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EFFECT OF DIETARY FIBRE AND FAT CONTENT ON THE REPRODUCTIVE PERFORMANCE OF RABBIT DOES BRED AT TWO REMATING TIMES DURING TWO SEASONS

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SUMMARY : One hundred and forty one rabbit does were used to study the effect of four diets differing in energy concentration (8.92 to 11.86 MJ DE/kg), fibre and fat content, two parturition-remating intervals (1 or 9 d), and two seasons (hot season and rest of the year) on productive performance throughout a 18 months period. Addition of a 3.5 % of pork lard to a diet containing 18 % ADF implied an increase of energy digestibility (by 8 %, P<0.05), DE content (by 15 %, P<0.001), feed intake (by 6 %, P<0.1), and DE intake (by 22.5 %, P<0.05). Fat addition did not affect average weight of does, prolificacy, or replacement rate, but improved fertility (by 7 %, P<0.1), weaning weight per pup (by 3 %, P<0.1), and numerical productivity per cage and year (by 12 %, P<0.05). An increase of dietary fibre content (from 18.0 to 23.8 % ADF) decreased linearly (P<0.001) energy digestibility, and DE content, but increased (P<0.05) feed intake, so that neither DE intake (2.56 MJ/d as average) or does productivity were significantly affected. Intensification of reproduction system elicited a shorter parturition interval (- 3.2 days, P<0.05), but also a decrease of average does weight (- 0.14 kg, P<0.05), a lower conception rate (P<0.05), and a higher pup mortality, so that numerical productivity per cage and year was not significantly affected by treatment. The increase of temperature during the hot season decreased feed intake (by 21 %, P<0.001), average weight of does (- 0.15 kg, P<0.05), fertility (- 16 %, P<0.001), numerical productivity (- 23 %, P<0.001), and weaning weight (- 7 %, P<0.01). No significant effects of the interactions diet x remating interval or diet x season were found on any of the variables studied.

RESUME : Effet de la teneur en fibre et en matières grasses de l'aliment sur les performances de reproduction de lapines conduites selon deux rythmes de reproduction au cours de deux saisons.
Cent quarante et une lapines ont été utilisées pour étudier les effets de : 4 régimes à concentration énergétique croissante (8,92 à 11,86 MJ ED/kg), différant par leur teneur en cellulose et en matières grasses, de deux intervalles parturition-saillie (1 ou 9 jours) et de deux saisons (la saison chaude et le reste de l'année), sur les performances de production au cours d'une période de 18 mois. L'addition de 3,5 % de saindoux à un régime contenant 18 % d'ADF implique une augmentation de la digestibilité de l'énergie (8 %, P<0,05), de la teneur en ED (15 %, P<0,001), de l'ingestion alimentaire (6 %, P<0,1), et de l'énergie digestible ingérée (22,5 %, P<0,05). L'addition de matières grasses n'a pas affecté le poids moyen des lapines, la prolificité, ou le taux de renouvellement, mais a amélioré la fertilité (7 %, P<0,01), le poids au sevrage des lapereaux (3 %, P<0,1), et le nombre de lapins produit par cage et par an (12 %, P<0,05). Lorsque la teneur en fibre s'accroît (de 18,0 à 23,8 % ADF), la digestibilité de l'énergie décroît linéairement, de même que la teneur en ED de l'aliment ; par contre l'ingestion augmente (P<0.05) de manière telle que ni l'ingestion quotidienne d'ED (2,56 MJ/jour en moyenne) ni la productivité des lapines ne sont significativement modifiées. L'intensification du système de reproduction fait apparaître un intervalle entre deux mise bas plus court (- 3,2 jours, P<0,05)) mais aussi la diminution du poids moyen des lapines (- 0,14 kg, P<0,05), un taux de fécondation plus bas (P<0,05) et une plus forte mortalité des lapereaux, bien que la productivité numérique par cage et par an ne soit pas significativement modifiée par le traitement. L'ingestion alimentaire diminue avec l'augmentation de la température ambiante (- 21 %, P<0,001), ainsi que le poids moyen des lapines (- 0,15 kg, P<0,05) la fertilité (- 16 %, P<0,001), la productivité numérique (- 23 %, P<0,001) et le poids au sevrage (- 7 %, P<0,01). Il n'y a d'effet significatif de l'interaction régime x rythme de reproduction ou régime x saison sur aucune des variables étudiées.

INTRODUCTION

Highly productive rabbit does might require high concentrated diets, especially when feed intake is a limiting factor, as it is the case in primiparous does (CASTELLINI and BATTAGLINI, 1991), and for intensive systems of reproduction or high ambient temperature (MENDEZ *et al*, 1986).

On the other hand, previous work seems to indicate an interaction between source of energy and digestible energy intake, which was not affected when varying dietary fibre content (MENDEZ *et al.*, 1986 ; LEBAS, 1988), but increased, together with does productivity, when adding fat to the diet (MAERTENS and DE GROOTE, 1988 ; FRAGA *et al.*, 1989).

The aim of this work has been to study the long term effect on the reproductive performance of

Table 1 : Ingredients and chemical composition of diets.

	1	2	3	4
Ingrédients % :				
Barley grain	30.0	35.0	25.0	18.5
Wheat bran	15.0	17.5	18.5	16.5
Sunflower meal–38	12.0	9.0	9.0	9.0
Soybean meal–44	11.0	9.0	9.0	9.0
Lucerne hay	25.0	25.0	25.0	25.0
Barley straw	–	–	4.5	9.0
Rice hulls	–	–	4.5	8.5
Pork lard	3.5	–	–	–
Dicalcium phosphate	1.4	1.4	1.4	1.4
Calcium carbonate	0.4	0.4	0.4	0.4
Sodium chloride	0.4	0.4	0.4	0.4
Bentonite	1.2	2.2	2.2	2.2
Vitamin/mineral mix*	0.1	0.1	0.1	0.1
Chemical analysis, % Dry Matter :				
Dry matter	91.8	91.4	91.6	91.8
Ash	10.4	10.4	11.0	11.2
Crude protein	19.5	18.4	18.5	18.0
Crude fibre	11.9	12.0	15.0	16.9
Acid detergent fibre	18.0	18.0	20.2	23.8
Ether extract	6.6	2.9	2.1	2.6
Gross energy(MJ/kgDM)	18.5	17.4	17.2	17.4

* Provided by Phillis Duphar, Madrid, Spain. Mineral and vitamin composition (g/kg) : Cu 3 ; Fe 30 ; I 0.25 ; Zn 15 ; Thiamine 0.5 ; Riboflavin 1.5 ; Pantothenic acid 3 ; Pyridoxine 0.5 ; Niacin 4 ; Choline chloride 50 ; Vitamin B_{12} 0.004 ; Retinol 1.65 ; Cholecalciferol 0.25 ; α-tocopherol 8 ; Phytylmenaquinone 2.

commercial doe rabbits of an increase of dietary energy concentration by lowering fibre content, or adding fat, and its interaction with reproductive system and ambient temperature.

MATERIAL AND METHODS

Animals :

Sixty-four New Zealand x Californian does were initially used to study the influence of four diets and two remating intervals on does reproductive performance ; eight animals were randomly allocated to each combination of treatments. A 3-months adaptation period was included before controlling rabbit performance over a 18-months experimental period. During the trial 77 animals died or were discarded for different reasons (illness, unfertility or low prolificay) ; they were immediately replaced by nulliparous does.

Diets :

Three diets (2, 3 and 4) were formulated for increasing levels of fibre (18, 21 and 24 % of ADF, on DM basis). The effect of fat addition was studied by adding 3.5 % pork lard at the 18 % ADF level (diet 1). The proportion of the other ingredients were varied in order to maintain an energy to protein ratio around 77.4 kJ DE/g digestible cude protein, and to keep the contents of essential nutrients at the levels recommended by LEBAS (1986). Chemical and ingredient composition of diets are shown in table 1.

Remating intervals after parturition :

Does were assigned to each of two treatments defined by the remating interval after parturition : 1 or 9 days. Weaning age and dry period interval (from weaning to the next parturition) were 28 or 30 days and 3 or 11 days, respectively. All does having less than five pups per litter were rebred 24h after parturition ; does that failed to conceive or lost all their pups were immediately given the opportunity to remate.

Digestibility trial :

Six young rabbits weighing between 1.8 and 2.0 kg were used for each diet, to determine apparent digestibility of energy, crude protein and crude fibre. Following a 10 days period of adaptation, animals were housed in metabolism cages that allowed separation of feces and urine. Collections were made on four consecutive days ; feces produced daily were collected in labeled polyethylene bags and stored at –20°C.

Feeding trial :

Productive traits (parturition interval, prolificacy and weight at weaning) were recorded and accumulated per cage throughout the experimental

Table 2 : Effect of diet on feed intake and reproductive performance of does rabbits.

	Diets					
	1	2	3	4	SEM	Significance
No of litters	189	177	171	175		
Average weight of does, (kg)	3.96	4.01	3.94	3.93	0.08	NS
Feed intake (g/day)	264a,b	249a	274a,b	288b	9	*
Parturition interval (days)	51.3	54.8	56.8	55.5	2.5	+
No born total/litter	9.0	8.7	8.5	9.0	0.5	NS
No born alive/litter	8.2	7.7	7.8	8.0	0.5	NS
No weaned/litter	6.8	6.5	6.4	6.4	0.4	NS
Weaning weight (g/rabbit)	523a	507a	506a	453b	10	**
Replacement rate of does (%/year)	130	99	114	143	17	NS

a,b Means in the same row with different superscript differ (P<0.05) ; + P<0.10 ; * P<0.05 ; ** P<0.01 ; NS : non significant.

period. Feed consumption and weight of does were recorded monthly. The diets were offered *ad libitum* in late pregnancy (from day 28 on) and troughout lactation. All other animals received a fixed amount (140 to 160g/day) of diet.

Animals were housed in flat deck cages measuring 600 x 500 x 330mm high. A cycle of 16 hours light 8 hours dark was used troughout the year. Building temperature was maintained between 14 and 19°C., except from the 15th of June to the 15th of September when varied from 22 to 29°C (hot season). The trial started in March, so that two summer periods were included in the trial.

Analytical methods :

Chemical analysis of diets were made following the method of VAN SOEST (1963) for acid detergent fibre and AOAC (1984) for dry matter, ash, crude protein, ether extract and crude fibre. Gross energy was determined by adiabatic bomb calorimetry.

Statistical analysis :

The data were analysed using the ANOVA procedure of SAS (1985) as a 4 x 2 x 2 factorial structure, with type of diet, remating interval and season as the three factors.

Replacement of does and pup mortality were analysed using a non parametric procedure (NPAR1WAY). Mean separation was made using a t–test, except for replacement of does and mortality rates, for which a chi-square test was used.

RESULTS AND DISCUSSION

Digestibility trial :

Type of diet affected (P<0.001) energy digestibility, which increased (P<0.05) with fat addition and decreased linearly (P<0.001) with dietary fibre content : 70.0, 64.8, 60.4 and 55.9 % (SE = ± 2.3) for diets 1, 2, 3 and 4 respectively. These results agree with the general effects observed in previous work with rabbits (DE BLAS *et al.*, 1992). Digestible energy contents derived from these values were 11.86, 10.31, 9.53 and 8.92 MJ/kg (as-fed basis) for diets 1, 2, 3 and 4 respectively. No significant effects of type of diet were found on crude protein or crude fibre

Table 3 : Reproductive performance and feed intake of does mated 1 and 9 days after parturition

	Treatments			
	1	9	SEM	Significance
No of litters	367	345		
Average weight of does (kg)	3.89	4.03	0.05	*
Feed intake (g/day)	268	270	6.5	NS
Parturition interval (days)	53.0	56.2	1.8	*
No born total/litter	8.7	8.6	0.4	NS
No born alive/litter	7.7	7.9	0.4	NS
No weaned/litter	6.3	6.6	0.3	+
Weaning weight (g/rabbit)	459	534	7.1	***
Replacement rate (%/year)	146	97	12	+

+ P<0.10 ; * P<0.05 ; ***P<0.001 ; NS : non significant

Table 4 : Effect of environmental temperatures on feed intake and reproductive performance.

	Treatment		SEM	Significance.
	Hot season	Rest of the year		
No of litters	330	382		
Average weight of does (kg)	3.89	4.04	0.05	*
Feed intake (g/day)	235	297	6.5	***
Parturiton interval (days)	59.0	50.9	1.8	***
No born total/litter	8.4	9.1	0.4	*
No born alive/litter	7.2	8.4	0.4	**
No weaned/litter	6.2	6.6	0.3	**
Weaning weight (g/rabbit)	479	514	7.1	**
Replacement rate (% / year)	121	120	12	NS

* P<0.05 ; ** P<0.01 ; *** P<0.001 ; NS : non significant

digestibilities, which average (mean ± SE) 75.8 ± 1.8 and 17.8 ± 6.5 respectively. Energy to protein ratio of diets varied from 73.2 to 79.5 kJ DE/g of digestible protein.

Feeding trial :

The effect of type of diet on intake and does performance is shown in table 2. Fat addition tended to increase (P<0.10) feed intake (264 *vs* 249 g/day for diets 1 and 2 respectively), which implied a significant (P<0.05) increase in energy intake (3.13 vs 2.56 MJ DE/day, respectively), as observed in previous short- (FRAGA *et al.*, 1989) and medium-term (MAERTENS and DE GROOTE, 1988) trials. Fat addition did not affect either average weight and replacement rate of does, prolificacy, or feed conversion rate (MJ DE/rabbit weaned), but tended to improve (P<0.10) fertility rate and weaning weight of young rabbits, by 7 and 3 %, respectively. Numerical productivity also increased significantly (P<0.05) : 48.5 vs 43.3 (SE = ± 1.5) rabbits weaned per cage and year for diets 1 and 2 respectively.

On the other hand, an increase of dietary fibre content (from 18.0 % in diet 2 to 23.8 % ADF in diet 4) increased linearly (P<0.05) feed intake, from 249 to 288g/day, but did not affect DE intake, which averaged 2.56 MJ/day, neither any of the productive parameters studied, excepting weaning weight which decreased significantly in diet 4. Similar results have been obtained in previous long term studies when varying level of fibre from 20.4 to 27.1 (MENDEZ *et al.*, 1986) or from 15.9 to 25.1 % ADF on DM (LEBAS *et al.*, 1988).

The results of this study seem to confirm a positive effect of dietary fat on DE intake and performance which has not been observed in fattening rabbits (PARTRIDGE *et al.*, 1986 ; SANTOMA *et al.*, 1987 ; FERNANDEZ and FRAGA, 1992) or when increasing DE concentration by lowering dietary fibre content, and support the recommendation by MAERTENS (1992) to include 4-5 % of fat in diets for breeding doe rabbits.

The effect of remating interval on does performance is shown in table 3. As observed in previous work (e.g. PARTRIDGE *et al.*,1984 ; MENDEZ *et al.*, 1986) remating does 1 day after parturition implied a shorter parturition interval with respect to those remated 9 days after, but also a higher mortality during the suckling period, a lower litter size at weaning, and an impairment of fertility rate, so that numerical productivity (no. of rabbits weaned per cage and year) did not differ between both treatments. On the other hand , a less intensive system of reproduction increased weaning weight of rabbits (+ 16 %, P<0.001) and reduced replacement rate of does (P<0.10). No significant effect of remating interval were observed on feed intake or on average weight of does. The interaction type of diet x remating interval did not affect any of the traits under study.

The effect of environmental temperature on does productivity is shown in table 4. Feed intake, reproductive traits, and weaning weight were impaired significantly during the hot season, as occured in a previous paper (MENDEZ *et al.*, 1986). No significant effects of the interaction diet x temperature were found on any of the variables studied, as also observed BORGIDA and DUPERRAY (1992) in fattening rabbits.

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