MILK YIELD AND COMPOSITION IN RABBIT DOES USING HIGH FAT DIETS

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Abstract - Fifty-seven lactations of 43 New Zealand x Californian rabbit does were used to investigate the effect of high fat diets on milk yield; simultaneously the effects of two litter sizes (medium and large) and two environmental temperatures (warm and hot) were studied. Another 15 lactations of 15 New Zealand x Californian rabbit does were used to study the effect of the same diets on milk composition at 7, 21 and 28 days of lactation.
Hot environmental temperature decreased($p<0.001$) feed intake and milk yield of does, while large litter size increased these ($p<0.001$). The inclusion of fat at high concentrations did not affect milk yield, but increased ($p<0.05$) the milk fat content at 7 and 28 days of lactation.

INTRODUCTION

Hyperprolific doe rabbit lines that produce a very large litter size have been developed in recent years. However, these lines present such high pup mortalities that they have been questioned (MORISSE, 1987). Pups' low viabilities during the first days of life may be due to deficient thermoregulation or to an insufficient feed energy intake (TORRES *et al.*, 1979; FRAGA *et al.*, 1989). Throughout this period, milk yield of does determines the viability and growth of pups, since they drink almost only maternal milk during the first 21 days.

Milk yield of does may be affected by breed of doe, remating interval, litter size, feed composition, and environmental conditions (MCNITT and LUKEFAHR, 1990; TORRES *et al.*, 1979; MAERTENS and DE GROOTE, 1990). Previous works tried to increase milk yield using concentrated energetic diets, based on increased carbohydrate content (SABATER *et al.*, 1993) or with light fat contributions of between 1 and 3% (FRAGA *et al.*, 1989). Old pelleting equipments didn't allow higher fat levels because they affected the equipment and especially the quality of the pellet.

New sprayer equipment permits the inclusion of a higher fat content in pellets without decreasing their quality. Their use could produce high energy diets without a diminution of fibre level, favouring milk yield of does, and consequently higher growth and viability of pups. In a previous work done in our laboratory to evaluate the effect of animal or vegetable fat inclusion at high concentrations (12 and 10%, respectively) on the productive efficiency of does, a significant diminution of pup mortality and a significant increase of 21-day litter weights were found (data not published). The aim of this work was to establish how fat inclusion at high levels affected milk yield and composition at different ambient temperature conditions and different litter sizes.

MATERIALS AND METHODS

Animals

Fifty-seven lactations from a total of 43 New Zealand x Californian does were used throughout a 13-month period to study the influence of two high fat diets versus a control diet on milk production. Simultaneously, the effect of two litter sizes: medium (M) for 7-8 pups and large (L) for more than 10 pups, and two environmental temperatures: warm (W) when minimal temperature was under 24°C and hot (H) when it was above 24°C, were studied.

Milk production was measured daily using the weight (doe) - suckle - weight (doe) method. To prevent free nursing, does were placed in a cage next to the nest box. Suckling took place once a day (around 9:00 a.m.). Feed intake and weight of does during the first 1-21 days of lactation and during the last 21-35 days of lactation were measured.

Another group of 15 lactations from 15 New Zealand x Californian rabbit does under warm temperature was studied to determine the influence of high fat diets on composition of milk (5 lactations per treatment). A litter size of 8 pups was kept constant throughout lactation. The pups were separated from their mother to prevent suckling for a period of 24h before sample collection in the morning. The doe was injected intravenously with 5 IU oxytocin to enhance maximum contraction of myoepithelial cells, and milk was collected manually by gently massaging the mammary gland. Volumes of 30 to 40 ml per doe were obtained from all mammary glands. Samples were taken at the 7th, 21st and 28th days of lactation.

Does were kept under the same managerial conditions, weaned at 35 days and remated 14 days after parturition. They were housed in individual cages, provided with feeders, automatic nipple drinkers and nest boxes.

Table 1 : Composition and chemical analysis of diets (g/100g fresh matter basis)

Ingredient[1]	C	A	V
Barley	35	20	20
Soya 44%	12	18	--
Soya full-fat	--	--	24
Lucerne hay	50	50	50
Soya oil	--	--	2.5
Commercial tallow	--	8.5	--
Calcium dihydrogen phosphate	2.3	2.8	2.8
Sodium chloride	0.4	0.4	0.4
Vitamin mineral supplement	0.2	0.2	0.2
DL-Metionine	0.1	0.1	0.1
Chemical analysis			
Dry matter (DM)	92.2	92.9	92.7
Ash	10.2	10.6	10.6
Ether extract (EE)	2.6	11.7	9.9
Crude fibre (CF)	16.6	16.6	17.0
Crude protein (CP)	18.0	19.0	19.8
Digestible protein (DP)	13.0	14.0	15.1
Gross energy (MJ/Kg DM (GE)) 17.8	19.8	19.4	
Digestible energy (MJ/Kg DM (DE))	11.0	12.2	12.4
DE/DP (KJ/g)	84.6	87.1	82.1

[1] all diets contain 100 ppm antioxidant and 66 ppm robenidine
[2] contains (gKg^{-1}) : thiamin, 0.25 ; riboflavin, 1.5 ; calcium pantothenate, 5 ; pyridoxine, 0.1 ; nicotinic acid, 12.5; vitamin A, 2 ; vitamin D, 0.1 ; vitamin E, 15 ; vitamin K, 0.5 ; vitamin B_{12}, 0.006 ; choline chloride, 100 ; $MgSO_4.H_2O$, 7.5 ; ZnO, 30 ; $FeSO_4.7H_2O$, 20 ; $CuSO_4.5H_2O$, 3 ; KI, 0.5 ; $CoCl_2.6H_2O$, 0.2 ; Na_2SeO_3, 0.03 ; BHT antioxidant, 0.2.

Diets

The composition and chemical analysis of the diets are shown in Table 1. Starting from a control diet with 2.6 g/100g of ether extract (C), two isoenergetic diets, in energy digestible terms, were formulated adding fat from animal sources up to 11.7 g/100 g DM (A) and fat from vegetable sources up to 9.9 g/100 g DM (V), maintaining the same proteic source (soya) and the same level of forage content (lucerne).

Does were fed *ad libitum* one of the three diets throughout lactation, and the pups after 21 days combined milk and some of the same feed on their mother.

Milk chemical analysis

Milk samples were analyzed for total solids, ash, fat and protein. Total solids and ash were obtained using the AOAC method (1984). Fat content was determined using the Gerber method according to BRITISH STANDARDS INSTITUTION (1951). Crude protein was calculated by KJELDAHL method according to the FIL STANDARD: 20B (1993).

Statistical analysis

Data were statistically treated with diet (C, A and V), environmental condition (warm and hot) and litter size (medium and large) as independent variables, using the GLM procedure for unbalanced blocks. The lactation curves were fitted by least squares. Statistical Analysis System package (SAS, 1989) was used.

RESULTS AND DISCUSSION

Milk yield

The effect of diet fat content, litter size and ambient temperature on milk yield and feed intake of does is shown in Table 2.

Table 2 : Effect of diet fat content, litter size and ambient temperature on milk yield and feed intake of does

	Milk production (g/week)					Feed intake (g DM/day)		
	1st week	2nd week	3rd week	4th week	5th week	Total	1-21 days	22-35 days
Diet								
C n=15	997 ±60.3	1483 ±72.9	1625 ±81.7	1401 ±67.6	820 ±79.3	6326 ±285.4	322 ±17.7	341 ±17.8
A n=22	840 ±66.9	1380 ±80.9	1481 ±90.6	1403 ±75.0	883 ±87.9	5987 ±316.5	265 ±19.6	282 ±19.7
V n=20	918 ±47.6	1388 ±57.6	1604 ±64.5	1434 ±53.4	789 ±62.6	6133 ±225.4	269 ±14.0	296 ±14.0
Significance	NS	NS	NS	NS	NS	NS	*	*
Litter size								
Medium n=20	751 ±55.4	1208 ±67.0	1362 ±75.0	1231 ±62.1	747 ±72.8	5299 ±262.0	270 ±16.2	287 ± 16.3
Large n=37	1086 ±39.3	1625 ±47.6	1779 ±53.3	1595 ±44.1	914 ±51.7	6999 ±186.1	301 ±11.5	326 ±11.6
Significance	***	***	***	***	*	***	**	***
Ambient temperature								
Warm n=37	1019 ±40.4	1560 ±48.8	1749 ±54.7	1509 ±45.2	897 ±53.0	6733 ±191.0	303 ±11.9	348 ±11.9
Hot n=20	818 ±54.6	1274 ±66.1	1391 ±74.0	1317 ±61.2	764 ±71.8	5565 ±258.5	267 ±16.0	265 ±16.1
Significance	**	**	***	*	NS	***	NS	***

* $p < 0.05$; ** $p < 0.01$; $p < 0.001$; NS : not significant ; n = number of lactations

Although feed intake was significantly lower with fat diets throughout lactation (p<0.05), fat inclusion in diets had no significant effect on milk yield.

Frequently, the reduction of pups' mortality and the increase of 21-day litter weights have been linked to an increase in milk yield of does. However, the improvement of these variables obtained in our laboratory with A and V diets (data not published) cannot be explained by an increase in milk yield, because it was similar for the three diets throughout lactation.

Litter size affected significantly milk yield (p<0.001) and feed intake of does (P<0.01 for the first 21 days; P<0.001 for the last 14 days) both increasing when number of pups was higher. Only in the 5th week milk yield was not significantly different either group. Some authors (DE BLAS and GALVEZ, 1973; TORRES *et al.*, 1979; MCNITT and LUKEFAHR, 1989; SABATER *et al.*, 1993) described a linear relation between milk production and number of pups.

Finally, under warm temperatures milk yield was significantly higher than under hot, maximum in 3rd week (p<0.001) and minimum in the 5th week when milk yield declined. Feed intake was always higher under warm conditions and showed a significant increase (p<0.001) at the end of lactation. MAERTENS and DE GROOTE, 1990; RAFAI and PAPPS, 1984; FERNANDEZ-CARMONA *et al.*, 1994 and FERNANDEZ-CARMONA *et al.*, 1995) have also described how feed intake and milk production of lactating does decreased in hot conditions and so did their productive efficiency.

Milk composition

The effect of diet fat content on the milk composition of doe rabbits is shown in Table 3.

The main constituents of rabbit milk show a different behaviour pattern to the diet.

Milk total solids concentration was always higher for A and v diets, but only at the 7th day of lactation could a significant effect (p<0.05) be reported. Ash content of milk was significantly different at the 28th day of lactation (p<0.05).

The type of diet did not affect the milk protein content, perhaps due to the constant level and source of protein in diets. Milk fat content, was significantly different at the 7th and 28th days of lactation. At these days milk samples coming from fat diets had a higher fat concentration (4-5%) than from control diets.

Table 3 : Effect of diet on milk composition (%)

	C	A	V	s.e.	Significance
Total solids (TS)					
7th day	28.9[a]	32.8[b]	31.9[b]	0.89	*
21st day	30.7	31.1	31.7	1.18	NS
28th day	37.3	41.4	40.4	1.85	NS
Ash					
7th day	1.9	1.7	1.5	0.18	NS
21st day	1.8	1.9	1.8	0.16	NS
28th day	2.3[ab]	2.6[a]	1.8[b]	0.17	*
Crude protein (CP)					
7th day	10.1	11.1	11.4	0.34	NS
21st day	12.4	11.4	11.0	0.43	NS
28th day	14.6	14.4	14.0	0.96	NS
Crude fat (CF)					
7th day	13.4[a]	17.8[b]	17.3[b]	0.94	*
21st day	15.4	16.5	16.1	1.14	NS
28th day	19.1[a]	23.7[b]	23.3[b]	1.05	*

No analysis were carried out before the 7th day of lactation, but there are no reasons to suppose that the trend of milk fat is different for the three diets during the first week of lactation. Therefore, the diminution of pups' mortality found may be due to a higher content of milk fat in the first days of lactation and not to a higher milk yield.
Consequently, though the weight of litter at 21st day of lactation is a good milk yield predictor, when diets with a high fat content are used this weight may be due to a higher milk fat content, and the milk yield could be overestimated. These results emphasize the production of milk to be reported in terms of fat corrected-milk or milk energy.

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Produccion y composicion de la leche de conejas alimentadas con piensos ricos en grasa - Se han utilizado 43 conejas Neozelandesas x California a lo largo de 57 lactaciones para investigar el efecto de la inclusión de altas concentraciones de grasa sobre su producción de leche; simultaneamente, se estudió el efecto de dos tamaños de camada (medio y grande) y dos condiciones ambientales diferentes (templado y caliente) sobre ésta. Para determinar el efecto de estas dietas sobre la composición de la leche a los 7, 21 y 28 días de lactación, se utilizaron otras 15 lactaciones.
La ingestión de pienso y la producción de leche de las conejas disminuyeron en condiciones de temperatura caliente ($p<0.001$), mientras que aumentaron para tamaños de camadas grandes ($p<0.001$). La inclusión de altos niveles de grasa no afectó a la producción de leche, pero aumentó ($p<0.05$) su contenido en grasa los dias 7 y 28 de lactación.