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THE INFLUENCE OF THE DIETARY ENERGY CONTENT ON THE PERFORMANCES OF POST-PARTUM BREEDING DOES

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Introduction

Rabbits are extremely suitable for intensive meat production. The ability to mate immediately after parturition, implant and thereafter sustain pregnancy concurrent with lactation, is a distinct advantage to other farmed species. Futhermore the milk output is both quantitatively (60-70g/kg liveweight) as qualitatively very high (Lebas, 1971).

The energy exchanges of lactating does have been studied in detail by Partridge et al. (1983 and 1986). They estimate the maintenance requirement of lactating does between 424 and 475 kJ metabolizable energy/kg W 0.75. At peak lactation (week 3) daily metabolizable energy requirement was 3.41 MJ. The total daily requirement of a standard doe (4 kg) would therefore be approximately 4.57 MJ (Partridge et al., 1983) or 4.81 MJ digestible energy (DE).

To satisfy this energy requirement from the feed alone, intakes in excess of 440g/d would be needed of a diet containing 10.9 MJ DE/kg (actual recommandation of Lebas, 1986). Literature data about daily feed intake (Laffolay,1985) indicate that this quantity is probably the intake limit. Futhermore it is not well defined if the lactating doe is able to adjust her feed intake as a function of its dietary energy concentration and if so over what range of DE-content.

Several studies mention or indicate that an energy deficit could be responsable for a reduced weight of young at weaning (Jouglar et Lebas, 1986), a decreased milk output (Partridge et al., 1983), an impaired reproductive performance (Parigi-Bini et al.,1986), especially when the rabbit does are submitted to intensive remating programs. But little information is available about recommended dietary DE-density during the successive reproduction cycles and if the energy concentration has an influence on longterm reproduction performances.

The objective of the present study aimed therefore to determine the impact of the dietary energy concentration on the performances of post-partum breeding does during a 9 month reproduction period.

Material and methods

The experiment was conducted over a 9-month reproduction period. The first mating took place in the second half of March 1986, while the latest weanings were performed at Februar 1987.

Diets

Using linear programming 3 least-cost diets were formulated with constant energy-nutrient ratios (table 1). Diets differed in DE-content, respectively the recommended density (N-diet: 10.8 MJ/kg), a low energy diet (L-diet: recommendation -10%) and a high energy diet (H-diet: recommendation + 10%).The protein content (total and digestible) as the lysine content were adjusted taking into account the results of a previous experiment (Maertens & De Groote,1988). Because of the negative correlation between the crude fibre and the dietary DE-content, it was not possible to respect a constant energy-fibre ratio. A minimum of 12% crude fibre or 11% undigestible crude fibre was claimed. All diets were pelleted (4.0 x 10 mm). The energy and protein digestibility of the diets was checked in an subsidiary digestibility trial. Six broiler rabbits of 7-8 weeks of age were used per diet. Details about the procedure of the digestibility trials have already been reported (Maertens & De Groote, 1981).

Every three months the diets were prepared using the same preserved raw materials (except wheat shorts) to protect against the variability of the different batches of a feedstuff. The experimental diets were offered always *ad libitum* throughout the successive litters, starting at the first positive palpation.

Animals and housing

French hybrid rabbits (Elco) were bought at the age of 10 weeks. After one week of adaption, they were fed at libitum a standard diet containing 16.5% cpr and 9.5 MJ DE/kg. All does were first bred at approximately 16 weeks of age. They were randomly allocated to the dietary treatments at the first positive palpation. Initially 81 does were used (n=27/ treatment). But one young doe was not pregnant in the H-group, so that only 26 does were used in this treatment. After four months 15 additional Elco nulliparous does were introduced. Because more does were cancelled after 4 months in the L-diet group, 7 of them were introduced in this group and only 4 in both other populations.

Does were housed in a windowless building, on flatt-deck cages (60 x45 cm), and 16h of light per day was provided. A minimum temperature of 16°C was maintained during the winter. Use was made of over-under pressure ventilation system. Manure was removed twice a week with a scraper. On day 28 of gestation does received their metal nest box (30 x 30 cm). They were fixed outside the cage and white wood shavings were used. The males were housed in a separate, similar compartment and received only 9h of light.

Breeding shedule and preweaning litter management

All does were re-bred within 24h after parturition. Palpation was performed at day 14. Not pregnant does were immediately presented to the male. Does were mated during the experiment by a randomly selected buck. The ratio bucks-does was maintained between 1/8 and 1/7 throughout the experiment.Does refusing 5 times consecutively the male or which were not pregnant 3 times consecutively, were eliminated. Also signs of diseases as mastitis, pododermatitis, abcesses and pasteurellosis were reasons to eliminate does. At the end of the experimental period, does were re-bred post-partum. In this case the results of the last experimental litter were not influenced by a non-pregnancy period.

Litter size was standardized to 8 pups at parturition by cross fostering, to exclude the effect of litter size on milk production and feed consumption (Lebas, 1987). If not enough pups were available, the day after parturition litter size was completed to 8 . Nest box was removed when the litter was 21d old. Pups were weaned at 28 d of age.

Milk production

Daily milk production was measured on 10 does, in each treatment group, during 5 consecutive lactations. These does had two cages, a cage for kindling where the pups stayed before weaning and a cage next to her litter where the doe was placed after parturition and initial nursing. Once a day (between 8.00 and 10.00h) these does were transferred to the pup cage for suckling. Using the weight(doe)-suckle-weight (doe) method, milk production was determined. With this housing system it was futher possible to measure daily feed consumption of the doe and separately of her litter. The pups received the experimental diets from day 16 of. Weighings were done with an electronic balance (6000 +/- 0.1g). To exclude the effect of motion, use was made of an animal weighing package (Mettler, Lab Pac).

Data recording and statistical procedures

The following data were recorded on all does: prolificacy, conception rate, litter weight at 21d and 28 d, pre-weaning mortality, doe and litter feed consumption from 1 to 21d and 21d to 28d, doe weight at birth, mating and 21d and 28d. On 10 does/diet an extra daily recording of milk production, feed intake and body weight was performed.

Data were statistically treated using analysis of variance. Means were compared with the method of least significant differences.

Results

A survey of the results is given in table 3. The total number of kindlings was respectively for the L-,N- and H-diet: 177, 173 and 172. Post-kindling data of respectively 4, 8 and 10 litters were excluded. Reasons were: doe-mortality at parturition or during lactation period ,a severe health problem with the doe which had an influence on the performances of her litter and an insufficient number of pups to standardise litter size

Fertility

The overal conception rate (CR) , using an intensive breeding system was high (>70%). Differences in CR between experimental groups were not significant. In the first half of the experimental period the CR was 10% lower for does fed the L-diet in comparison with the other two treatments. But after 9 months this difference was lowered to 3-4% (table 3).

A decreased prolificacy of nearly 1 pup was observed for does fed the L-diet. When only the litter size of real post-partum (p.p.) litters was judged, a significant (H-diet) to highly significant (N-diet) increased number of newborns was found.

Milk production

The total milk production for does on the high energy diet was significantly higher ($p<0.05$) than those on the low energy diet (table 4). The difference between treatments was most noticeable during the first 3 weeks of lactation, after which time the daily milk output became very low.

Lactation yields of does immediately pregnant after parturition are shown in figure 1. Does fed the L-diet had during the whole lactation period the lowest daily milk production. This difference was most distincted between day 3 and day 16 and amounted on average 19 g (N-diet) and 28 g (H-diet) in that period. For non-p.p. pregnant does a similar, but not so pronounced tendency was noted.

Indirect judging of milk ability of does can also be assessed by the 21-day weight of the litter. These results of the total population (table 3), confirmed the effect of the dietary energy concentration on milk production. Respectively a litter-weight of 2.90, 2.95 and 3.10 kg was obtained.

Doe body-weight

at the different physiological states. At parturition mean body-weight was 3.82 ± 0.35 kg. In the first 24h after parturition does lose weight, this explains the slightly lower weight at mating. After 3 weeks of lactation mean body-weight was for all groups between 4.28 and 4.21 kg.

Weaning weight and pre-weaning mortality

Litter weaning weight was significantly influenced (p<0.01) by the dietary energy density (table 3) and amounted 4.45, 4.66 and 4.87 kg, respectively for L-, N-and H-diet. Pup weaning weight was 584, 601 and 620g. Results were further analysed taking into account the effect of parity number (1st vs 2nd and following) and the physiological state (p.p.pregnant or not).For young does a significant(p<0.05) difference in individual weaning weight of pups was observed (fig.2),respectively between the L-diet and both other diets.In the following litters the difference in weaning weight was smaller, in case of 52 g still 31 g between the L-and H-diet. Because litter size was smaller for L-groups, differences in litter-weight at weaning were even more pronounced.

Post partum pregnancy decreased weaning weight of pups (fig.3) The average difference in litter weight amounted respectively 258, 90 and 279 g. But differences between the dietary treatments, both for p.p. pregnant and for non-p.p. pregnant does were larger than the effect of concurrent lactation and gestation. A significant (N-diet) to highly significant (H-diet) increased litter weight at weaning was obtained for p.p. litters, while for non-p.p. pregnant litters the significancy (p<0.01) was between L-and N-diets and the H-diet.

Partly due to the standardisation of the initial litter size, pre-weaning mortality was very low (<5%). Respectively 7.62, 7.76 and 7.85 pups/litter were weaned. But litter size at weaning was significantly higher, with increasing energy density (table 3). This was the case both in the 1st and the following litters and also independent of concurrent lactation and gestation (fig.2&3). Total losses of pups between standardisation and weaning were respectively : 7.5, 7.5 and 8.7%. When also the weaned pups of excluded litters were taken into account, these percentages lowered to 6.8, 6.9 and 6.2%.

Feed and energy intake of does

Feed intake was significantly (p<0.01) increased for does fed the low energy diet, while the difference between the N-diet and H-diet was not so distincted (table 3). This consumption is mainly from the doe alone (0-21d) or together with her litter (21-28d) Both before and after 3 weeks of lactation mean daily DE-intake/cage was significantly (p<0.01) higher when fed the H-diet: 4.38 & 5.84 vs 4.07 & 5.38 (L-diet) and 4.15 & 5.58 MJ (N-diet). Because does did not fully adjust their feed intake as a function of its dietary DE-density, also mean daily digestible protein intake was significantly different.

For does were lactation yield was studied more in detail, DE-intake curve is given in fig. 4. Especially during "top" lactation (day 10 to 17), a large difference in daily energy intake was observed for p.p. pregnant does. Respectively 4.31, 4.56 and 4.86 MJ/day. But also for non-p.p. pregnant does, daily DE-intake was higher with increasing DE-content (fig.5), especially in the first half of the lactation period. While after day 20 energy intake was comparable.

Feed intake of young before weaning

Rabbit pups, in all groups, started with solid feed intake on day 21. Before this age, daily pellet intake was lower than 1g/pup. Mean total feed intake/young was respectively 136.6g(L-diet), 158.3g(N-diet) and 137.6g(H-diet). This means an intake of 1325, 1719 and 1637 kJ DE or a decreased DE-intake for diet L of 20-23% in comparison with the two other diets.

Longevity of does

The mean number of litters, per initial doe and during the nine month experimental period was: 5.48 (L-diet), 5.56 (N-diet) and 5.85 (H-diet). Somewhat more than 50% of the does were still in production after 9 months, respectively 15, 14 and 14 of the initial number.

Any relationship between dietary treatment and mortality causes (diagnosis by dr. Peeters, NIDO) could not be observed. Also indications of dietary influences on elimination reasons were not evident.

Discussion

Although not always significant, increased performances were obtained for nearly all production traits with increasing DE-content. The most obvious explanation can be found in the energy intake. In our experiment and in contrast with the common view (Lebas, 1986), high productive does could not adjust their voluntary food consumption to achieve comparable DE-intake. In consequence increased energy intake was observed with increasing dietary DE-content. As shown by Partridge et al.(1983 and 1986), differences in available energy intake leads to a response in milkproduction.

The least concentrated diet still contained 9.7 MJ DE, which is clearly above the under limit for broiler rabbits, and is comparable with an avarage DE-content of commercial diets (Maertens, 1987). An explanation for this difference with growing rabbits is probably that the intake capacity of the doe limits the possibility to increase sufficiently the feed intake. Evidences for this thesis are numerous:

(1) The difference in DE-intake not only occurred during "top" lactation, but also in early lactation stage. This indicates that daily feed consumption of high productive does is near the intake limit during lactation.

(2) Does which were able to eat daily more than 500g of the L-diet, had a comparable DE-intake and in consequence a comparable milkproduction.

(3) The intake capacity of primiparous does is lower than for multiparous does. This explains the large difference (>10%) in weaning weight of the 1st litter between diet L and both other diets.

(4) The daily intake during the successive litters increased. This could be an evidence why dietary differences were most pronounced in the first half of the experimental period.

Taking into account the protein requirements of lactating does (Partridge,1986), it may be assumed that the differences in dig. protein intake are not responsable for the responses noted in this experiment.

Other literature data concerning dietary energy concentration on the performances of high productive does do not always agree. Sanchez et al.(1985) obtained also the best results with the most concentrated diet. Mendez et al.(1986) on the other hand, observed a comparable DE-intake for diets differing in DE-content between 8.9 and 9.8 MJ. Even for p.p. breeding does a positive effect of an increased energy concentration was not noticed. Besides differences in the range of energy levels studied, the low performance level of the does used in that experiment could also been responsable. For exemple 21d litter weight was more than 40% higher in our experiment.

Concerning the feed intake of the pups we have to mention the following remark: because pups and does were separated (10/diet) consequences on daily feed intake of young were important. An evidence was found in the litter weight at weaning when compared with "normal" housed litters. At 21d this difference was very small (<3%) but at weaning, litter weight of young separated from their mother was significantly decreased (>10%). This proves that the feed intake before weaning was lower in these litters or that the doe initiate the pups to drink and to eat. Futhermore, in agreement with Szendro et al.,(1985) a large difference in feed consumption was observed between litters which mother was p.p. pregnant or not.

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Table 1. Composition of experimental diets.

	L	N	H
Sunflower meal 28	3.8	10.9	20.5
Soybean meal 44	7.4	7.6	-
Soybeans-full fat	-	-	11.8
Rapeseed meal	4.5	5.0	5.5
Cornglutenfeed 20	7.2	8.0	8.8
Rice shorts	4.5	5.0	5.5
Alfalfa meal	9.0	10.0	11.0
Cassava meal	8.9	10.0	11.0
Wheat shorts	31.5	26.0	4.25
Beet pulp	-	6.4	7.7
Flax chaff	9.0	2.8	-
Straw meal	7.5	-	-
Wheat bran	-	-	1.8
Oats	-	-	0.95
Linseed oil meal	-	-	1.85
Renderers fat	0.24	0.94	1.65
Molasses	3.6	4.0	4.4
DL-methionine	0.03	0.01	-
Vit.-min. mix	2.7	3.0	3.3
$CaCO_3$	0.13	0.35	-

Table 2. Chemical composition and DE-content of diets.

	L	N	H
Crude protein, %	15.4	17.8	19.6
Crude fibre, %	14.1	11.8	11.0
Lysine, %	0.74	0.83	0.92
Meth.+cystine, %	0.64	0.63	0.71
Digest. protein, %	11.4	13.6	15.3
Digest. energy, MJ/kg	9.7	11.0	11.9
Ca, % (1)	1.4	1.3	1.4
P, % (1)	0.8	0.9	0.9

(1): calculated

Table 4. Total milkproduction (kg) of does (1), as a function of the energy concentration and their physiological state.

Diet DE-content	L 9.7	N 11.0	H 11.9	Stat. (2) signif.
Does p.p. pregnant				
number of lactations	23	23	23	
1-21d	4.30a	4.63ab	4.83b	*
21-28d	0.46	0.55	0.57	NS
total	4.76a	5.19ab	5.40b	*
Does p.p. non-pregnant				
number of lactations	15	16	15	
1-21d	4.54	4.66	4.88	NS
21-28d	1.60	1.67	1.94	NS
total	6.14	6.33	6.81	NS

(1) lactations 2-5 (2) *: $p<0.05$ NS: not signif.different

Table 3. Effect of diet on the performances of post-partum breeding does and their offspring.

Diet	L		N		H		VC	Stat.
DE/kg (MJ)	9.7		11.0		11.9		(%)	sign.
Conception rate (%)	69.5		73.1		72.2		-	NS
Litter size (alive)								
all litters(1)	8.76^{a}	(177)(3)	9.62^{b}	(173)	9.39^{ab}	(172)	34.7	*(4
p.p. litters	8.18^{Aa}	(101)	9.37^{B}	(107)	9.26^{ABa}	(103)	34.8	**
rematings	10.28	(42)	10.28	(35)	10.29	(38)	35.5	NS
Litter weight (g)								
21 d	2902^{A}	(173)	2950^{AB}	(165)	3099^{B}	(162)	13.5	**
28 d	4447^{A}	(172)	4660^{AB}	(165)	4868^{B}	(160)	15.2	**
Doe body-weight								
at birth	3854	(176)	3809	(172)	3788	(170)	9.4	NS
21 d	4280	(173)	4231	(165)	4241	(162)	8.9	NS
28d	4236	(172)	4156	(165)	4187	(160)	8.8	NS
Litter size(2)								
at 21 d	7.72^{A}	(173)	7.80^{A}	(165)	7.91^{B}	(162)	6.3	**
at 28 d	7.62^{Aa}	(172)	7.76^{ABb}	(165)	7.85^{B}	(160)	7.6	**
Feed consumption/cage (g)								
0-21 d	8810^{A}	(173)	7909^{B}	(165)	7694^{B}	(162)	12.1	**
21-28 d	3887^{A}	(172)	3542^{B}	(165)	3422^{B}	(160)	16.9	**
Energy intake (MJ/day)								
0-21 d	4.07^{A}	(173)	4.15^{A}	(165)	4.38^{B}	(162)	12.1	**
21-28 d	5.38^{A}	(172)	5.58^{ABa}	(165)	5.84^{Bb}	(160)	16.9	**
Protein intake (g dig. prot./day)								
0-21 d	47.8^{A}	(173)	51.2^{B}	(165)	56.1^{C}	(162)	12.1	**
21-28 d	63.3^{A}	(172)	68.8^{B}	(165)	74.8^{C}	(160)	16.9	**

(1) first litter included

(2) data of standardised and survived litters

(3) number of data

(4) * : $p<0.05$ ** : $p<0.01$

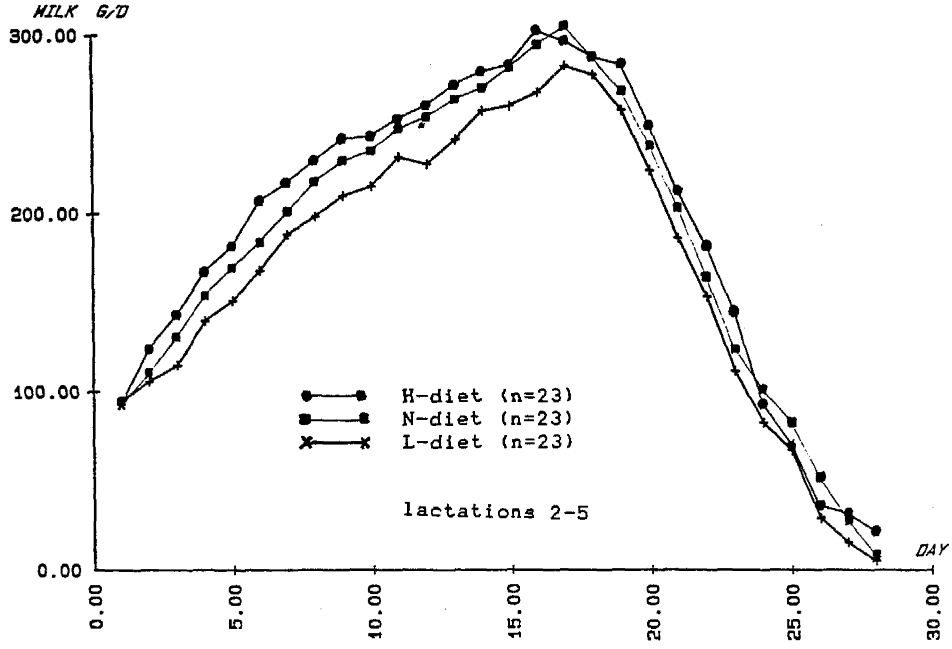

Fig.1. Lactation yield of p.p. pregnant does

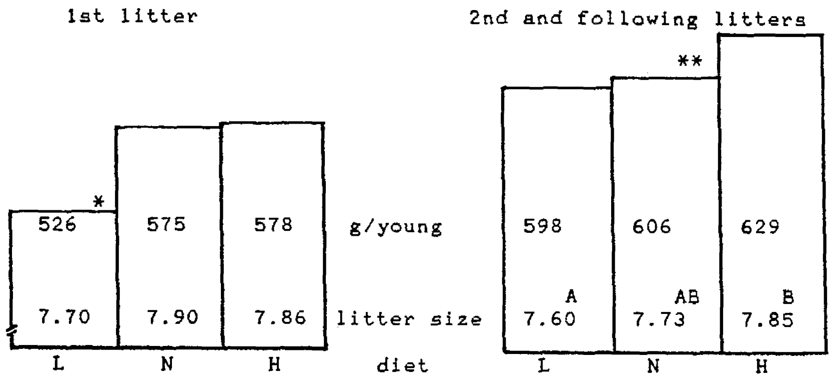

Fig.2. Influence of dietary energy content on weaning weight.

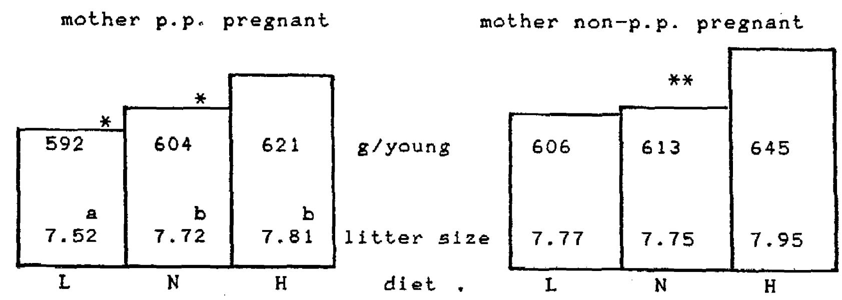

Fig.3. Influence of dietary energy content and concurrent lactation on weaning weight.

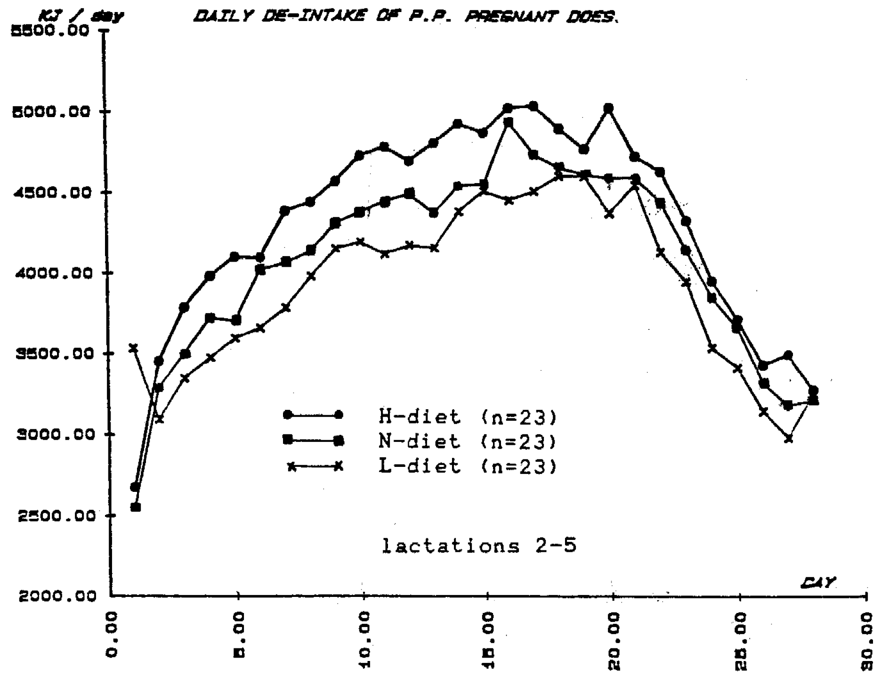

Figure 4.

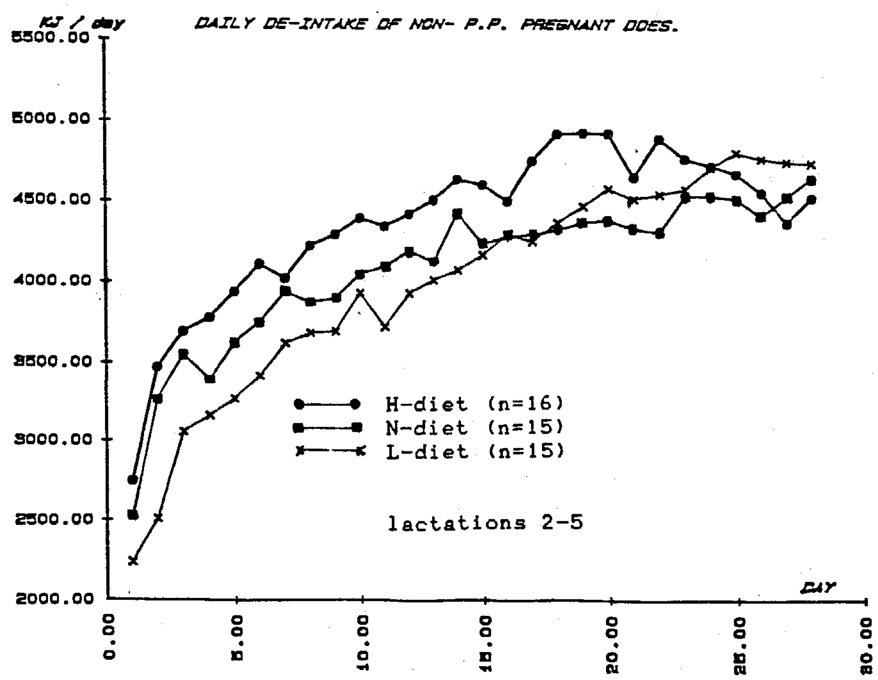

Figure 5.

Summary

An experiment utilizing 90 hybrid does was conducted for 9 months to determine the effect of dietary energy concentration on the performances of post-partum breeding does. From the first positive palpation, the does were fed at libitum diets containing either 9.7, 11.0 or 11.9 MJ DE/kg (determined in a digestibility trial). With exception of the crude fibre, least-cost diets were formulated with constant energy-nutrient ratios, using linear programming. To reduce the high initial variability, all litters were standardised to 8 pups at parturition. Milk production, seperate feed intake of the doe and her litter were measured daily on 10 does of each group (n=30).
A comparable conception rate (+70%) was obtained but a lower P <.05) litter size was observed for does fed the 9.7 MJ diet. When only the litter size of the "true" post-partum litters was considered this difference (P<.01) was even more pronounced (respectively 8.2, 9.4 and 9.3 born alive/litter). Milk production was higher (P<.05) for does fed the high energy diet in comparison with the low energy diet. This difference was only pronounced if the doe was immediately pregnant after parturition. Mortality of the young before weaning was very low (<5%) and tended to be higher on the lower energy diets. Individual weight at weaning (day 28) was signficantly (P<.01) influenced by the treatments and reached respectively 584, 601 and 620g. As expected, feed intake increased with decreasing energy density, but daily energy intake was still higher for the more concentrated diets. Especially during "top" lactation (day 10 to 17) a difference in daily energy intake was observed. Also the pups before weaning were not able to adjust their feed intake in function of the dietary energy concentration. In all treatment groups around 50% of the does reached the end of the experiment. The number of parities/initial doe was respectively 5.48; 5.56 and 5.85.

Résumé

Quatre-vingt dix lapines hybrides ont été alimentées à volonté, dès la première palpation positive avec des régimes apportant 9,7 (Lot L); 11,0 (Lot N) ou 11,9 MJ (lot H) d'énergie digestible par kg d'aliment. Pendant toute la durée d'essai (9 mois) les lapines étaient soumises à un rythme de reproduction intensif. A l'exception de la fibre brute, les rapports énergie-nutriment étaient constants dans les rations "moins couteux", calculées à l'aide d'un programme linéaire. La taille de toutes les portées a été standardisée à 8 lapereaux. La production laitière et la consommation alimentaire de la mère et séparément de la nichée ont été déterminés journalier sur 10 femelles dans chaque lot (n=30). La fertilité était comparable dans les lots (+70%), mais la prolificité était réduite (P<0,05) pour les lapines recevant l'aliment moins énergétique. Cette différence était encore plus prononcée pour les vraies portées post-partum (respectivement, 8,2; 9,4 et 9,3 lapereaux nés vivants/portée).
La distribution de l'aliment H a entraîné une production laitière plus élevée (P<0,05) en comparaison avec l'aliment L. Cette différence était seulement prononcée quand la femelle était gestante immédiatement après la mise bas. La mortalité des lapereaux avant le sevrage était très réduite (<5%) et même moins élevée dans le lot H. Le poids au sevrage (jour 28) était significativement (P<0,01) influencé par les traitements et atteignait respectivement 584, 601 et 620g. Comme prévu, la consommation alimentaire était plus élevée pour les aliments moins énergétique, mais les quantités d'énergie digestible ingérées étaient accrues dans le lot N et H, surtout pendant la période maximale de la production laitière (jour 10 à 17). Aussi les lapereaux avant le sevrage, n'étaient pas capable d'ajuster leur consommation alimentaire en fonction de la concentration énergétique. Dans tous les lots environ 50% des lapines ont atteint la fin de l'essaie. Par femelle initiale on a obtenue respectivement dans les trois lots : 5,48; 5,56 et 5,85 nichées.