WORLD RABBIT SCIENCE 1997, 5 (1), 33-38.

EFFECTS OF DIETARY FAT ON REPRODUCTIVE PERFORMANCE OF RABBIT DOES : A REVIEW.

FORTUN-LAMOTHE L.

Station de Recherches Cunicoles, INRA Centre de Toulouse, BP 27, 31326 CASTANET TOLOSAN, France

ABSTRACT : Addition of fat permits a noticeable increase of digestible energy intake by rabbit does (231 kJ per day / 1 % ether extract). Additional energy intake is used in priority for milk production. This leads to heavier young rabbits at weaning (+2.1 % for each 1 % increase in ether extract). Fat inclusion also modify milk composition (fatty acids proportions), but influence on suckling rabbits survival is unclear. Effects of dietary fat on fertility of rabbit does are non existent or positive. Positive effects should be overall related to the increase of dietary energy content associated with fat inclusion. Effects on prolificity are controversial. Finally, fat addition seems not to reduce body mobilization in primiparous does, however, in a longer term, it should improve female body condition.
In conclusion, fat inclusion permits overall a higher milk production, but some negative effects of fat on prolificity obtained impose to use this feedstuff in the diet of reproductive rabbits with carefulness. Nevertheless, fat addition could be justified for some breeding conditions (hot temperature).

RESUME : Effets de l'incorporation de matières grasses dans l'aliment des lapines sur leurs performances de reproduction : une synthèse.
L'incorporation de matières grasses permet une augmentation sensible de l'ingestion d'énergie digestible par les lapines (231 kJ par jour / 1 % extrait éthéré). L'énergie ingérée en supplément est prioritairement utilisée pour la production laitière, ce qui se traduit par une augmentation du poids des lapereaux au sevrage (+2.1 % par 1 % d'extrait éthéré ajouté). La composition du lait est également modifiée suite à l'incorporation de matières grasses dans l'aliment (profil des acides gras du lait), mais les conséquences sur la survie des lapereaux ne sont pas claires. L'addition de matières grasses a parfois un effet positif sur la fertilité des lapines qui serait plutôt imputable à l'augmentation de la concentration énergétique de l'aliment qui lui est associée. Les effets sur la prolificité sont contradictoires et demandent à être élucidés. Enfin, l'incorporation de matières grasses ne semble pas réduire la mobilisation des réserves corporelles chez les lapines primipares, mais permettrait à plus long terme une amélioration de l'état corporel des femelles.
En conclusion, l'incorporation des matières grasses dans l'aliment des lapines reproductrices permet surtout une augmentation de la production laitière et du poids des lapereaux au sevrage. Plusieurs résultats négatifs concernant la prolificité ont été obtenus, et imposent une certaine prudence. Des conditions d'élevage particulières (température élevée) peuvent cependant justifier l'utilisation de cette matière première.

INTRODUCTION

During the two last decades there was a noticeable improvement of the litter size in the rabbit in response to genetic selection. Moreover, the intensification of the reproductive rhythm become widespread (mating or artificial insemination from 1 to 10-11 days after parturition) and go with a partial superposition of pregnancy and lactation. In such conditions, the nutrient requirements of the reproductive does are very high and the voluntary feed intake is often insufficient to supply all the needs (milk production and foetal growth ; XICCATO, 1996). Therefore, body mobilization (proteic and lipidic) is necessary to reduce the nutritional deficit, more especially at the moment of lactation peak (PARIGI BINI *et al.*, 1992 ; FORTUN *et al.*, 1993). This situation is emphasized in primiparous does when body growth is not achieved and ingestion capacity is not complete (XICCATO, 1996), as well as under hot temperature because of a reduced feed intake (BARRETO and DE BLAS, 1993). Poor body conditions and negative energy balance are considered to be associated with lower reproductive performance and reduced longevity.

An increase in the digestible energy content of the diet should theoretically decrease the nutritional deficit of the female, and reduce its harmful influences. However, in the rabbit species, composition of the diet must respect a minimum level of dietary fibers and a maximum level of dietary starch in order to prevent digestive disorders (LEBAS, 1989 ; GIDENNE, 1996). Consequently, the inclusion of fat in the diet of reproductive does could be of interest to increase its energy content without decrease too much its fiber level. Indeed, FERNANDEZ *et al.* (1994) previously demonstrated that dietary digestible energy content increases approximately 250 kJ for each 1% increase in ether extract.

Previous experiments have shown that fat supplement in the diet for growing rabbits decrease the feed intake, improve the digestible energy intake and the food conversion rate, but has no important effect on growth rate (SANTOMA *et al.*, 1987 ; FERNANDEZ *et al.*, 1994). In this article we proposed a review of data concerning the effects of fat inclusion in the diet for rabbit does on their reproductive performance.

DESCRIPTION OF THE REVIEWED TRIALS

A great diversity among trials should be noted concerning the experimental conditions (table 1). For example, parity and genetic potential of the does as well as the reproductive rhythm used differed greatly among experiments. Moreover, fat come from animals (beef tallow or pork lard ; 7 trials) or vegetables (sunflower or soybean ; 5 trials), while in two trials both source of fat (animal *vs* vegetable) were compared (BARGE and MASOERO, 1986 ; FERNANDEZ-CARMONA *et al.*, 1996). The fat inclusion level was varied and lead to ether extract ranged from 2.0 to 11.7 % (figure 1). Consequently, the digestible energy content of the diet and the digestible proteins / digestible energy ratio varied widely (9.7 to 13.0 MJ / kg MS and 8.9 to 11.9 g DP / MJ DE, respectively). It should be noted that when the control diet had a lower energy content than the fat-added diet, the effects of fat inclusion are superposed with those of dietary energy level (8 trials). On the opposite, some authors studied the effects of fat inclusion using control diets containing similar digestible energy content than fat-added diet (DE BLAS *et al.*, 1995 ; FORTUN-LAMOTHE and LEBAS, 1995 ; XICCATO *et al.*, 1995 ; LEBAS and FORTUN-LAMOTHE, 1996).

Table 1 : Experimental conditions of the reviewed trials (sometimes the same diets were employed by different authors).

N	Reference	DE (MJ/kg MS)	DP/DE g/MJ	% Fat added	Fat Source[1]	% Ether extract[2]	Parity[3]	Litter size[4]	Rythm[5]
1	Perez *et al.* (1996)	9.9	13.7	.	.	2.0	P		1
2	+ Fortun-Lamothe and Lebas (1995)	12.2	12.1	.	.	2.0	P	10.6	1
3	+ Lebas *et al.* (1996)	12.2	11.9	3.0	V	5.2	P, M	10.9	4
4	Castellini and Battaglini (1991)	12.5	11.2	2.0[6]	V	6.0	M	8.2	2, 13
		11.1	11.2	0.5	V	3.2			
5	Maertens and De Groote (1998)	9.7	11.7	0.2	V	3.3	M	9.2	1
		11.0	12.4	0.9	V	3.9			
		11.9	12.8	2.5	V	6.5			
6	Barge and Masoero (1986)	11.3	11.8	2.0	V	5.3	P, M	7.7	10
		11.3	11.8	2.0	A	5.2			
7	Fernandez-Carmona *et al.* (1996)	11.0	11.8	.	.	2.6	P, M	6.2	?
		12.2	11.5	8.5	A	11.7			
		12.4	12.7	2.5[6]	V	9.9			
8	Viudes de Castro *et al.* (1991)	13.0	12.2	3.1	A	6.6	P	9.9	9
		9.7	13.9	.	.	2.6			
9	Fraga *et al.* (1989)	12.9	11.9	3.5	A	6.6	M	8.7	1, 9
10	+ Cervera *et al.* (1993)	11.4	12.4	.	.	2.9	M	8.0	1, 9
11	+ Barretto and De Blas (1993)	10.4	13.2	.	.	2.1	M	7.9	1, 9
12	+ Simplicio *et al.* (1991)	9.7	13.8	.	.	2.6	P, M	6.6	9
13	Parigi Bini *et al.* (1996)	10.4	13.2	.	.	3.3	P	7.9	10, 28
		11.2	13.2	3.0	A	6.0			
14	Xiccato *et al.* (1995)	11.3	12.5	.	.	3.6	P	5.1	4
		12.2	12.4	.	.	3.4			
		11.9	12.1	2.5	A	5.2			
15	De Blas *et al.* (1995)	11.9	11.9	.	.	2.3	M	8.5	6
		12.0	11.4	0.3	A	2.8			
		11.9	11.5	1.1	A	3.6			
		11.8	11.5	2.1	A	4.7			
		11.7	11.4	3.0	A	5.7			

1, A : animal fat; V : vegetable oil.
2, Published ether extract, excepted reference 5 : calculated ether extract.
3, P : primiparous does; M : multiparous does.
4, Young born alive
5, Reproduction rhythm : day of mating or IA after parturition.
6, The diet contained also full-fat soybean, equivalent to 1.9% and 4.3% of oil, for reference 4 and 7 respectively.

DIET DIGESTIBILITY

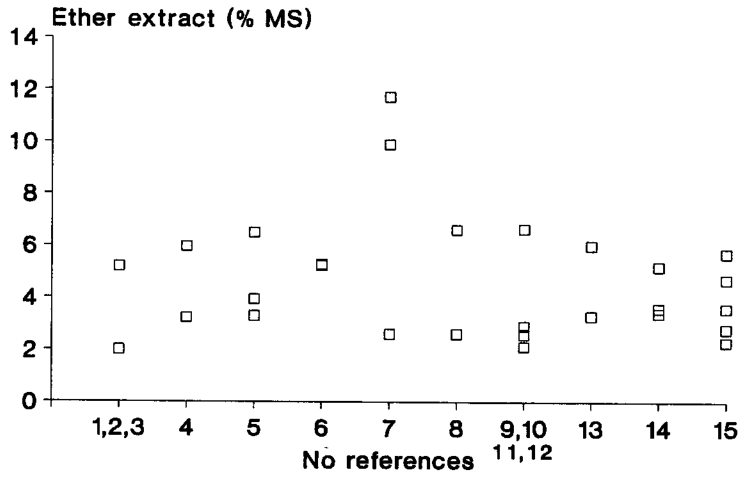
The digestibility of added fat depend on fat source (vegetable oil > animal fat) but is generally high (86 to 98 % ; MAERTENS *et al.*, 1990 ; FERNANDEZ *et al.*, 1994). On the opposite, the fat linked to plant structure are less digestible. Therefore, fat inclusion in the diet lead to increased ether extract (EE) digestibility.

As a general rule, digestibility of gross energy (GEd) is closely related to dietary fiber level (DE BLAS *et al.*, 1992). Consequently, the substitution of starch for fiber + fat, at similar dietary energy content, resulted in a decrease of energy digestibility (DE BLAS *et al.*, 1995 ; PEREZ *et al.*, 1996). However, the addition of fat at levels higher than 200 g/kg modifies the relation between ADF and GEd (atypic response) and GEd become generally higher after addition of fat in the diet (DE BLAS *et al.*, 1992 ; FERNANDEZ *et al.*, 1994). Fat source did not seem to affect this parameter (DE BLAS *et al.*, 1992 ; FERNANDEZ *et al.*, 1994 ; SANTOMA *et al.*, 1987).

The influence of fat inclusion on crude fiber and crude protein digestibility is not clear and lead to conflicting results (SANTOMA *et al.*, 1987 ; DE BLAS *et al.*, 1992 ; FERNANDEZ *et al.*, 1994).

Most of the trials concerning the effects of fat inclusion on digestibility have been carried out with growing rabbits

Figure 1 : Dietary ether extract level in the studies reviewed.



(SANTOMA *et al.*, 1987 ; FRAGA *et al.*, 1989 ; DE BLAS *et al.*, 1992 ; FERNANDEZ *et al.*, 1994). However, the results of PEREZ *et al.* (1996) showed that the extrapolation of digestibility measurements from growing rabbits to reproductive does is not always exact. Even if the few data of digestibility measurement already obtained on reproductive does given a fat-added diet are in agreement with those obtained with growing rabbits (DE BLAS *et al.*, 1995) they need to be confirmed.

FEED AND ENERGY INTAKE

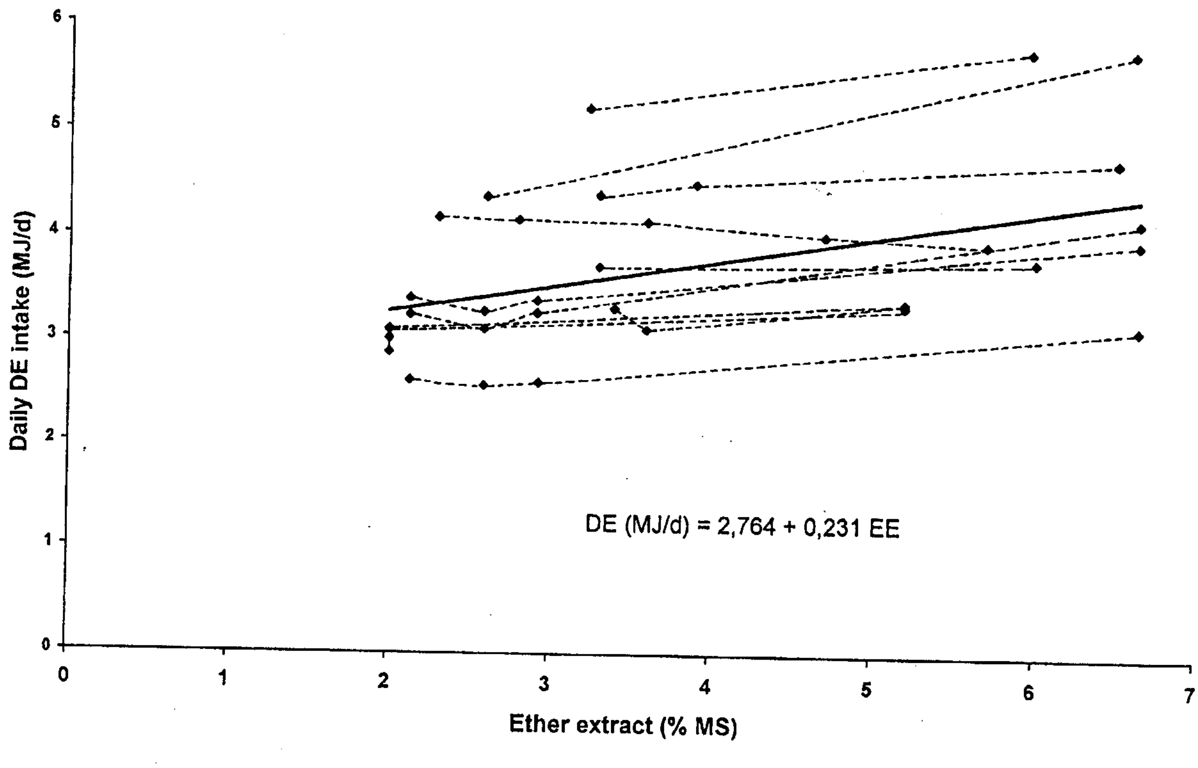
Generally (8 trials), an increase of the dietary DE content resulting from fat inclusion lead to a decreased feed intake : -2.6 % for each 1 % increase in ether extract (CASTELLINI and BATTAGLINI, 1991 ; CERVERA *et al.*, 1993 ; MAERTENS and DE GROOTE , 1988), but effects are not always significant. On the opposite, for similar dietary DE content, feed intake is higher for fat-added diet, more especially during the first weeks of lactation (FRAGA *et al.*, 1989 ; FORTUN-LAMOTHE and LEBAS, 1995 ; LEBAS and FORTUN-LAMOTHE, 1996). However, DE BLAS *et al.* (1995) observed no significant effect of substitution of starch for fiber + fat on feed intake.

Contrary to what is observed about feed intake, results concerning the effects of dietary fat on DE intake lead to consensus. Fat inclusion in the diet permit an increase of DE intake (figure 2), more especially during lactation. The regression equation obtained from bibliographic data (12 references) is as follows (number in parentheses indicate SE):

Daily energy intake (MJ/d) = 2.764 (± 0.32) + 0.231 (± 0.078) EE ; $P<0.01$; $r = 0.48$, $P<0.01$.

It was suggested that fat inclusion improve food

Figure 2 : Influence of dietary ether extract on digestible energy intake.



palatability, nutrient equilibrium and gut conditions (CHEEKE, 1987 ; XICCATO *et al.*, 1995).

BODY WEIGHT AND COMPOSITION

CASTELLINI and BATTAGLINI (1991) observed a higher live weight at the time of mating for does given continuously over one year a fat-added diet than for does given a less energetic diet (+3.2 %). However, the addition of fat in the diet have generally (8 trials) no significant effect on does live weight (MAERTENS and DE GROOTE , 1988 ; BARRETO and DE BLAS, 1993 ; XICCATO *et al.*, 1995 ; LEBAS and FORTUN-LAMOTHE, 1996).

Live weight is not a good indicator of body tissue mobilization due to great variations of gut content and tissue hydratation (PARTRIDGE *et al.*, 1983 ; XICCATO *et al.*, 1995). Therefore, study of body composition is necessary to estimate variation of body reserves. The distribution of fat-added diet during the first reproduction cycle (primiparous does) seems to have poor influence on body composition (FORTUN-LAMOTHE and LEBAS, 1995 ; XICCATO *et al.*, 1995; PARIGI-BINI *et al.*, 1996). XICCATO *et al.*, (1995) suggested that high-energy diets could accentuate body reserve mobilization as they stimulate primarily milk production. On the opposite, the weight of adipose tissues is 60 % higher for does given a fat-added diet than for does given a diet with moderate energy content during four successive reproduction cycles (LEBAS and FORTUN-LAMOTHE, 1996). Therefore, at long term a fat-added diet could improve does body condition, as well as a highly energetic diet containing no supplementary fat.

FERTILITY

Effects of dietary fat on fertility are controversial. CASTELLINI and BATTAGLINI (1991) studied does conducted with intensive (mating on day 2 *post partum*) or semi-intensive reproduction rhythm (mating on day 12-14 *post partum*) over one year. They showed a higher conception rate for does given a high-energy diet (+2 % of fat) than for does given a low-energy diet (+0.5 % of fat ; +6.8 %). It should be noted that this result is explained by a positive effect of the high-energy diet on the conception rate of the does conducted with the intensive reproduction rhythm, while the diet had no influence on the conception rate of the does conducted with the semi-intensive reproductive rhythm. In the same way, MAERTENS and DE GROOTE (1988) observed a positive effect of a high-energy diet (2.5 % or 0.94 % of fat) on conception rate of intensively reared does, over a 5 months period ($\approx$ +10%). However, this difference existed no more after 9 months. But, LEBAS and FORTUN-LAMOTHE (1996), using an intensive reproduction rhythm (mating 3-4 days after parturition) could not demonstrate any effect of fat inclusion *per se* on this parameter, but in this study the average conception rate was low (50 %).

Inclusion of animal fat seems to have no effect on the replacement rate of does (BARRETO and DE BLAS, 1993 ; DE BLAS *et al.*, 1995). However, the source of fat influences the percentage of culled does which seems higher with animal fat than vegetable fat (+87 % ; BARGE and MASOERO, 1986).

Finally, LEBAS and FORTUN-LAMOTHE (1996) observed no effect of fat addition on parturition interval. On the contrary, in the study of BARRETO and DE BLAS (1993), the fertility rate tended to be improved for does given the highest energetics diet (fat-added diet).

As a general rule, an increase of dietary energy content seems to be beneficial to the fertility of intensively reared does, independently of fat addition *per se*.

PROLIFICITY

Data concerning effects of fat addition on litter size at birth lead to conflicting results. Several studies showed no significant effect of fat addition on litter size (CASTELLINI and BATTAGLINI, 1991 ; CERVERA *et al.*, 1993 ; FORTUN-LAMOTHE and LEBAS; 1995). On the opposite, some authors found a negative effect of fat addition on this parameter (VIUDES DE CASTRO *et al.*, 1991 : -2.7 born alive ; PARIGI-BINI *et al.*, 1996 : -1.8 born alive). In the same way, LEBAS and FORTUN-LAMOTHE (1996) observed more dead born rabbits in the group of does receiving the fat-added diet (0.9 *vs* 0.5 ; $P<0.05$). These contradictions are difficult to explain, but impose to use fat in the diet of reproductive does with carefulness. More especially, influence of other feedstuffs as well as digestible protein / digestible energy ratio (DP / DE) in the prolificity of does given a fat-added diet need to be elucidated.

MILK PRODUCTION AND COMPOSITION

Total milk production (from birth to weaning) was 7 to 12 % higher for does given a fat-added diet than for does given a diet without fat (MAERTENS and DE GROOTE, 1988 ; XICCATO *et al.*, 1995 ; PARIGI BINI *et al.*, 1996). Results of XICCATO *et al.* (1995) and PARTRIDGE *et al.* (1983) indicate that the addition of fat could improve the utilization of DE for milk production.

CHRIST *et al.* (1996) and LEBAS *et al.* (1996) showed that lipid content of the milk tended to be higher for does given a fat-added diet (+10 %). However, this tendency was not confirmed by others results (FRAGA *et al.*, 1989 ; DE BLAS *et al.*, 1995 ; XICCATO *et al.*, 1995). LEBAS *et al.* (1996) observed a lower protein content in the milk of does receiving a fat-added diet (-8 %). Nevertheless, this result is conflicting with those of DE BLAS *et al.* (1995) and XICCATO *et al.* (1995) which found no effect of fat inclusion on this parameter. Finally, the energy content of does milk seems to be not modified by the dietary fat content (XICCATO *et al.*, 1995 ; LEBAS *et al.*, 1996). These differences could be explained, at least partly, by the diets used but also by methodological differences (day of sampling, ...).

All authors showed strong modifications of milk fatty acid composition in response to dietary fat, which at least partly reflect modifications of dietary fatty acids composition. These modifications and their extent depend on fat origin. Generally, unsaturated acid content of the milk increase when vegetable oil was added to the diet. Additionally, medium chain fatty acids content (C8 to C15) decreases, while long chain fatty acids content (C16 to C22) increases in the milk of does given a diet containing fat (FRAGA *et al.*, 1989 ; CHRIST *et al.*, 1996 ; LEBAS *et al.*, 1996).

LITTER WEIGHT AND SURVIVAL

FORTUN-LAMOTHE and LEBAS (1995) showed that fat inclusion don't influence the foetal growth nor the composition of foetuses. This is in agreements with results of

XICCATO *et al.* (1995) obtained with litters born from does given fat-added diet.

All the authors showed that addition of fat in the diet have a positive effect on litter growth during lactation which must be related to the positive effect of dietary fat on milk production. Therefore, the weight of young rabbits at weaning is higher when their mother received a fat-added diet : +2.1 % for each 1 % increase in ether extract (MAERTENS and DE GROOTE, 1988 ; CASTELLINI and BATTAGLINI, 1991 ; FORTUN-LAMOTHE and LEBAS, 1995).

Some fatty acids (C8 and C10) have been shown to have a bacteriostatic influence in suckling rabbits (CANAS RODRIGUEZ and SMITH, 1966). Consequently, a positive effect of dietary fat on young survival, through modification of fatty acid composition of does milk, have been hypothesized (CHRIST *et al.*, 1996). However, addition of fat have usually no effect on survival of the young during lactation (FRAGA *et al.*, 1989 ; BARRETO and DE BLAS, 1993 ; CERVERA *et al.*, 1993 ; FORTUN-LAMOTHE and LEBAS, 1995), excepted in the trial of LEBAS and FORTUN-LAMOTHE (1996). These latter observed a negative effect (-3.3 %) of fat-added diet on young survival during lactation, which could be explained by the associated modifications of milk composition and/or the low DP / DE ratio in the fat-added diet (LEBAS, 1989).

INTERACTIONS WITH ENVIRONMENTAL OR BREEDING FACTORS

Temperature.

Under hot temperature, feed intake as well as reproductive performance of the does are reduced (BARRETO and DE BLAS, 1992). Results of SIMPLICIO *et al.* (1991) and FERNANDEZ-CARMONA *et al.* (1996) suggested that addition of fat in the diet is advisable to improve energy intake and litter weight of does reared under hot temperature. Moreover, FERNANDEZ-CARMONA *et al.* (1996) showed a positive effect of animal fat inclusion on litter size at birth (7.1 *vs* 5.7 ; +24 %) and young survival during lactation (+30 %). However, it should be noted that in this study prolificity is low (6.2 born alive) and mortality during lactation is very high (46 % of mortality between birth and day 35 of lactation in the control group).

Reproductive rhythm.

Results about interaction between diet and reproductive rhythm are conflicting. FRAGA *et al.* (1989), BARRETO and DE BLAS (1993), as well as CERVERA *et al.* (1993) did not find any interactions between these two factors. On the opposite, results of PARIGI BINI *et al.* (1996) suggested that the distribution of fat-added diet to (semi-) intensively reared does will improve their energy deficit and thus the body mobilization because of a greater milk production.

CONCLUSION

The differences reported by various authors could be partly explained by the different experimental conditions : type of fat, fat levels, dietary energy content ... However, some general rules could be draw out the results obtained.

- Fat inclusion in the diet permit an increased energy intake more especially during lactation.
- The higher energy intake always lead to a higher milk production and permits a higher litter weight at weaning.
- In spite of a higher energy intake, the fat inclusion appear to have no positive effect on energy deficit of the doe, and body mobilization during lactation remains necessary.
- The fat inclusion induces modification in the milk fatty acids composition, but its effect on suckling rabbits survival remains to be demonstrated.
- Results concerning fertility and prolificity are controversial and must be elucidated. Positive effects observed on fertility seemed to be usually related to the higher dietary energy content of fat-added diet, independently of fat *per se*. Some negative effects of fat on prolificity have been obtained and impose to use fat in the diet for reproductive does with carefulness.

In conclusion, the interest of fat inclusion in the diet of reproductive does is mitigated, and permit overall higher milk production and higher litter weight at weaning. Nevertheless, it could be considered as cheap energy source permitting an increase of dietary energy content for a moderate cost while keeping sufficient dietary fiber level. However, some technological problems are associated with this feedstuff. Fabrication of pelleted diet become more difficult when fat is added at level higher than 30-40 g / kg, and rancidity could occur with animal fat what could decrease the diet palatability.

Received : October 1996
Accepted : December 1996

REFERENCES

BARGE M. T., MASOERO G., 1986. Impiego di grasso animale o vegetale in diete per coniglie appartenenti a due gruppi etnici e sua influenza sulla carriera riproduttiva. *Zootec. Nutr. Anim., 12, 367-378.*

BARRETO G., DE BLAS J. C., 1993. Effect of dietary fibre and fat content on the reproductive performance of rabbit does bred at two remating times during two seasons. *World Rabbit Science, 1, 77-81.*

CANAS RODRIGUEZ A., SMITH H.W., 1966. The identification of the antimicrobial factors of the stomach content of suckling rabbits. *Biochem. J., 100, 79-82.*

CASTELLINI C., BATTAGLINI M., 1991. Influenza della concentrazione energetica della razione e del ritmo riproduttivo sulle performance delle coniglie. *Atti IX Congr Naz ASPA, 477-488.*

CERVERA C., FERNANDEZ-CARMONA J., VIUDES DE CASTRO P., BLAS E., 1993. Effect of remating interval and diet on the performance of female rabbits and their litter. *Anim. Prod., 56, 399-405.*

CHEEKE P.R., 1987. Rabbit feeding and nutrition. *Academic Press, Orlando, Florida.*

CHRIST B., LANGE K., JEROCH H., 1996. Effect of dietary fat on fat content and fatty acid composition of does milk. in : *Proc. 6th World Rabbit Congress, 9-12 July, Toulouse, France, vol 1, 135- 138.*

DE BLAS J. C., TABOADA E., MATEOS A. A., NICODEMUS N., MENDEZ J., 1995. Effect of substitution of starch for fiber and fat in isoenergetic diets on nutrient digestibility and reproductive performance of rabbits. *J. Anim. Sci., 73, 1131- 1137.*

FERNANDEZ C., COBOS A., FRAGA M. J., JUNE 1994. The effect of fat inclusion on diet digestibility in growing rabbits. *J. Anim. Sci., 72, 1508-1515.*

FERNANDEZ-CARMONA J., CERVERA C., BLAS E., 1996. High fat diets for rabbit breeding does housed at 30°C. in : *Proc. 6th World Rabbit Congress, 9-12 July, Toulouse, France, vol 1, 167- 169.*

FORTUN L., PRUNIER A., LEBAS F., 1993. Effects of lactation on fetal survival and development in rabbit does mated shortly after parturition. *J. Anim. Sci., 71, 1882-1886.*

FORTUN-LAMOTHE L., LEBAS F., 1995. Effects of dietary energy level and source on foetal development and energy balance in concurrently pregnant and lactating primiparous rabbit does. *Anim. Sci., **62**, 615-620.*

FRAGA M. J., LORENTE M., CARABANO R. M., DE BLAS J. C., 1989. Effect of diet and of remating interval on milk production and milk composition of the doe rabbit. *Anim. Prod., **48**, 459-466.*

GIDENNE T., 1996. Conséquences digestives de l'ingestion de fibres et d'amidon chez le lapin en croissance : vers une meilleure définition des besoins. *INRA-Productions Animales, **9(4)**, 243-254.*

LEBAS F., 1989. Alimentation énergétique et azotée des lapines reproductrices. *Cuniculture, **88**, 195-196.*

LEBAS F., 1989. Besoins nutritionnels des lapines. Revue bibliographique et perspectives. *Cuni-sci., **5**, 1-27.*

LEBAS F., FORTUN-LAMOTHE L., 1996. Effects of dietary energy level and origin (starch *vs* oil) on performance of rabbits does and their litters. in : *Proc. 6th World Rabbit Congress, July 9-12, Toulouse, France, vol **1**, 217-222.*

LEBAS F., LAMBOLEY B., FORTUN-LAMOTHE L., 1996. Effects of dietary energy level and origin (starch vs oil) on gross and fatty acid composition of rabbit milk. in : *Proc. 6th World Rabbit Congress, July 9-12, Toulouse, France, vol **1**, 223-226.*

MAERTENS L., DE GROOTE G., 1988. The influence of the dietary energy content on the performances of post partum breeding does. *in : Proc. 4 th World Rabbit Congress, Budapest, 42-52.*

MENDEZ J., DE BLAS J. C., FRAGA M. J., 1986. The effects of diet and remating interval after parturition on the reproductive performance of the commercial doe rabbits. *J. Anim. Sci., **62**, 1624-1634.*

PARIGI BINI R., XICCATO G., CINETTO M., DALLE ZOTTE A., 1992. Energy and protein utilization and partition in rabbit does concurrently pregnant and lactating. *Anim. Prod., **55**, 153-162.*

PARIGI BINI R., XICCATO G., DALLE ZOTTE A., CARAZZOLO A., CASTELLINI C., STRADAIOLO G., 1996. Effect of remating interval and diet on the performance and energy balance of rabbit does. in : *Proc. 6th World Rabbit Congress, 9-12 July, Toulouse, France, vol **1**, 253-258.*

PARTRIDGE G. G., FULLER M. F., PULLAR J. D., 1983. Energy and nitrogen metabolism of lactating rabbits. *Br. J. Nutr., **49**, 507-516.*

PEREZ J.M., FORTUN-LAMOTHE L., LEBAS F., 1996. Comparative digestibility of nutrients in growing rabbits and breeding does. in : *Proc. 6th World Rabbit Congress, July 9-12, Toulouse, France, vol **1**, 267-270.*

SANTOMA G., DE BLAS J.C., CARABANO R.M., FRAGA M.J., 1987. The effects of different fats and their inclusion levels in diets for growing rabbits. *Anim. Prod., **45**, 291-300.*

SIMPLICIO J.B., FERNANDEZ-CARMONA J., CERVERA C., BLAS E., 1991. Efecto del pienso sobre la producciôn de la coneja a une temperatura ambiente alta. *Invest. Agric. Prod. Sanid. Anim., **6**, 67-74.*

VIUDES DE CASTRO P., SANTACREU M. A., VICENTE J. S., 1991. Effet de la concentration énergétique de l'alimentation sur les pertes embryonnaires et foetales chez la lapine. *Reprod. Nutr. Dev., **31**, 529-534.*

XICCATO G., 1996. Nutrition of lactating does. *in : Proc. 6th World Rabbit Congress, 9-12 July, Toulouse, France, vol **1**, 29- 46.*

XICCATO G., PARIGI-BINI R., DALLE ZOTTE A., CARAZZOLO A., COSSU M. E., 1995. Effect of dietary energy level, addition of fat and physiological state on performance and energy balance of lactating and pregnant rabbit does. *Anim. Sci., **61**, 387-398.*