significantly ($P < 0.05$) lower feed intake (12-17 g/d) than LS-9 and LS-12. During reproduction, no differences in feed intake between treatments were found. Litter size before weaning influenced body development. At weaning, body weight (BW) between treatments differed significantly ($P < 0.05$), 852 ± 12 vs. 773 ± 12 vs. 657 ± 12 g for LS-6, LS-9 and LS-12). Compensatory growth was observed and from the end of first lactation onwards, no difference in BW between treatments was found.
At the end of rearing, LS-12 contained significantly ($P < 0.05$) less fat than LS-6 (16.9% vs. 20.1%, respectively). The lowest losses from end of rearing to end of experiment in fat content (-50%) and energy (- 30%) were found in LS-9 and LS-12.
Based on the results of this study it can be concluded that litter size before weaning does not contribute to a higher feed intake and a decreased energy loss during the first lactation.

INTRODUCTION

The current rearing management of rabbit does, focussing on maximal productivity, does not seem to prepare the animals well enough to cope with high energy demands during first lactations. In concurrently pregnant and lactating young does, significant loss of body lipids and energy (on average -40% and –20% of the initial content, respectively) were observed (Parigi-Bini and Xiccato, 1993). These losses seem to be due to an insufficient voluntary feed intake (Xiccato, 1996) and lead to reproductive problems and a high replacement rate, which are undesired from welfare and economic point of view.
The energy deficit in reproductive young does can not be solved sufficiently by management measures during the reproduction period (Cervera et. al., 1993; Parigi-Bini et al., 1996; Xiccato et al., 1995). Management measures during rearing focussing on stimulation of body development and feed intake capacity could be another approach to solve the problem, but information on this is lacking. Feed intake regulation during rearing seems to be a suitable factor for this purpose (Rommers et al., 1999). Therefore, two experiments were performed to

study the effect of milk intake before weaning on subsequent body development and composition, and feed intake in young reproductive does.

MATERIAL AND METHODS

Two identical experiments were performed from April 1997 till December 1998 (Experiment 1) and from January 1998 till November 1998 (Experiment 2).

Animals and Husbandry

Multiparous non-lactating New Zealand White does (33 and 55 in the first and second experiment, respectively) were inseminated with fresh mixed sperm of ten bucks. At the first day after kindling (= day 0), litters were checked. After removal of stillborn, extreme tiny (<45 gram) and heavy (>100 gram) kits, litters of similar does (based on parity and milk production) were mixed. Kits were randomly assigned to one of the following three treatments 1) six kits (LS-6), nine kits (LS-9) or twelve kits (LS-12) per litter. After this, does were given free access to the nestboxes.

During the pre-weaning period, litters were checked for dead kits, which were removed and replaced by kits from other does with similar litter size. These kits were marked and excluded from subsequent measurements. At day 21, nestboxes were removed in order to stimulate the solid feed intake of the kits. Does and kits had free access to a standard commercial diet, containing 10.3 MJ/kg metabolizable energy (ME) and 17% crude protein.

At weaning (day 30), female kits whose body weight deviated less than 15% of the average kit weight of the litter were selected and 16 and 42 (the first and second experiment, respectively) were taken randomly per treatment. Animals were housed in individual cages and fed ad libitum a standard commercial diet (10.3 MJ/kg ME, 17% crude protein) until the end of the experiment.

At the end of rearing (14 ½ weeks of age), does were checked for receptivity (considered receptive if the vulva was colored (red - red/ purple) and swollen). Receptive does were artificially inseminated (A.I.) with fresh mixed sperm of 12 bucks. After the first and second kindling, does were inseminated 10 days PP. Non-receptive and non-pregnant does were excluded from the experiment. Litter size was standardized at eight and nine kits for the first and second parity, respectively at the 1st day after kindling (=day 0). The experiments were finished after weaning of the second litter.

The experiments were carried out in three identical deep-pit system compartments with 64 doe cages per compartment. The animals were housed under controlled illumination. Before weaning the animals were kept at a 16 hours photoperiod. During rearing, the animals were submitted to a constant photoperiod of 12 hours. The last five days before the first insemination the photoperiod was prolonged to 16 hours to evoke receptivity. During the reproduction period a photoperiod of 16 hours was maintained. A minimum house temperature of 16 ^{o}C was set.

Measurements

1) *Animals*. All animals removed during the experiment were recorded with reason of withdrawal. During reproduction, the kindling rate was determined as total number of kindling divided by the total number of inseminations.
2) *Body weight and feed intake*. Before weaning, kits were weighed at day 0, day 21 and day 30. After weaning, the animals were weighed once every week until 14 ½ weeks of age and during the first and second parity, at kindling and at day 16 and 30 of lactation.

Feed intake was determined after weaning until 14 ½ weeks of age, for the first gestation period and during the first two parities from kindling till day 16 of lactation, from day 16 till day 30 of lactation and from weaning till kindling.

3) Body composition. In the first experiment, the body composition at the end of reproduction (immediately after weaning of the second litter) was determined for all does, pregnant of the third litter (5, 8 and 4 for respectively LS-6, LS-9 and LS-12). In the second experiment 10 animals per treatment were randomly taken five days after the first insemination.
Animals were weighed immediately before slaughter and the content of the digestive tract, bladder and uterus was removed to determine empty body weight (EBW). The empty bodies were frozen at –20 ^{o}C until mincing and homogenization. Representative samples of the empty bodies were analyzed. Dry matter content was determined by freeze-drying. Nitrogen content was analyzed in fresh samples by Kjeldahl analysis. Protein was calculated by the nitrogen content multiplied 6.25. Fat content was determined by extraction of freeze-dried samples with petroleum-ether and drying the extract at 80 ^{o}C in a vacuum oven (10 kPa) to constant weight. Ash was determined in oven-dried samples in a furnace at 550 ^{o}C. Energy was measured in freeze-dried samples with bomb calorimeter (IKA C 7000, IKA Analysentechnik, Heitersheim, Germany).

Statistical analyses

The experiments were set-up as a randomized block design, assigning the three treatments over three adjacent cages (block). Analyses of variance were carried out using the GLM procedure of the Statistical Analyses System (SAS, 1990) with block and treatment put into the model. Block was left out of the model if not significant. In the reproduction period, blocks became unbalanced because of removal of does. Therefore, block was left out of the model. A Chi-squared test (SAS, 1996) was used to analyze differences in kindling rate.
The initial empty body weight and composition of the animals slaughtered at the end of the experiment was estimated from initial live weight by linear equations derived from the 10 does per treatment slaughtered at the end of rearing.

RESULTS AND DISCUSSION

During the rearing period, one animal of LS-12 was removed due to severe skin mould (*Microsporum sp.*). 61.5 % of the does kindled after the first insemination at 14 ½ weeks of age (28, 32 and 28 for LS-6, LS-9 and LS-12, respectively). From these animals, 53.4% was successfully inseminated 10-12 days PP (16, 16 and 15 for LS-6, LS-9 and LS-12 respectively). No difference in kindling rate between treatments was found.
In total, only one third of the total number of animals at start was able to sustain the semi-intensive reproductive rhythm of 42 days. 55% of the total culling was related to reproductive problems (not pregnant after two successive inseminations, abortion and dystocia), which is in agreement with previous data collected at our Center (not published).

In Table 1, the average daily feed intake during rearing and different stages of reproduction is presented. In the rearing period, feed intake of LS-12 was lower ($P < 0.001$) than LS-6 and LS-9 (152 ± 2 vs. 169 ± 2 and 164 ± 2 g/d for LS-12, LS-9 and LS-6, respectively). LS-12 animals had a significantly ($P < 0.05$) better feed conversion 3.8 ± 0.3 than LS-6 and LS-9 (4.0 ± 0.3 and 3.9 ± 0.3 respectively). This seems to be related to the development of the empty body composition. At the end of the rearing period, the EBW of LS-12 contained significantly less fat and had more protein and ash. The formation of protein involves binding of water and leads to higher body weight gain (BWG) than the formation of fat. The better feed conversion of LS-12 can thus be explained.

Table 1. Effect of litter size before weaning (LS-6, LS-9 and LS-12) on average daily feed intake (g/d) during rearing and different stages of reproduction, for does successfully inseminated at 14 ½ weeks of age and 10-12 days PP (LSM and s.e.).

Treatment	LS-6	LS-9	LS-12
		Rearing	
Number of animals	58	58	58
Feed intake	$169^a \pm 2$	$164^a \pm 2$	$152^b \pm 2$
Feed conversion	$4.0^a \pm 0.3$	$3.9^a \pm 0.3$	$3.8^b \pm 0.3$
		First parity	
Number of animals	28	32	28
First gestation period	176 ± 5	171 ± 5	168 ± 5
1st lactation: kindling – day 16[1]	322 ± 10	341 ± 9	319 ± 10
1st lactation: day 16 – weaning[2]	451 ± 13	480 ± 11	455 ± 12
		Second parity	
Number of animals	16	16	15
Weaning – second kindling	219 ± 8	223 ± 8	213 ± 8
2nd lactation: kindling – day 16[1]	387 ± 11	388 ± 11	393 ± 12
2nd lactation: day 16 – weaning[2]	547 ± 16	552 ± 16	555 ± 17

[1] In the first parity litter size was standardized at the first day after kindling at eight kits, in the second parity at nine kits.
[2] Feed intake of doe and kits.

During first gestation, the feed intake did not differ between treatments (176 ± 5 vs. 171 ± 4 vs. 168 ± 5 g/d for LS 6, LS-9 and LS-12 animals respectively). Also in the first and second parity no difference in feed intake between treatments was found. During the first 16 days of the first lactation an average amount of 327 ± 5 g/d of feed was consumed, whereas in the second lactation this amount was increased to 389 ± 6 g/d feed on average. It appears that animals from large litters are consuming less feed during rearing and deposited less fat in their carcass, but feed intake during subsequent pregnancy and reproduction period is similar to the other treatments.

In table 2 the average body weight at different stages of rearing and reproduction are presented. At weaning a significant difference ($P < 0.001$) in the average BW per treatment was found (855 ± 14 vs. 733 ± 16 vs. 664 ± 16 g for LS-6, LS-9 and LS-12). At 21 days age, a 28% difference in BW was found between LS-6 and LS-12. This is similar to data of Szendrö et al. (1996), who found a 31.9% difference in BW between LS-6 and LS-10 and Mohammed and Szendrö (1992), who reported a 33.4% difference in body weight gain between LS-6 and LS-10. From 21 days of age onward compensatory growth was observed in LS-9 and 12. Compensatory growth could occur because solid feed was given ad libitum. From 5 weeks after weaning onwards, no difference between the BW of LS-9 and LS-6 was found.
At the first mating (14 ½ weeks of age) LS-12 was still significantly ($P < 0.001$) lighter then LS-6 and LS-9 (3850 ± 49 vs. 3778 ± 49 vs. 3524 ± 50 g for LS-6, LS-9 and LS-12, respectively). There was no difference in BW between the animals per treatment, which became pregnant or not at first mating (14 ½ weeks of age). At weaning of the first litter, no differences in BW between treatments were found anymore. At the end of first lactation, animals had fully compensated their difference in BW at first mating.

Table 2. Effect of litter size before weaning (LS-6, LS-9 and LS-12) on body weight (g) and body weight gain (g/d) during rearing and body weight at different stages of reproduction, for does successfully inseminated at 14 ½ weeks of age and 10-12 days PP (LSM and s.e.).

Treatment	LS-6	LS-9	LS-12
		Rearing	
Number of animals	58	58	58
Start	68 ± 1	68 ± 1	67 ± 1
21 days	459^{a} ± 9	371^{b} ± 11	327^{c} ± 10
30 days (weaning)	855^{a} ± 14	733^{b} ± 16	664^{c} ± 16
First insemination (14 ½ weeks)	3850^{a} ± 49	3778^{a} ± 49	3524^{b} ± 50
Average daily weight gain from weaning until first mating	42.0^{a} ± 0.6	42.0^{a} ± 0.6	40.1^{b} ± 0.6
		First parity	
Number of animals	28	32	28
Kindling	4059^{a} ± 74	3902^{ab} ± 70	3699^{b} ± 74
Weaning	4521 ± 96	4417 ± 89	4257 ± 96
		Second Parity	
Number of animals	16	16	15
Kindling	3943 ± 97	3918 ± 97	3810 ± 104
Weaning	4416 ± 103	4477 ± 103	4314 ± 110

[ab] Means with a different letter in a row differ significantly ($P < 0.05$).

In Table 3, the chemical body content at the end of the rearing and reproduction period are given per treatment for does, treated the same from first inseminations at 14 ½ weeks of age onwards.

Table 3. Effect of litter size before weaning (LS-6, LS-9 and LS-12) on empty body composition at end of rearing (initial) and reproduction (final) for does, pregnant of first insemination from 14 ½ weeks of age onwards (LSM ± s.e.).

Treatment	LS-6		LS-9		LS-12	
Animals no.	5		8		4	
	Initial[1]	Final	Initial[1]	Final	Initial[1]	Final
Weight (g)	3596 ± 178	4507 ± 149	3669 ± 141	4699 ± 118	3390 ± 199	4507 ± 166
EBW (g)	3445 ± 161	3557 ± 170	3487 ± 127	3928 ± 134	3260 ± 180	3727 ± 190
Empty body composition:						
Water (%)	57.1	67.9 ± 1.0	58.1	66.7 ± 0.8	59.3	67.4 ± 1.1
Protein (%)	19.4	20.0 ± 0.2	19.7	20.0 ± 0.4	20.3	20.6 ± 0.2
Fat (%)	20.1	8.2 ± 1.2	18.7	9.5 ± 0.9	16.9	8.3 ± 1.3
Ash (%)	2.8	3.2 ± 0.1	2.9	3.2 ± 0.1	3.1	3.2 ± 0.1
Energy (MJ/kg)	12.5	7.9 ± 0.4	12.0	8.5 ± 0.3	11.3	8.1 ± 0.4

[1] Estimated values from linear regression equations, not analyzed statistically.

The genotype, feeding, environmental conditions and weight at weaning were the same in both experiments. Moreover, at the end of rearing, BW was highly correlated with EBW (r^2=0.98) and no influence of EBW on chemical content per treatment was found. Therefore, initial body content of animals in experiment 2 can be used to determine body development at the end of rearing for animals in experiment 1. For the slaughtered does (10 per treatment), the empty body of LS-12 contained significantly ($P < 0.05$) more water, more protein and ash and less fat than LS-6. At the end of the experiment, no difference in body composition between treatments was found. Animals of LS-6, being the heaviest and fattest at start of reproduction, had lost more fat and energy than LS-9 and LS-12, which is in agreement with Xiccato et al. (1999). They reported that fatter does at first kindling have higher energy loss during the first lactation.

During the first two parities, BWG and an increased EBW were observed in all treatments. However, in all cases a reduction of fat and energy content was observed. The highest loss in fat and energy occurred in LS-6 (60% and 37% loss of the initial content for fat and energy respectively) compared to 50% and 30% loss in fat and energy in LS-9 and 12, respectively. Because LS-6 had the highest fat content at the beginning of the reproduction period, at the end it was still comparable to LS-12 (8% of the EBW). In LS-12 compensatory growth was observed during the first parity. At the end of the experiment, LS-12 had compensated for the deviation in body composition at the start of the rearing period. This is in line with the findings of Ledin (1984), who stated that animals will compensate for the reduction in BW and deviation from normal body composition if enough time is given after feed restriction.

CONCLUSIONS

Based on our results, the litter size does not affect individual feed intake during subsequent reproduction but influences their body development and fat content at first mating and in the subsequent reproduction period. Kits raised in large litters are lighter at first mating, but are able to compensate for the reduction in BW and fat content. Kits raised in small litters lost most fat and energy during the reproduction period. Lower losses in fat content and energy content were observed in LS-9 and LS-12.

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