REPRODUCTIVE AND PHYSIOLOGICAL RESPONSES OF RABBIT DOES UNDER DIFFERENT NUTRITIVE LEVELS BEFORE THE FIRST PARTURITION

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ABSTRACT

The objective of the research was to study the effect of different feeding levels before the first kindling on the reproductive performance and blood plasma profile of rabbit does and on the litter performance during two reproductive cycles. The trial was carried out on Grimaud female rabbits (15 weeks old) reared according to three nutritive treatments: the control group (C) was fed *ad libitum* a commercial pellet (CF=18.7% DM; DE=11.7 MJ/kg DM), the restricted group (R) was fed an 80% *ad libitum* intake of commercial feed and the fiber group (F) was fed *ad libitum* a high-fiber pellet (CF=24.6% DM; DE=9.8 MJ/kg DM). The experimental diets were offered for 8 weeks until the first kindling, after which the does were fed the control pellet *ad libitum*. A blood sample was taken from each doe five days after delivery. At the first reproductive cycle, the live body weight of the females at the end of the treatment was significantly different, as C rabbits had a higher ($P<0.01$) body weight than those R and F groups. The growth rate was higher ($P<0.01$) in C rabbits than in R females and the F group was intermediate. Feed intake was higher ($P<0.01$) in F rabbits than in C subjects; the R females showed the lowest ($P<0.01$) consumption. After first delivery, the C and F rabbits exhibited higher ($P<0.05$) body weights than R does, but at weaning the females of the three groups had similar live weight. The F group had a higher ($P<0.05$) number of inseminations/pregnancy and a higher ($P<0.05$) insemination-pregnancy interval compared to the other groups. The *interpartum* interval did not exhibit different values among the groups. The F group produced litters with higher ($P<0.05$) birth weight because of lower litter size than the C and R groups. At weaning the litter weight was similar among the groups. The number of rabbits at weaning was similar for the three groups as well as the mortality rate. Blood triglycerides levels were higher ($P<0.05$) in F and R does than in C females. Neither total proteins nor urea levels differed. Regarding mineral content, plasma calcium was higher ($P<0.05$) in R does than in the other two groups and phosphorus was higher ($P<0.05$) in R and F females. The results indicate that feed restriction on pubertal females up to one week before the first parturition affects the growth and has significant effects on certain reproductive and physiological parameters during the first reproductive cycle. It does not, however, negatively influence the productive response of litters. In the second reproductive cycle no relevant difference among the groups was observed for does and litter performance.

Key words: Feeding restriction, Reproductive performance, Blood plasma.

INTRODUCTION

The feeding restriction can have relevant effects on several physiological characteristics (Chilliard *et al*., 1998) in relation to the duration and intensity of treatment. The nutritive restriction can be performed in two ways: by decreasing the quantity of feed or by reducing its energy content by adding a high level of fiber. The main result of a high-fiber diet in growing females is an increased gastrointestinal capacity (De Blas *et al*., 1986) which may influence the feed intake of does and therefore lactation and reproductive responses, especially during the first reproductive cycle. If feed restriction is followed by *ad libitum* feeding, the does have an increasing feed intake during lactation, which makes possible to reduce body energy deficit that generally occurs (Maertens, 1992; Parigi-Bini

and Xiccato, 1998). Regarding the physiological responses of reproductive female rabbits under feeding restriction, significant effects on the biochemical profile were observed (Forthun-Lamothe *et al*., 1994).

The goal of the research was to study the effect of different nutritive levels before the first kindling on the reproductive performance and physiological response of rabbit does and on the growth of their litters.

MATERIALS AND METHODS

Animals and diets

Female rabbits (140 subjects) were used for the trial; the 105-day-old animals belonged to the Grimaud genotype. The rabbits were divided into three groups (Table 1): the control group (C) was fed a commercial pellet *ad libitum*, the restricted group (R) was fed the same pellet as 80% *ad libitum* intake and the fiber group (F) received a high-fiber pellet *ad libitum*.

The chemical composition of the C diet (Table 1) agrees with the recommendations (De Blas and Mateos, 1998), but crude fiber was slightly higher than values indicated (Maertens, 1992).

Table 1: Chemical composition (%DM) and nutritive value of the diets

	Control	Restricted	Fiber
Dry matter (DM) (%)	89.8	89.8	89.3
Crude protein	18.5	18.5	16.9
Ether extract	3.1	3.1	2.6
Crude fiber	18.7	18.7	24.6
Ash	8.4	8.4	10.5
NDF	40.9	40.9	45.3
ADF	24.4	24.4	31.5
ADL	4.9	4.9	5.2
Digestible energy (DE) (MJ/kg)	11.7	11.2	9.8
Digestible protein/DE (g/MJ)	12.4	12.7	12.0

The experimental diets were given to the animals over 4 weeks before the first artificial insemination (AI at 19 weeks of age) and for 4 weeks until a week before delivery. Thereafter, the does were fed the control pellet *ad libitum* during the first lactation and weaning period of the litter and the second reproductive cycle. The does were mated 11 days *postpartum.* AI/pregnancy was calculated as the ratio between number of AI and the established pregnancy; AI-pregnancy interval of each reproductive cycle was calculated as the time interval between the first AI and the established pregnancy. The diagnosis of pregnancy was performed 10 days after AI. Litter size was equalized to 8 kits, lactation was controlled (once per day for 5-10') until 19 days *postpartum*. The rabbits were weaned at 35 days of age. The environmental temperature was 15°C and the relative humidity was 80%. The photoperiod was 16L:8D. During the first and second cycle, five days after delivery, blood samples were taken from the marginal ear vein of the doe in the morning and after daily nursing.

Chemical analyses

The two pellets were submitted to chemical analyses in accordance with official methods (AOAC, 2000); a digestibility trial was carried out on 8 animals (same age and nulliparous) of each group to evaluate the nutritive value of the three diets (EGRAN, 1996). Blood sample was collected in vacutainers with lithium heparin (140 USP) and was immediately centrifuged for 15' at 3500 rpm and the plasma was frozen at -20°C. The analyses on plasma were performed using the HITACHI- 911 (Roche BM) instrument and kits.

Statistical analysis

All data underwent a one-way ANOVA (SAS Instruments, 2000) with dietary treatment as main effect. Differences among means were tested by Duncan's multiple range test (SAS, 2000).

RESULTS AND DISCUSSION

As shown in Table 1, the fiber diet had a higher fiber content, which decreased energy and other nutrient contents. At any rate, the other parameters were within the range recommended for growing female rabbits (De Blas and Mateos, 1998). As expected, the DE content was lower in the fiber diet, but the DP/DE ratio was similar between the diets.

Table 2 shows the growth of breeding females and their liveweight and feed intake as does. At the beginning of the experiment the females had a similar body weight, but at the end of the treatment the C rabbits had a significantly higher (P<0.01) body weight than rabbits in the R and F groups. The growth rate was higher (P<0.01) in C rabbits than in R females and the F group was intermediate. An opposite result was observed for feed intake, which was higher (P<0.01) in F rabbits than for controls. The R females had the lowest (P<0.01) consumption, as it was expected. The F daily intake was higher than the C group due to the lower energy content; the animals attempted to meet their energy and protein requirements and the gastrointestinal capacity allowed them to reach a 2% higher feed intake.

Table 2: Productive performance of pubertal females and does

			Control	Restricted	Fiber	MSE
	Young breeder rabbits					
	Initial 105 d liveweight (g)		3182	3164	3181	54998
	Final 161 d liveweight (g)		4015 ^{A}	3828 ^{B}	3913 ^{B}	69709
	Daily growth (g/d)		14.87 ^{A}	11.83 ^{B}	13.06 ^{AB}	12.84
	Daily feed intake (g/d)		245 ^{B}	195 ^{C}	251 ^{A}	25
	Rabbit does					
Cycle I	Live weight					
	- at litter equalization (g)		3669 ^{a}	3496 ^{b}	3642 ^{a}	90139
	- at weaning (g)		4008	3922	3953	81873
	Daily growth (g/d)[1]		334 ^{ab}	436 ^{a}	310 ^{b}	57294
	Daily feed intake (g/d)[1]		310	339	324	1780
Cycle II	Live weight					
	- at litter equalization (g)	g	3564	3550	3623	93302
	- at weaning (g)	"	3866	3821	3764	107172
	Daily growth (g/d)[1]	"	456 ^{a}	330 ^{b}	326 ^{b}	56817
	Daily feed intake (g/d)[1]	"	316	297	289	18730

a, b: P<0.05; A, B: P<0.01; MSE: mean square error; [1]from litter equalization up to 21 days of lactation

After the first delivery, the C and F rabbits exhibited higher (P<0.05) body weight than the R does, but at time of weaning the mothers in the three groups had similar live weights. After the end of the nutritional treatments, the R does were allowed to have a compensatory growth with a 9.4% relatively higher daily feed intake compared to C rabbits. At the second reproductive cycle, the body weight of the does was similar among the groups. The C does exhibited higher (P<0.05) body growth than the R and F groups.

Table 3 shows the reproductive responses of the rabbit does. The F group had a higher (P<0.05) number of AI/pregnancy when compared to the other groups as well as longer AI-pregnancy interval. This result suggests inadequate nutritional conditions resulting in a poor physiological state for the establishment of pregnancy. The *interpartum* interval did not show different values. It is well remembering that the value of this parameter did not take into account the rejected females (after two negative inseminations) which were more present in C group (8.3 vs. 4.3%) than in the other groups.

Table 3:Reproductive performance of the rabbit does

		Control	Restricted	Fiber	MSE
Cycle I	AI/pregnancy (n)	1.00 [b]	1.00 [b]	1.08 [a]	0.02
	AI-pregnancy interval (d)	0 [b]	0 [b]	1.08 [a]	4.52
	Interpartum (d)	46.4	49.9	46.2	88.3
	Litter size (n)	10.57 [a]	9.67 [ab]	9.34 [b]	4.66
Cycle II	AI/pregnancy (n)	1.18	1.39	1.22	0.19
	AI-pregnancy interval (d)	2.47	5.53	3.06	37.82
	Interpartum (d)	43.0	44.4	42.8	19.6
	Litter size (n)	10.20	9.29	9.32	2.91

a, b: P<0.05; MSE: mean square error

The energy deficiencies for the F females were evident in the litter size data, which were higher (P<0.05) in the C than in the F group, whereas the R females were intermediate. At the second reproductive cycle no significant effect on litter size was observed.

The litter performance is shown in Table 4. At first cycle, the F group exhibited kits with higher (P<0.05) weight at birth because of lower litter size than the C and R groups. At weaning the kits weight was similar among groups. The number of rabbits at weaning was similar for the three groups as well as the mortality rate. At second cycle no effect of previous nutritional treatment was found among the groups.

Table 4: Productive performance of litters

		Control	Restricted	Fiber	MSE
Cycle I	Live weight				
	- at birth (g)	50.1 [b]	48.9 [b]	55.4 [a]	71.4
	- at weaning (g)	771	792	766	8104
	Weaned rabbits/litter (n)	7.73	7.62	7.60	0.43
	Mortality (%)	8.4	9.8	5.0	376.8
Cycle II	Live weight				
	- at birth (g)	57.0	60.5	59.1	130.4
	- at weaning (g)	824	812	842	12989
	Weaned rabbits/litter (n)	7.52	7.67	7.50	0.78
	Mortality (%)	5.3	7.8	7.8	308.4

a, b: P<0.05; A, B: P<0.01; MSE: mean square error

Table 5 shows the blood plasma profile of the does at 5 days *post-partum*. In the first reproductive cycle, among the variables involved with the energy profile, only the level of triglycerides differed among the groups, with higher (P<0.05) values in the F and R does than in the C rabbits. This is probably due to an increase of feed intake after energy restriction. Parigi-Bini *et al*. (1990) observed significant modification of energy metabolism in late pregnancy, as glucagons level increased and glucose and triglycerides decreased. Neither total proteins nor urea levels differed.

Table 5: Blood plasma variables of rabbit does at 5 days after the first and second kindling

		Control	Restricted	Fiber	MSE
Cycle I	Glucose (mmol/l)	6.68	6.91	7.17	0.34
	Triglycerides (mmol/l)	0.48 [b]	0.64 [a]	0.61 [a]	0.03
	Total proteins (g/l)	55.82	58.75	59.09	19.64
	Urea (mmol/l)	6.88	7.06	6.71	0.77
	Calcium (mmol/l)	3.71 [b]	3.89 [a]	3.71 [b]	0.04
	Phosphorus (mmol/l)	1.48 [b]	1.82 [a]	1.80 [a]	0.10
Cycle II	Glucose (mmol/l)	6.68	6.52	7.66	0.72
	Triglycerides (mmol/l)	0.65	0.57	0.58	0.03
	Total proteins (g/l)	61.17	61.29	53.42	75.48
	Urea (mmol/l)	5.23	5.96	5.77	1.25
	Calcium (mmol/l)	3.76	3.64	3.61	0.08
	Phosphorus (mmol/l)	1.34	1.51	1.64	0.09

a, b: P<0.05; MSE= mean square error

As far as concerns mineral content, plasma calcium was higher (P<0.05) in R does than in the other two groups and phosphorus was higher (P<0.05) in R and F females. The higher mineral content is

probably due to the higher feed intake observed in the last week before delivery and until the equalization of the litters (data not shown), after which also mineral intake increased. It is worth remembering that calcium generally presents higher homeostasis than phosphorus (Sweenson and Reece, 2002) and other factors other than the increased feed intake, such as an hormonal effect on the mobilizing of mineral reserves by skeletal may also occurred. It is known that thyroid hormones influence mineral metabolism and in restricted does the plasma level of T_4 was higher than in the other groups (data not shown). At the second cycle, the blood plasma profile did not change among the groups.

CONCLUSIONS

The results indicate that the qualitative restriction performed during the pubertal age until the first delivery may have significant effects on some reproductive and physiological parameters of rabbit does. The animals under quantitative and qualitative feed restriction exhibited compensative growth as a consequence of increased feed intake after restricted feeding. Further research is needed to elucidate the effect of feeding treatment on the productive and physiological responses of does.

REFERENCES

AOAC 2000. Official Methods of Analysis (17th edition). *Association of Official Analytical Chemists. Arlington, VA, USA.*

Chilliard Y., Bocquier F., Doreau M. 1998. Digestive and metabolic adaptation of ruminants to undernutrition and consequences on reproduction. *Reprod. Nutr. Dev., 38, 131-152.*

De Blas C., Mateos G.G. 1998. Feed formulation. *In: De Blas C. and Wiseman J. (Eds). The Nutrition of the Rabbit. CABI Publishing, CAB International, Wallingford, Oxon, UK, 241-253.*

De Blas C., Santoma G., Carabaño R., Fraga M.J. 1986. Fibre and starch levels in fattening rabbit diets. *J. Anim. Sci., 63, 1897-1904.*

EGRAN - European Group on Rabbit Nutrition 1996. Metodo europeo di riferimento per la determinazione in vivo delle digeribilità di diete per conigli. *Zoot. Nutr. Anim., 22, 47-51.*

Forthun-Lamothe L., Prunier A., Etienne M., Lebas F. 1994. Influence of the nutritional deficit of fœtal survival and growth and plasma metabolites in rabbit does. *Reprod. Nutr. Dev., 34, 201-211.*

Maertens L. 1992. Rabbit nutrition and feeding: a review of some recent developments. *In*: *Proc. 5th World Rabbit Congress, 1992 July, Corvallis, Oregon, USA, Vol. B, 889-913.*

Parigi-Bini R., Xiccato G. 1998. Energy metabolism and requirements. *In:* D*e Blas C. and Wiseman J. (Eds). The Nutrition of the Rabbit. CABI Publishing, CAB International, Wallingford, Oxon, UK, 103-131.*

Parigi-Bini R, Xiccato G., Cinetto M. 1990. Repartition de l'energie alimentaire chez la lapine non gestant pendant la premiere lactation. *In: Proc. 5èmes Journées de la Recherche Cunicole, Paris, France, Vol. II, 1-8.*

SAS 2000. User's guide, Statistics (version 6.03). *Edition SAS Institute Inc., Cary, NC.*

Sweenson M. J., Reece W.O. 2002. Fisiologia degli animali domestici. *Idelson – Gnocchi Ed., Napoli, 695-696.*