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SUMMER COMPLEMENTARY FEEDING OF RABBITS

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INTRODUCTION

During summer, the recorded temperature in intensive rabbitery in Southern France oscillates between a low 25°C during the night to over 35°C during the day, frequently for several weeks. Heat waves also occur in Northern areas, although shorter in duration.

Temperature over 25°C reduces growth in caged rabbits (COLIN, 1974, 1985, 1990 - PRUD'HON, 1976 - AUXILIA, 1977 - WITHORFF et al, 1988) as body heat dissipation is impaired through the skin by the fur coat and the lack of sweating glands (HARKNESS, 1988) and the animal reaction is to increase panting and reduce feed intake. Daily temperature variation allows some adaptation as shown with does by MAERTENS and DE GROOTE, 1990.

To alleviate this seasonal growth reduction, improvement of feed intake through genetic selection (EBERHART, 1980 - FINZI, 1990) has been proposed, but a better balance of nutrients is also suggested. LEBAS and OUHAYOUN, 1987, have shown the advantage of increasing protein level to maximize growth rate in warmer conditions. A reduction of metabolism heat production by feeding digestible fat instead of carbohydrate or organic acid producing constituents is known in pigs (NOBLET et al, 1989) and could be expected with heat stressed rabbits.

Feeding a high protein and fat complement named "canicule" with the standard commercial feed (COFNA, H32 brand) as a function of temperature has been successfully tried in the field and this experiment was conducted to appreciate in controlled conditions the effect on intake and performances of a fixed proportion of 30 % of this complement in a ration fed at normal (18°C) and high (30°C) temperature.

MATERIAL AND METHODS

96 rabbits, NZ x Calif hybrids (HYPLUS, GRIMAUD Frères, France), weaned at 28 days at the Talhouet rabbitery unit, are sorted into 4 comparative groups of 24 with balanced litter origin, sex and weight. They are then affected at random to make a repetition group of 6 rabbits.

Each repetition group of 6 is placed in a 0.35 m2 cage (i.e. 17 rabbits/m2) and the 24 cages are affected to one of the two rooms (3,5 x 2,5 x 2,2 m) of 19 m3 (i.e. 0,4 m3/rabbit) of the building.

Building ventilation is dynamic, with lateral extraction of the air, lighting is constant (8 hours/day) and temperature is continuously recorded and monitored to 18°C (15-20°C) in one room and 30°C (27-32°C) in the other.

Water and feed are provided ad libitum. The control group had only the "standard" feed, the complement one a rough mix of 30 % "canicule" and 70 % "standard" feed. Both feeds are in 4 mm pellet form.

Ingredients used in these proprietary formulas are : sugar beet pulp, cane molasses, spring wheat and wheat feed, barley, alfalfa meal (17 CP), soybean meal (46 CP), sunflower meal normal (28 CP) or semi decorticated (35 CP), fish meal (65 CP), animal fat, rapeseed crude oil, commercial mineral and vitamin mix.

The "standard" feed has been formulated using growing rabbit nutrient requirements, rabbit indigestible fibre (11 % minimum), essential amino acid balance and digestible energy for pigs as described in INRA 1989. DE level is 2.350 kcal/kg with a minimum of 3 g/Mcal DEp of lysine.

The "canicule" feed was ajusted to allow 15 % more essential amino acid, i.e. a 3,45 g lysine/Mcal ED in the 2.500 DEp/kg mixed (30/70) ration along with at least proportional concentration to lysine of the other essential amino acids.

Proximate analysis given in **Table 1** is performed on an average sample collected for each feed and with the EEC methods of feed analysis (meth B for fat, enzymatic for starch) and, for lignin, by the non N corrected method of VAN SOEST and WINE, 1967.

Amino acid determination is performed after hydrochloric acid 6N during 24 hours and separation by ion exchange on an automatic Biotronik SC 5000 device.

Table 1 - FEED PROXIMAL ANALYSIS, AVERAGE (%)

	Standard	Canicule
Crude protein	16.50	26.60
Crude fat	3.10	10.20
Crude fiber	14.50	11.80
Ash	7.90	10.20
Methionine	0.30	0.70
Meth + cystine	0.57	1.14
Threonine	0.56	1.04
Lysine	0.64	1.29
Calcium	1.22	1.88
Phosphorus	0.66	0.79
Lignin	4.30	4.10
Starch	13.50	4.60
Sugars	7.70	9.60

Feed intake was evaluated at each animal weighing date (49 and 68 days of age), all the animals were slaughtered at 68 days of age.

Carcass yield after 24 hours chilling, legs cut, is determined as well as total perirenal fat.

A sample of perirenal fat was pooled for each of the 4 groups. Analysis for their fatty acid content is determined, after methylation, by GLC with a Hewlett Packard automatic analyser (ISO 5508 - 1978).

Statistical analysis is completed using an analysis of variance (SPSS/PC +) software (SSPS Inc Ed., 444 North Michigan Av., CHICAGO, Illinois).

RESULTS

Only one rabbit died in the 18°C "canicule" group and all the other individual data could be used.

No significant interaction between the main factors temperature and feed was found for the variables analysed, so they could be statistically analysed separatly.

Starting weight was high (639 ± 80 g at 28 days) and growth rates were good with an average daily gain of 37.7 ± 2.7 at 30°C and 43.5 ± 3.6 at 18°C. The growth data per period given in **Table 2** show that, if overall temperature effect was very significant ($P < 0.001$) with a 14 % average difference, only the early period (28-49 days) demonstrated a lightly advantage of "canicule" with 6.6 % improvement over the "standard" feed alone ; it was not significant during the late (29-68 days) one. So the full period effect was small (2.5 %) and of low statistical ($P < 0.10$) significance.

Table 2 – AVERAGE GROWTH RATE (g/d ± SD) OF THE 4 GROUPS, PER PERIOD (d)

Temperature	30°C (27-32)		18°C (15-20)	
Feed variable	standard	Can + stan	standard	Can + stan
Nb repetitions	24	24	24	23
28-49 days	39.5 ± 3.0 c	42.8 ± 4.3 b	45.1 ± 4.6 ab	47.4 ± 4.7 a
49-68 days	34.8 ± 4.2 b	32.9 ± 3.7 b	40.5 ± 5.5 a	40.7 ± 5.1 a
28-68 days	37.3 ± 2.1 b	38.1 ± 3.2 b	42.9 ± 3.8 a	44.2 ± 3.4 a

a, b, c : data with the same letter are not statistically different ($P < 0,01$)

Feed intake shows a very similar pattern as growth rate with a 22.5 % increase of feed intake at 18°C compared with the 30°C one (Table 3). The "canicule" small favorable (+ 3 g/d) effect in the early period and the 30°C room is of low significance (P < 0.10) and was not found of signification on the whole period.

Table 3 - AVERAGE FEED INTAKE (g/d ± SD) OF THE 4 GROUPS, PER PERIOD (d)

Temperature	30°C (27-32)		18°C (15-20)	
Feed variable	standard	Can + stan	standard	Can + stan
Nb repetitions	24	24	24	23
28-49 days	85.3 ± 1.8 c	88.8 ± 4.9 b	98.9 ± 2.8 ab	101.3 ± 2.7 a
49-68 days	115.7 ± 6.2 b	114.1 ± 4.2 b	148.5 ± 4.3 a	147.6 ± 3.4 a
28-68 days	99.7 ± 2.4 b	100.8 ± 4.5 b	122.5 ± 2.7 a	123.3 ± 1.3 a

Feed conversion (Table 4) shows a highly significant improvement for the full period from 2.82 as an average at 18°C to 2.66 at 30°C. When corrected by covariante to the same weight of 2.3 kg, the difference is much smaller and statistically non significant, P < 0,10 (2.83 v 2.75 corrected values). The temperature effect was not significant during the early period of growth (2.12 v 2.17 average conversion rates). The "canicule" effect is never of significance. Only with the covariance correction of feed conversion at 2.3 kg it is possible to have a slight (P < 0.08) effect shown with 2.84 for "standard" against 2.74 for "canicule".

Table 4 - AVERAGE FEED CONVERSION (± SD) OF THE 4 GROUPS, PER PERIOD (d)

Temperature	30°C (27-32)		18°C (15-20)	
Feed variable	standard	Can + stan	standard	Can + stan
Nb repetitions	24	24	24	23
28-49 days	2.16 ± 0.06 *	2.08 ± 0.09 *	2.20 ± 0.06 *	2.14 ± 0.08 *
49-68 days	3.33 ± 0.11 b	3.47 ± 0.21 ba	3.67 ± 0.16 a	3.64 ± 0.11 a
28-68 days	2.68 ± 0.03 bc	2.65 ± 0.13 c	2.86 ± 0.08 a	2.79 ± 0.02 ab

* non significative differences

At slaughter, carcass yield was very significantly improved (+ 1.3 %) by "canicule" feeding as well as temperature (+ 1.0 %) as shown in Table 5. This critera shows an interaction feed x temperature and the "canicule" effect is only significant for high temperature.

Table 5 - AVERAGE CARCASS WEIGHT AND PERIRENAL FAT OF THE 4 GROUPS, AT SLAUGHTER

Temperature	30°C (27-32)		18°C (15-20)	
Carcass yield (%)	56,4 ± 1,50 b	58,4 ± 1,90 a	56,2 ± 1,30 b	56,8 ± 1,20 b
Carcasse weight (g)	1195 ± 58 d	1255 ± 91 c	1325 ± 97 ab	1361 ± 81 a
Perirenal fat (g)	17,6 ± 4,60 c	20,5 ± 5,20 c	21,9 ± 6,20 b	28,3 ± 7,00 a
Perirenal fat (% carcass)	1,47 ± 0,37 b	1,63 ± 0,38 b	1,65 ± 0,43 b	2,08 ± 0,49 a

Perirenal fat, even after correction of carcass weight, was lower at higher temperature (1.86 vs 1.55) very significantly and "canicule" feed had an effect of the same amplitude when temperature is not taken into account. No significant interaction was found but "canicule" effect on fat was higher (+ 29 %) at 30°C than 18°C (+ 16 %). That effect is difficult to interpret because of differences in carcasse weight.

A pooled sample of fat collected in the perirenal area was analysed for fatty acid composition. The major change is a small effect of feed variable shown in the pooled data in Table 6. The very specific C16:1 and C17 iso high level of fatty acids in the "canicule" ration was not found in the perirenal deposited fat. "Canicule" feed had very little effect on fat deposition in the perirenal area as shown.

Table 6 - "CANICULE" AND RABBIT PERIRENAL FAT COMPOSITION IN CERTAIN FATTY ACIDS (%)

Perirenal fatty acids	<C16	C16	C17 C16 ins	C18	C18:1	C18:2	C18:3	C20 ins	C22 ins
"standard" feed	4.4	27.7	4.7	7.6	30.3	20.1	3.6	-	0.6
30 % "canicule" feed	6.4	30.3	3.2	7.8	29.3	18.2	3.4	0.4	-
"canicule" ration fatty acids	3.9	16.2	3.2	5.2	27.4	9.9	2.2	1.7	1.7

DISCUSSION

With the "standard" feed, the 12°C (18/30) increase in temperature of this trial had the expected effect on growth (- 5,6 g/d), feed intake (23 g/d) and feed conversion (+ 0,04) when compared with the 4.2 g difference found by LEBAS and OUHAYOUN, 1987, for a 12.6°C (11.4-24) difference at a lower level of temperature and 12 g/d found by EBERHART, 1980, for 12°C (18/30) variation but with very slow growing rabbits. These data are also in line with the practical data collected by AUXILIA and MASOERO, 1977, for periods with average temperature of 22°C and 30°C showing 7 g/d growth difference.

With milking does, MAERTENS and DE GROOTE, 1990, found a 11 % feed intake depression with about 13°C average temperature difference (16/29°C). The effect of heat on reductioin of fat deposition is also in agreement with LEBAS and OUHAYOUN, 1987, but we do not find the endogenous/exogenous fat effect they proposed to explain the higher fat insaturation they noticed in leaner carcasses.

Substitution of a high protein, high energy from fat feed ("canicule") at 30 % rate in the "standard" feed is more difficult to interpret. Its effect varied with the period of growth although a significant but small favorable effect (+ 2.5 g/d) was found on total growth rate. The favorable effect on global feed conversion - 0,16 (2.66/2.82) was no more significant when corrected by regression on final weight. The feed conversion at 2.3 kg was then only improved by 0.08 (2.83/2.75) with a $P < 0.14$ of significance.

Using a calculated pig digestible energy content of the feed because the value for rabbit could not be predicted for the "canicule" feed, this feed increased by about 8 % the rabbit energy intake during each period but resulted in growth response on the first one only. The only significative effect in the second was a higher fat deposition as noticed in the slaughter measurements and deducted by the higher feed conversion.

Energy conversion (DE Mcal/kg growth) was very similar with "canicule" or "standard" feed at the early period (5.2) suggesting a similar protein to fat deposition and DE efficiency for growth as during the late one "canicule" ratio was 8.9 against 8.2 for "standard" feed, a 8.9 % increase.

Calculation based on the energy requirement for maintenance given by JIN et al, 1990, of 354 kcal/kg $P^{0.75}$, with a ME efficiency for growth of 0.44 combined with the ME/DE ratio estimated at 0.965 from pig data (NOBLET et al, 1989) shows that in the finishing period the "standard" feed net energy for growth was 420 kcal for 37.7 g/d as the "canicule" and was 461 for 36.7 g/d. The calculated cost of energy for growth is then 11.1 vs 12.6 kcal/g, a 13 % increase with "canicule" which is to compare with the percentage of perirenal fat in the carcass of respectively 1.56 and 1.85 % i.e. an increase of 18 %.

These speculations lead to interpret the growth effect of "canicule" as a higher energy and protein intake during the early period as well as a better protein or essential amino acids adjustment on energy for post weaning feeding and only a more efficient energy conversion effect in fat deposition on the second period.

Conclusion is that the "canicule" complementation during summer is of larger interest for carcass quality and yield than for increase of growth performance. The higher fat level and saturation of the fat are to be considered because it is an improvement of quality in a season when the rabbit meat market is depressed and the lower grade carcasses subjected to more depreciated value than in winter. It is also noticeable, in field trial specially, that skin and fur quality are also visually very much improved with "canicule".

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