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EFFECT OF DIFFERENT FEEDING LEVELS DURING REARING AND AGE AT FIRST INSEMINATION ON BODY DEVELOPMENT, BODY COMPOSITION, AND PUBERTY CHARACTERISTICS OF RABBIT DOES

ROMMERS J.M. [1], MEIJERHOF R. [2], NOORDHUIZEN J.P.T.M. [3], KEMP B. [4]

[1] Research Institute of Animal Husbandry, 8230 AD LELYSTAD, The Netherlands
[2] Hybro, 5830 AA BOXMEER, The Netherlands.
[3] Department of Farm Animal Health, Faculty of Veterinary Medicine, University of UTRECHT, The Netherlands.
[4] Department of Animal Sciences, Wageningen Institute of Animal Science, Wageningen University and Research Center, 6700 AH WAGENINGEN, The Netherlands.

ABSTRACT : An experiment was performed to study the effect of feeding level during rearing and age at first mating on body growth, body development and puberty of rabbit does. Experiment started at six weeks of age, using 64 animals of a strain of New-Zealand White rabbits. Feeding level was either *ad libitum* (AL) or restricted (R) and animals were inseminated at 14.5 or 17.5 weeks of age. In R-animals, feed restriction was up to 58% of AL from 6 to 12 weeks of age. From 12 weeks of age onwards, feeding level was steadily increased to stimulate body growth and sexual development. Average feeding level of R-animals during rearing was 79% of AL. Five days after insemination, 10 animals per treatment were slaughtered to determine body composition, corpora lutea (CL) and embryos. At 14.5 weeks of age, R-animals were lighter ($P < 0.001$; 3621±232 and 4121±343 g for R-14.5 and AL-14.5, respectively) and their empty bodies (EB) contained 12% less ash, 11% less protein and 41% less fat than EB of AL-14.5 animals. When rearing period was extended to 17.5 weeks of age, R-17.5 animals reached a similar BW as AL-14.5 animals (4139±256g). From 14.5 to 17.5 weeks, R-animals were able to compensate for differences in ash and protein content, but fat content of the EB was 14% lower compared with EB composition of AL-14.5 animals. When rearing period was extended with three weeks under AL feeding conditions, animals gained 9% in BW (4489±309 g), mainly caused by deposition of fat tissue (+ 34%). First insemination at older age improved receptivity and embryo recovery. Best performance was found for AL-17.5 animals (receptivity 81.3% and embryo recovery rate of 84.7%). No differences were found in puberty characteristics between AL-14.5 and R-17.5 animals. From R-14.5 animals, only 12.5 % was receptive at insemination. According to the number of animals with CL, only 50% of this group had reached puberty, indicating that these animals were too immature to start reproduction. Based on this experiment, it can be concluded that restricted feed intake during rearing resulted in retardation of puberty. Delayed first mating to older age in restricted fed animals resulted in similar protein and ash development and similar puberty characteristics compared with ad lib fed animals, but preventing excessive fat deposition. Delaying first mating to older age under ad libitum feeding conditions resulted in the heaviest animals with the highest fat content, but also the best puberty characteristics. Therefore, more research is needed to study the effect of feeding level and extended rearing period on future reproduction and culling of does.

RESUME : Effet de niveaux d'alimentation différents pendant l'élevage et de l'age à la première insémination sur le développement et la composition corporelle et la puberté des lapines.
On a étudié l'effet de différents niveaux d'alimentation pendant l'élevage et de l'âge à la première saillie sur la croissance, le développement corporel et la puberté des lapines. L'expérimentation a porté sur 64 lapins néo-zélandais blancs ayant atteint l'âge de 6 semaines. Les niveaux d'alimentation ont été *ad libitum* (AL) ou restreint (R) et les lapines ont été inséminées à 14,5 et 17,5 semaines d'âge. Pour le groupe R, la restriction est allée jusqu'à 58% du groupe AL entre le 6ème et la 12ème semaine d'âge. A partir de la 12ème semaine d'âge le niveau alimentaire a été accru de manière à permettre le développement corporel et sexuel. Le niveau moyen d'alimentation du groupe R pendant la période de croissance représentait 79% de celui du groupe AL. Cinq jours après l'insémination, 10 lapines par groupe ont été sacrifiées pour déterminer la composition corporelle, les corps jaunes (CL) et les embryons. Les animaux du groupe R-14,5 étaient plus légers ($P<0,001$; 3621 ± 232 et 4121 ± 343g pour R-14,5 et AL-14,5 respectivement) et les carcasses entières (EB) contenaient 12% de cendres, 11% de protéines et 41% de gras de moins que les EB du groupe AL-14,5. Quand la période d'élevage s'est prolongée jusqu'à 17,5 semaines, les animaux du groupe R-17,5 ont atteint des poids vifs similaires à ceux à ceux du groupe AL-14,5 (4139 ± 256g). les différences de contenu en cendres et en protéines ont été compensés entre 14,5 et 17,5 semaines les animaux R, mais le contenu en matières grasses de leurs carcasses étaient inférieur de 14,5% à celui des animaux du groupe L-14,5. Les animaux élevés 3 semaines supplémentaires et nourris *ad libitum* ont augmenté leur poids vif de 9% (4489 ± 309 g) a cause de l'augmentation du tissu graisseux (+ 34%). La première insémination à l'âge le plus élevé augmente la réceptivité et le nombre d'embryons. La meilleure performance concerne le groupe AL-17,5 : réceptivité 81,3% ; taux de récupération d'embryons 84,7%). Aucune différence n'a été détectée concernant la puberté entre les deux groupes. Seuls 12,5% des lapines du groupe R-14,5 ont été réceptives à l'insémination. Seuls 50% des lapines R-14,5 présentaient des corps jaunes, montrant qu'elles n'avaient pas atteint la puberté et étaient trop jeunes pour devenir reproductrices. On peut en conclure qu'une consommation restreinte pendant la croissance conduit à un retard de puberté. Retarder la première saillie à un âge plus avancé chez des lapines à l'alimentation réduite conduit à des contenus en cendres et en protéines similaires et à des caractéristiques de puberté comparables à ceux de lapines nourries *ad libitum*. Retarder la première saillie à un âge plus avancé chez des lapines nourries *ad libitum* conduit à obtenir des animaux plus lourds et plus gras, mais ayant les meilleures caractéristiques de puberté. D'autres études sont nécessaires pour étudier l'effet du niveau d'alimentation et de la prolongation de la période d'élevage sur la future production des lapines.

INTRODUCTION

The current rearing management of rabbit does does not appear to prepare animals well enough for subsequent reproduction, in which concurrent lactation and pregnancy demand a high nutritional intake. Nutritional energy deficit during first lactation is considered responsible for the decreased reproductive efficiency and the high replacement rate of young does (XICCATO *et al.*, 1995; XICCATO, 1996). The energy

Correspondance: J.M. Rommers, Research Institute of Animal Husbandry, P.O. Box 2176, 8230 AD LELYSTAD, The Netherlands
e-mail address: J.M.Rommers@PV.AGRO.NL

deficit in reproductive young does cannot be solved sufficiently by management measures during reproduction (CERVERA *et al.*, 1993; XICCATO *et al.*, 1995; PARIGI-BINI *et al.*, 1996). Solutions such as an adapted rearing program (PARIGI-BINI and XICCATO, 1993) were recommended, but information on this is scarce. Feed intake during rearing seems an important factor influencing body development (ROMMERS *et al.*, 1999). Under practical conditions, rabbit does are often fed ad libitum until first mating. First mating is recommended in rabbit production when 75 to 80% of final body weight is reached (LEBAS *et al.*, 1986), which commonly occurs between 14 to 16 weeks of age. Delaying first mating to older age might increase the risk of overconditioning, which might cause health problems during lactation or decrease reproductive performance. However, ROMMERS *et al.* (submitted) showed that does mated at 17.5 weeks of age and fed *ad libitum* during rearing showed better reproductive performance in their first parity as compared with does mated at 14.5 weeks of age. In this study of ROMMERS *et al.* (submitted) body weight and age at first mating were correlated. Therefore, an experiment was performed to study the effect of feeding level during rearing and age of first mating on body growth, body development and puberty features of rabbit does, with the objective to delay first mating to older age without excessive fat deposition.

MATERIAL AND METHODS

The experiment was performed from February to August 1999. The Use and Care Committee of the Research Institute of Animal Husbandry approved all protocols.

Animals and Husbandry

The experiment was performed with a strain of New Zealand White rabbits, bred at the Research Institute of Animal Husbandry. Before weaning, kits were raised in litters of nine kits. At weaning (30daysof age), from each of 16 litters, four female kits, with live weight deviating by less than 15% of the average litter weight, were selected. Each group of four sisters was taken and put into four adjacent individual cages (50 x 60 x 30 cm) of galvanized wire net, equipped with an automatic drinker, and a manual feeder. After weaning, animals were fed a standard commercial diet, containing 10.3 MJ/kg ME and 170 g/kg crude protein (ABC, Lochem, The Netherlands). Animals were fed according to treatment until five days prior to first insemination. From five days prior to insemination onwards all treatment groups were fed the standard diet ad libitum to stimulate receptivity. The experiment ended five days after first insemination when 10 animals per treatment were slaughtered.

Animals were housed in a deep-pit compartment with controlled lighting. Before weaning, animals were kept at a 16-h photoperiod. During rearing, animals were submitted to a photoperiod of 12 h. The first two weeks after weaning, a minimum ambient temperature of 18 °C was maintained. From two weeks after weaning onwards, the minimum ambient temperature was set at 16 °C.

Treatments

Treatments started at six weeks of age, using a 2 x 2 factorial design with feeding level and age of first insemination as factors. Feeding level was either ad libitum feeding (AL) or restricted feeding (R) until first insemination; first insemination was performed at either 14.5 or 17.5 weeks of age. Sisters were randomly assigned to one of the four treatments (AL-14.5, AL-17.5, R-14.5 and R-17.5).

From data of a previous experiment (ROMMERS *et al.*, submitted), body weight (BW) curve for AL-animals was fitted (see Figure 1). The BW curve for the R treatments was derived from this curve. From 6 to 10 weeks of age, body growth was purposively reduced to hinder protein development (LEDIN, 1984) by gradually reducing feed intake. From 10 weeks of age onwards, body growth was increased by gradually increasing feed intake to stimulate sexual development and puberty, following the slope of the AL-curve. Taking into account the fact that animals first compensate for the loss in protein (LEDIN, 19984), the purpose of the feeding plan was to prevent excessive fat deposition (which commonly occurs after 10 to 12 weeks of age; DE BLAS *et al.*, 1977; DELTORO and LOPEZ, 1985) by obtaining the same BW at 17.5 weeks

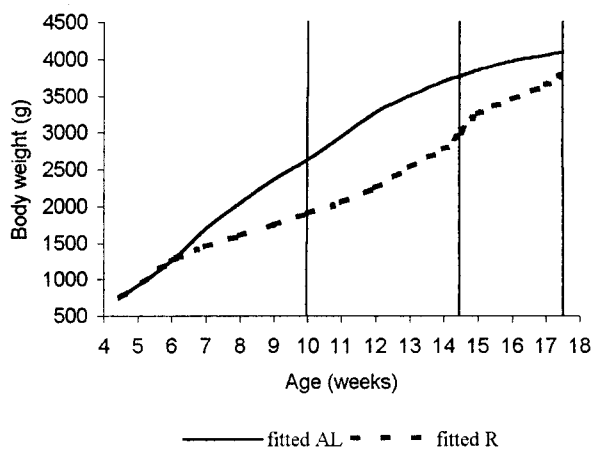

Figure 1 : Fixed body weight curve for the ad libitum (AL) and restrictive (R) feeding during rearing from weaning (4.5 weeks) to first insemination at 14.5 or 17.5 weeks of age.

of age as AL-animals had at 14.5 weeks of age.

The R-animals were fed daily a restricted amount of feed, aiming to follow the fixed BW curve as drawn in Figure 1. Therefore, BW was determined twice weekly from weaning until first insemination and based on BW feed intake was corrected in order to follow the fixed BW curve. If the daily supply was not eaten completely, remaining feed was removed.

Inseminations

Artificial insemination was performed with fresh mixed semen of 10 bucks, selected for growth performance. At the day of insemination, one mixed and diluted semen dose was prepared. Dilution was performed using a commercial extender (Galap, IMV, France) according to the method developed by ZÖLDÁG *et al.* (1988). A GnRH analogue was injected i.m. (0.2 ml Receptal, Hoechst Roussel Vet, Brussels) immediately after insemination to induce ovulation.

Measurements

Body weight and feed intake.

Animals were weighed individually twice weekly from weaning to first insemination. For AL-animals, feed intake was determined twice weekly by weighing of the feeder at beginning and end of each period and the weight of all feed supplies given in between were recorded. For R-animals the amount of feed not eaten per day was weighed weekly to determine actual feed intake. If wastage occurred, period and cage were recorded, and feed intake for this period was scored as missing value.

Body composition.

Body composition was determined for 10 animals per treatment (sisters). Animals were weighed and killed (CO-gas) five days after insemination, and the contents of the digestive tract and bladder were removed. Empty body weight (EBW) is defined as live weight minus gut and bladder content. In addition, empty stomach and uterine horns were weighed separately. Empty bodies (EB) were frozen at -20 °C until grinding 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 by 6.25. Fat content was determined by extraction of freeze-dried samples with petroleum-ether and drying the extract at 80 °C in a vacuum oven (10 kPa) to constant weight. Ash was determined in oven-dried samples in a furnace at 550 °C.

Puberty characteristics : Receptivity, number of corpora lutea (CL), number of embryos and embryo recovery rate.

Five days before insemination and at insemination, animals were checked for receptivity by the color and turgidity of the vulva. Animals were scored receptive, if the vulva was swollen and colored (red or red to purple). It could be pointed out that according to the authors' experience in their own rabbitry, frequent checking of vulva color does not seem to influence receptivity. From the 10 animals per treatment group slaughtered five days after insemination, reproductive tracts wereremoved and uterine horns were flushed with saline (twice 5 ml per uterine horn) and embryos were collected in a petridish. Number of embryos was counted under a light microscope (magnification x 10). Corpora lutea (CL) were counted on the ovaries. Recovery rate was calculated as number of embryos divided by number of CL.

Statistical Analyses

The experiment was a randomized block. A block consisted of four adjacent cages with sisters. The four treatments were randomized within a block. Analyses of variance were carried out using the GLM procedure of SAS (SAS Inst. Inc., Cary, NC, USA). Differences between LSMN were analyzed by the PDIFF option of the GLM procedure of SAS. Body weight, feed intake and body composition data were analyzed with block, feeding level, age of first insemination, and the interaction between feeding level and age of first insemination as factors. A Chi-square test was used to analyze treatment differences in receptivity and embryo recovery rate. Data are presented as means and standard deviations.

RESULTS

Animals

During the experiment, one animal of R-17.5 died four days after insemination. Liver necrosis and hemorrhagic fluid in the abdomen and cervix were observed at dissection. No other animals were culled during the experiment.

Body weight, feed intake and feed conversion

The actual BW curves for the treatments and fixed BW curves are in Figure 2. Between six and eight weeks of age, BW of R-animals was not reduced as planned. At six weeks of age, feed intake of R-animals was fixed at the average daily feed intake of the previous four days (7 to 10 days after weaning). This level ranged for individual animals between 99 and 152 g/d. In high feed intake levels, body growth was not reduced as expected, resulting in a higher average BW than planned. Therefore, feed intake was reduced to 115 g/d for all R-animals with a higher feed intake than 115 g/d at 7½ weeks of age (see Figure 3). This feeding level was maintained until 10 weeks of age.

From 10 weeks of age onwards, daily feed intake was steadily increased by 5 to 15 g/d weekly. From 12 weeks of age onwards the BW curve of R-animals ran parallel to the BW-curve of AL-animals. The AL-animals reached a higher BW as expected at first insemination at 14.5 as well as at 17.5 weeks of age. Because the same angle of the BW curve of AL-animals was followed for R-animals from 10 weeks of age, we succeeded in reaching similar BW for R-17.5 animals and AL-14.5 animals at first insemination (see Table 1).

Feed intake during rearing for AL and R-groups is in Figure 3. Average feeding level of R-animals during rearing was 79% of AL-animals. However, from six to 10 weeks of age, feed restriction was more severe (up to 58% of AL). From 10 weeks of age onwards, feeding level was steadily increased to stimulate body growth and sexual development (from 115±5 g to 238±8 g from 10 until 17 weeks of age, respectively). Around 12 weeks of age, feed intake of AL-animals had reached its maximum. From 15 weeks onwards, no difference in feed intake between R and AL group was found. During flushing, daily feed intake of R-animals (14.5 and 17.5) increased. R-14.5 animals consumed 27 g/d more food than AL-14.5 animals (253±16 for R-14.5 and 226±28 g for AL-14.5), whereas R-17.5 animals consumed 262±53 g/d during flushing and exceeded the feed intake of the AL group with 43 g/d.

Feed conversion during rearing was affected by feeding level and age of insemination (see Table 1). Ad libitum feeding as well as extended first insemination

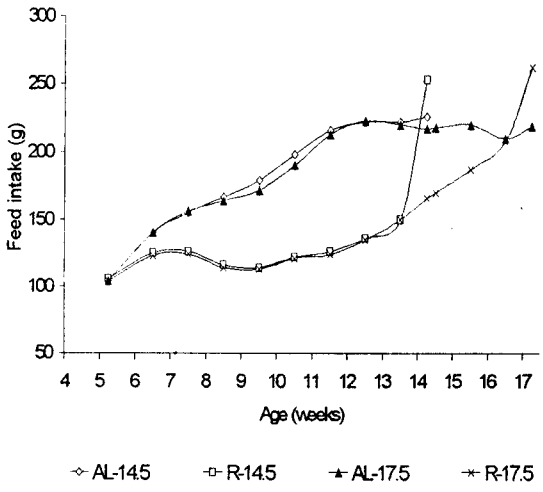

Figure 3 : Mean daily feed intake (g) during rearing for animals fed ad libitum (AL) or restricted (R) and inseminated at 14.5 or 17.5 weeks of age. The R-groups were flushed five days before insemination. The standard deviation of the AL-groups ranged from 10 to 56 g. The standard deviation of the R-groups ranged from 4 to 38 g.

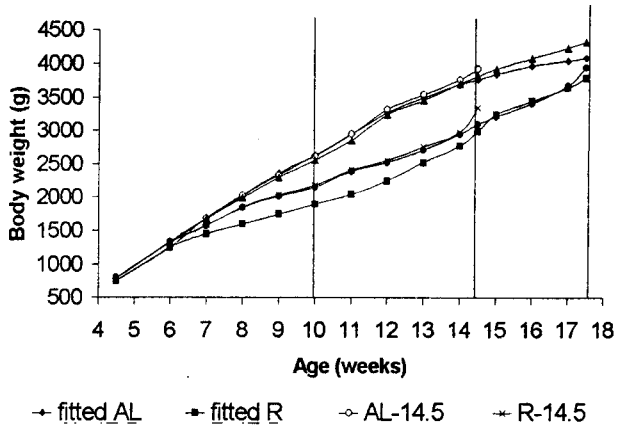

Figure 2 : Realized and fixed BW curves during rearing (from weaning to first insemination) for animals, fed ad libitum (AL) or restricted (R) and inseminated at 14.5 or 17.5 weeks of age. The standard deviation ranged from 65 to 384 g.

to 17.5 weeks of age resulted in a higher ($P < 0.001$) feed conversion compared to restrictive feeding or first insemination at 14.5 weeks of age (see Table 1). However, feed conversion of R-17.5 animals did not differ from AL-14.5 animals over the total rearing period.

Body development and body composition

At the start of the experiment (six weeks of age), AL- and R-animals had similar BW (see Table 1 and Figure 2). From seven weeks of age onwards, AL-animals were heavier ($P < 0.05$) than R-animals. No interactions between feeding level and age of first insemination were found until 14.5 weeks of age. At 14.5 weeks of age, no differences were found in BW and body gain (BG) between AL-14.5 and AL-17.5 animals. At 14.5 weeks of age, R-14.5 animals were heavier and had a higher ($P < 0.001$) growth rate as compared with R-17.5 animals, due to flushing before insemination. During the last three weeks of rearing (from 14.5 to 17.5 weeks), BG of R-animals was higher ($P < 0.001$) than AL-animals. At first insemination, R-17.5 animals had reached the same BW as AL-14.5 animals (see Table 1).

The body composition of the animals slaughtered five days after insemination is in Table 2. No interaction was found between feeding level and age of insemination. Feeding level and age of first insemination both affected body composition. Both AL feeding and insemination at 17.5 weeks of age resulted in heavier animals, with more ash, fat, and protein content. At 17.5 weeks of age, AL animals showed the highest weight and fat content; at the same age R-animals recuperated ash and protein, reaching the same

Table 1 : Body weight, body growth, feed intake, and feed conversion from weaning to first insemination for animals fed ad libitum (AL) or restricted (R) and inseminated at 14.5 or 17.5 weeks of age. Means and standard deviations are presented in the table.

Feeding level	Treatment				P value[1]	
	Ad Libitum		Restricted			
Age of insemination (weeks)	14.5	17.5	14.5	17.5	Feeding	Age
Number of animals	16	16	16	16		
BW at weaning (= 30 d) (g)	796 ± 75	792 ± 56	785 ± 64	799 ± 74	0.84	0.55
BW at six weeks (g)	1339 ± 113	1323 ± 74	1324 ± 114	1325 ± 107	0.69	0.65
BW at A.I. (g)	4121 ± 343	4489 ± 309	3621 ± 232	4139 ± 256	0.001	0.001
Average body growth (g/d)	43.2 ± 4.1	37.7 ± 3.0	36.8 ± 2.8	34.1 ± 2.3	0.001	0.001
Average feed intake (g/d)	180 ± 22	185 ± 21	139 ± 8	149 ± 8	0.001	0.028
Feed conversion	4.17 ± 0.29	4.91 ± 0.29	3.77 ± 0.25	4.40 ± 0.27	0.001	0.001

[1] No interactions were found between feeding level and age of insemination.

levels as AL-14.5 animals, whereas fat deposition was lower than in AL-14.5 animals.

The weight of the uterine horn was affected by feeding level and age of insemination. In AL-17.5 animals the full uterine horns were heaviest. After removal of embryo's no differences among AL-17.5, AL 14.5 and R-17.5 were found. R-14.5 animals had the smallest uterine horns.

Puberty characteristics

Puberty characteristics for the different treatments are in Table 3. Age and feeding level affected receptivity before flushing and at insemination. Both AL-feeding and insemination at 17.5 weeks of age resulted in more ($P<0.01$) receptive animals. At 17.5 weeks of age, AL animals showed the highest receptivity. The number of receptive animals was similar for R-17.5 and AL-14.5. The R-14.5 animals showed the poorest receptivity; only 2 of the 16 animals were receptive at insemination.

An interaction between feeding level and age of first insemination was found for the number of animals with CL. In the R-feeding group the number of animals with CL increased significantly ($P < 0.05$) when first mating was delayed, whereas in the ad libitum feeding group no significant increase was found with age. Age and feeding level did not affect the average number of CL (see Table 3), although numerically mean number of CL was lowest in R-14.5 group. An interaction was found between feeding level and age of first

Table 2 : Body composition of *ad libitum* (AL) and restricted (R) fed animals, inseminated at 14.5 and 17.5 weeks of age. Animals were slaughtered five days after insemination. Means and standard deviations are presented.

Feeding level	Treatment				P value[1]	
	Ad Libitum		Restricted			
Age of insemination (weeks)	14.5	17.5	14.5	17.5	Feeding	Age
Number of animals	10	10	10	9		
BW at slaughter (g)	4080 ± 281	4548 ± 228	3590 ± 179	4152 ± 304	0.001	0.001
EBW (g)	3719 ± 298	4189 ± 252	3217 ± 155	3779 ± 300	0.001	0.001
Av. weight full digestive tract (g)	576 ± 83	595 ± 57	553 ± 49	588 ± 52	0.35	0.15
Av. weight empty stomach (g)	28 ± 3	29 ± 5	31 ± 3	30 ± 3	0.03	0.99
Av. weight uterine horns full (g)	34 ± 5	45 ± 7	18 ± 5	32 ± 8	0.001	0.001
Av. weight uterine horns after removal of embryos (g)	11 ± 4	12 ± 3	6 ± 5	11 ± 2	0.013	0.005
Empty body composition:						
Water (g)	2115 ± 156	2270 ± 109	2002 ± 103	2251 ± 187	0.12	0.001
Ash (g)	111 ± 8	116 ± 9	98 ± 7	109 ± 12	0.001	0.004
Protein (g)	726 ± 53	794 ± 34	645 ± 27	752 ± 49	0.001	0.001
Fat (g)	754 ± 180	1013 ± 219	443 ± 84	651 ± 103	0.001	0.001

[1] No interactions between feeding level and age of insemination were found.

Table 3 : Effect of feeding level (*ad libitum* (AL) or restricted (R)) and age of first insemination (14.5 or 17.5 weeks) on puberty characteristics. Numbers, means and standard deviations are presented.

Feeding level	Treatment				P value		
	Ad Libitum		Restricted		Feeding	Age	Feeding * Age
Age of first insemination (weeks)	14.5	17.5	14.5	17.5			
Item							
Animals, no.	16	16	16	15			
Animals receptive before flushing, no.	5	7	0	7	0.17	0.01	NS
Animals receptive at insemination, no.	7	13	2	9	0.03	0.001	NS
Animals killed, no.	10	10	10	9			
Animals with CL, no.	9^{a}	10^{a}	5^{b}	9^{a}	0.07	0.01	0.05
Mean CL[1]	8.6 ± 3.6	9.8 ± 2.2	5.8 ± 2.4	8.1 ± 3.6	0.06	0.12	NS
Animals with embryos, no.	4^{bc}	10^{a}	1^{b}	5^{c}	0.02	0.001	0.05
Mean embryos[2]	9 ± 2.4	8.3 ± 1.7	9	9.5 ± 1.5	0.58	0.97	NS
Embryo recovery (%)	46.8^{a}	84.7^{b}	31.0^{a}	65.8^{c}	0.05	0.001	0.01

[1]Based on the number of animals with CL.
[2]Based on the number of animals with embryos.
[abc] Row means with different superscripts differ ($P < 0.05$).

insemination for number of animals with embryos. At 14.5 weeks of age feeding level did not affect number of animals with embryos, whereas at 17.5 weeks of age significantly ($P<0.05$) more animals with embryos were observed in the ad libitum feeding group compared to restrictive fed animals (10 for AL-17.5 and 5 for R-17.5). Feeding level and age of first insemination did not influence the mean number of embryos. An interaction was found between feeding level and age of first insemination for embryo recovery rate. Embryo recovery rate was significantly ($P<0.01$) improved at 17.5 weeks of age under ad libitum feeding, whereas at 14.5 weeks of age feeding level did not influence embryo recovery rate. AL-17.5 animals had the highest recovery rate. The worst puberty characteristics were found for R-14.5 animals. In five of the 10 slaughtered animals, CL was observed, indicating that five animals had reached puberty. In only one of these five animals, embryos were found.

DISCUSSION

The results of this experiment show that it is possible to delay first mating to older age without affecting body development for ash and protein, but preventing excessive fat deposition. For this purpose, different feeding strategies during rearing can be used. Feed restriction before weaning is not preferable (ROMMERS *et al.*, 1999) and an early restriction after weaning can affect (at four weeks of age) caecal traits (increase pH and reversed ratio of propionic and butric acid proportion), that favor conditions for pathogenic agents (MAERTENS and PEETERS, 1988). Therefore, in our experiment feed restriction was started at six weeks of age. The restrictive feeding plan was set to delay body growth from six to 12 weeks of age in order to be able to stimulate body growth, when sexual development starts (around 12 weeks of age) without having the problems of excessive fat deposition.

The body weight curves in Figure 2 show, that in our experiment ad libitum fed animals reached over 80% of mature BW at 14.5 weeks of age and were fit to start reproduction, according to the definition of LEBAS *et al.* (1986). The AL-14.5 group was used as control. Under the restrictive feeding regime (presented in Figure 3), animals were 500 g lighter at 14.5 weeks of age than ad libitum fed animals. The EB of restrictive fed animals contained 12% less ash, 11% less protein and 41% less fat than ad libitum fed animals.

The restricted fed animals reached similar BW compared with AL-14.5 animals when rearing period was extended with three weeks. So, with the adapted feeding regime, we were able to control BW as planned. The EB composition for ash and protein of restrictive fed animals at 17.5 weeks of age was similar to ad libitum fed animals at 14.5 weeks of age, only fat content was lower (-14%). Based on our results, it seems that from 14.5 to 17.5 weeks of age animals were able to compensate for differences in ash and protein content. This is in agreement with findings of LEDIN (1984), who reported that animals would try to correct for the deviation from normal body composition caused by restrictions during re-alimentation. From metabolic point of view, it can be suggested that R-animals were still using most of the nutrient intake for protein development instead of fat formation. In ruminant, it is shown (RUKKWAMSUK *et al.*, 1999) that overconditioning causes health problems due to fatty liver during lactation. There are indications (HARTMANN and PETERSEN, 1997), that feed

restriction during rearing increases body weight gain during the first three parities, resulting in heavier animals, but data on feed intake during lactation are not available.

When rearing period was extended with three weeks under ad libitum feeding conditions, mainly fat content of EB increased (+34%). Most of the ash and protein seemed to have been formed before 14.5 weeks of age. This is in agreement with findings of DELTORO and LOPEZ (1985), who reported that under ad libitum feeding conditions, medium-sized rabbits bone and muscle tissue have a high growth rate before sexual development occurs around 12 weeks of age. Also DE BLAS *et al.* (1977) found mainly an increase in fat content in rabbit does between three to five month of age, whereas ash and protein were unchanged. So, the results of our study show that with controlled feed intake during rearing, first mating can be delayed to older age without affecting protein and ash content of the EB, but preventing overconditioning.

The rearing method influences fertility performance of young does. Restrictive feed intake during rearing seems to delay puberty. From R-14.5 animals, only five of the ten slaughtered animals had CL and thus had reached puberty, whereas in nine of the 10 ad libitum fed animals CL were found. At slaughtering at 14.5 weeks of age, smaller (less developed) uterine horns were observed in restrictive fed animals. Based on these results, restrictive fed animals at 14.5 weeks of age seemed too immature for reproduction, although BW had reached 75 to 80% of mature BW. Even flushing during the last five days prior to insemination did not evoke receptivity as would be expected according to VAN DEN BROECK and LAMPOO (1979). This implicates that BW itself is not a good indicator to determine time of first insemination of young does, but rearing conditions should also be taken into account, according to the statement of MAERTENS (1987).

The puberty characteristics of restrictive fed animals at 17.5 weeks of age was similar to ad libitum fed animals at 14.5 weeks of age. This implicates that restrictive feeding can be used to prevent over condition at first insemination without negatively affecting puberty characteristics. There are some indications (HARTMANN and PETERSEN, 1995) that feed restriction during rearing has a positive effect on litter size after the first parity. Therefore, more research is needed to study the effect of restrictive feeding during rearing with delayed first insemination on subsequent reproductive performance.

Although delayed first insemination with three weeks under AL feeding conditions resulted in heavier animals, which EB contained more fat, the level of fatness did not seem to have negative effects on puberty characteristics. A high receptivity rate at insemination (81.3%) and a high recovery rate (84.7%) were found for AL-17.5. In a previous experiment (ROMMERS *et al.*, submitted), in which ad libitum fed non pregnant does were re-inseminated at 17.5 weeks of age, kindling rate and number of kits born alive were increased compared to animals inseminated successfully at 14.5 weeks of age. Also LEBAS and COUDERT (1984) reported, that first mating at older age had a positive effect on the rate of pregnancy, but after 16 to 18 weeks of age no further improvement was found (depending on breed). HULOT *et al.* (1982) reported that in ad libitum fed does, the percentage of does mated and ovulating reached one-third at 14 weeks and two-thirds at 17 and 20 weeks of age. However, LEBAS and COUDERT (1984) did not find an effect of early mating (at 15 weeks of age) on prolificacy, death during suckling, mortality and withdrawal of does, what is not corresponding with our results. Therefore, the effect of mating at older age under ad libitum feeding conditions on reproductive performance and culling rate of young is not clear and needs further research.

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