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CARCASS AND MEAT QUALITY OF GROWING RABBITS UNDER HIGH AMBIENT TEMPERATURE USING HIGH FAT DIETS

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SUMMARY- Growing rabbits of the same genetic origin (a three-way cross) were reared at two different environmental temperatures (18°C and 30°C) using three different diets. Diet V contained 9.9% vegetable fat, diet A contained 11.4% commercial tallow, diet C was a standard diet. They were slaughtered at the normal Spanish commercial weight (2 Kg), their carcasses were dissected and the meat was analysed. No interaction between the factors was found. Animals on diets V and A had a better dressing out percentage (60.5 and 60.7) than those on diet C. Rabbits carcasses from diets A and V were more compact and fatter than carcasses from diet C. Animals reared at high temperature grew slowly, had a poorer feed conversion ratio, and a better dressing out percentage (63.3 *v.* 56.4). Animal carcasses from the high temperature group had lighter livers and kidneys, were more compact and less fatty (4.26 per cent *v.* 5.46 per cent of dissectible fat). Meat from animals subject to high temperature had both higher pH and fat percentage (4.67 *v.* 4.03 on hind leg meat).

Key words : Temperature, dietary fat, carcass composition, meat quality.

INTRODUCTION

Addition of fat in diets for growing rabbits, with different levels lower than 8%, has been previously investigated (Raimondi *et al.,* 1974) but little work has been done on the effect of high dietary fat level on carcass composition (Ouhayoun *et al.*, 1986) or on meat quality (Pla and Cervera, 1997). Moreover these studies were performed at normal ambient temperatures in Europe. At high temperatures of 30-35°C as in tropical countries, the feed intake is reduced and growth impaired (Chiericato *et al.,*1995). In these conditions and because of a higher digestible energy intake (Cervera *et al.,* 1997), a high-fat diet seems to increase the live weight gain daily. The consequences of this on carcass and meat quality have not been studied and therefore this is the objective of this experiment.

MATERIALS AND METHODS

Diets

Three diets were formulated for this experiment. Diet V contained 9.9% vegetable fat (soya bean meal) and diet A had 11.4% animal fat (commercial tallow) (Table 1). Both V and A diets were formulated as isoenergetic diets and had a high DE content (12.3 MJ DE per Kg DM). Diet C was a standard diet (11.0 MJ DE per Kg DM).

Animals

Two groups of does were placed in two different environments. One group was situated in a conventional building where the medium temperatures varied from 14°C to 22°C. The average temperature was 18°C. The other group was put in a climatic chamber at a constant temperature of 30°C. Each group was divided in three subgroups which were fed respectively with the three diets (V, A and C) during gestation and lactation. Their offspring, a commercial three way cross, were also fed

with their respective diets from weaning to slaughter. The young rabbits in the climatic chamber (6, 7 and 5 from diets V, A and C, respectively) were housed at weaning (35 days) in individual cages. Those from of the conventional environment (10 from each diet) were housed in '5 kind' collective cages. Sex distribution was equal. Each rabbit had free access to water and their experimental diet. Feed consumption per cage was calculated from weaning to slaughter as fresh matter. When the rabbits reached the Spanish commercial weight of 2 Kg (the rabbits in the conventional building at 62 ± 4 days and the rabbits in the chamber at 87 ± 1 days of age) were slaughtered in the farms own abattoir and their carcasses stored at 3ºC for 24 hours.

Table 1. Main ingredients (%) and chemical composition (%DM) of the diets: V= vegetable fat enriched, A= animal fat enriched and C= control.

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

[1] contains (gKg^{-1}):thiamin, 0.25; riboflavin 1.5; calcium pantphenate, 5; pyridoxine, 0.1; nicotine acid, 12.5; vitamin A, 2; vitamin D, 0.1; vitamin E, 15; vitamin K, 0.5; vitamin B_{12} 0.006; chlorine 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.

Traits measured

When rabbits were housed in collective cages, feed conversion ratio was estimated as feed consumption of fresh matter per cage divided by the sum of the live weight of the animals in the cage. The carcasses were measured and retailed according to the norms of the World Rabbit Scientific Association (WRSA) (Blasco and Ouhayoun, 1996). The following variables were measured: Live weight (LW), Hot carcass weight (HCW), Chilled carcass weight (CCW), Dressing out percentage (DP=CCW/LW), Drip loss percentage (DLP=HCW-CCW/HCW). Weight of liver, kidneys and of the chest and neck organs (thymus, trachea, oesophagus, lung and heart) was also recorded. Total carcass length between the atlas vertebra and the distal part of *os ischii* and circumference at the level of the 7th lumbar vertebra were recorded. Reference carcass weight was the weight of the carcass minus the head, liver, kidneys and organs of chest and neck. Dissectible fat weight was the sum of the weight of the Scapular, Inguinal and Perirenal fat deposits.

Colour was measured with a CR-300 Minolta chromameter (Minolta Camera Co., Osaka, Japan) which gives the L*, a*, b* parameters as average of three measurements in each point. Measurements were taken on the carcass surface of the *m. longissimus dorsi* at the level of the 4th lumbar vertebra, on the meat of the 7th lumbar vertebra section of the *m. longissimus* and on the perirenal. Chroma $C^*=(a^{*2} + b^{*2})^{1/2}$ and Hue $H^*= \tan^{-1} (b^*/a^*)$ were calculated. Muscular pH of the *B. femoris* and pH of the *Longissimus dorsi* at the level of the 5th lumbar vertebra was also measured with a Crison MicropH 2001 (Crison Instruments, Barcelona, Spain) provided with a combined electrode penetrating 3 mm.

A hind leg was separated and dissected to find its meat/bone ratio. The chemical composition of her total meat was estimated by NIR spectrometry (Pla, 1996). Water holding capacity (WHC) of *m. longissimus* was measured according to the Grau and Hamm technique (Hamm, 1986) and was expressed as the ratio (x100) of muscle area to total area. Cooking loss was determined by cooking an *m. longissimus* in an electric oven at 200°C for 30 min, and weighing it 30 min later. WHC of cooked meat of *m. longissimus* was the WHC of 300±5 mg of muscle cooked as described before.

Statistical analyses

Least square means were computed by using the GLM procedure of the SAS package (SAS, 1990). The interaction diet-temperature was analysed and not significant for any of the variables studied, therefore the final model included only diet and temperature as fixed effects. Weaning weight was a covariate in growth analysis, live weight was a covariate for analysing feed conversion ratio and dressing out percentages, and reference carcass weight was a covariate in the analysis of the carcass.

RESULTS AND DISCUSSION

Temperature had a high effect on growth during lactation and fattening (Table 2). The same slaughtering weight (roughly 2 Kg) was reached at ages that differed by 40%, because the growth ratio was much lower at high temperatures than at ambient temperatures (Cervera *et al.*, 1997). Temperature also had a clear effect on feed conversion ratio, this was 21% higher at 30°C than at 18°C. The diet did not seem to affect the growth ratio. Differences on feed conversion ratio between diets were not significant but diet C seems to have a higher value (p=0.08).

The live weight of the rabbits at each temperature was similar at slaughter, but the carcass weight of the animals reared at 30°C was greater than the 18°C group and the dressing out percentage of the first group was higher as a consequence. The higher dressing percentage of this group could be the consequence of lower feed intake (85 *v.* 115 g/d) and that they were older (Ouhayoun, 1989). Rabbits on the three diets also had the same live weight but those on diet C had lower carcass weight and dressing out percentage, as previously stated (Pla and Cervera, 1997). The dressing percentages in the present work are higher with respect to those previously cited, this may be due to the high value of the 30°C group.

Contrary to the Pla and Cervera (1997) found no differences between diets were found in drip losses, but carcasses from the group 30°C lost more water probably due to its lesser adiposity.

Carcass colour measured on the *m. longissimus dorsi* was not affected by diet as Pla and Cervera (1997) found, but carcasses of rabbits reared at high temperature demonstrated the strongest colour probably because this animals were older at slaughter.

Diet did not affect the weight of the liver, kidney or the chest and neck organs, but those at 30°C had a lower kidney weight and a much lower liver weight than those from the 18°C group. The lower liver weight may be caused by a lower metabolic activity and a lesser glycogen content, although we did not measure this. Chiericato *et al.* (1993) also found a lighter liver weight in rabbits in summer than in winter, but no explanation was given.

Table 2. Growth and carcass traits of rabbits fed with different type of high fat diets (V = vegetable fat, A = animal fat, C = control) and at two different temperatures.

	Diet			Temperature		
	V	A	C	18 °C	30 °C	SE
Live weight, g	2048	2129	2004	2060	2060	50
Weaning weight, g	722	778	727	857[a]	628[b]	31
Growth ratio, g/d	35.2	35.8	34.9	43.1[a]	27.5[b]	1.1
Age, d	75.0	75.5	74.6	63.0[a]	87.0[b]	0.5
Feed conversion ratio, g FM/g	2.88	2.95	3.12	2.70[a]	3.27[b]	0.09
Hot carcass weight, g	1290[a]	1288[a]	1245[b]	1191[a]	1358[b]	12
Chilled carcass weight, g	1254[a]	1247[a]	1208[b]	1166[a]	1307[b]	13
Drip loss percentage	2.8	3.2	2.8	2.1[a]	3.8[b]	0.4
Dressing out percentage	60.5[a]	60.7[a]	58.4[b]	56.4[a]	63.3[b]	0.6
Carcass colour L*	54.3	53.9	55.5	54.9	54.3	0.6
C*	3.3	2.8	3.4	2.4[a]	3.9[b]	0.4
H*	-35.8	-17.4	-35.6	-12.3[a]	-46.8[b]	12.4
Liver weight, g	67.5	70.5	69.7	90.5[a]	47.9[b]	3.5
Kidneys weight, g	15.3	15.9	15.3	17.5[a]	13.6[b]	0.4
Thymus, trachea, oesophagus, lung and heart weight, g	27.4	27.6	28.1	27.9	27.4	0.7
Reference carcass weight, g	1029[a]	1020[a]	961[b]	911[a]	1095[b]	12
Length to circumference ratio	1.99[b]	1.93[a]	2.04[b]	1.95[a]	2.02[b]	0.02
Compactness, g/mm	3.05[a]	3.14[a]	2.80[b]	2.79[a]	3.19[b]	0.07
Scapular fat, g	8.3[a]	9.8[a]	6.3[b]	9.2[a]	6.9[b]	0.6
Perirenal fat, g	25.7[a]	22.7[a]	16.5[b]	27.0[a]	16.3[b]	1.4
Inguinal fat, g	18.3[a]	21.5[c]	13.3[b]	23.0[a]	12.2[b]	1.2
Dissectible fat percentage	5.51[a]	5.93[a]	3.14[b]	5.46[a]	4.26[b]	0.3

[a,b,c] Row means within factor with different superscripts differ at P<0.05.

Carcasses on fat-enriched diets were more compact and had lesser length to circumference ratio as Pla *et al.*(1994) found in adult rabbits, but were also the most compact. This disagrees with the results of the same authors with respect to adults.

As expected fat-enriched diets produced fatter carcasses in all the studied adipocite deposits (Ouhayoun *et al.*,1986), no differences between diets V and A were found except in the inguinal fat deposit, which was higher in the rabbits given the diet with added animal fat. Rabbits reared at high temperature were also considerably less fatty than those reared at low temperature as Chiericato *et al.* (1992) found. Chiericato *et al.*(1993) found higher values in winter than in summer, but Centoducati *et al.* (1990) did not detect any differences in fattening at different temperatures.

Table 3 shows the meat quality traits measured on *m. longissimus dorsi, biceps femoris* and in hind leg. No differences in water holding capacity were found but the meat of the rabbits given fat-enriched diets had less cooking loss, probably because of their lesser moisture content and higher fat content. The meat of rabbits subject to high temperature was less acidic, paler and had less fat but no differences in water holding capacity, cooking losses or moisture or protein percentage were found between the two temperature groups.

Meat-to-bone ratio of hind leg is used as a predictor of meat-to-bone ratio of the carcass (Blasco and Ouhayoun, 1996) and high fat diets or temperature does not seem to affect carcass meat content.

Table 3. Meat quality trais measured in muscles *Longissimus dorsi*, *Biceps femoris* and hind leg of rabbits fed with different type of high fat diets (V=vegetable fat, A=animal fat, C=control) and at two different temperatures.

	Diet			Temperature		
	V	A	C	17 °C	30 °C	SE
M. longissimus dorsi						
Water holding capacity (WHC)	36.1	33.9	33.8	33.8	35.4	0.9
Cooking loss	24.7^{a}	28.1^{a}	34.6^{b}	28.3	30.0	2.2
WHC of cooked meat	16.4^{a}	16.9^{a}	19.6^{b}	17.3	17.9	0.9
pH	5.86^{a}	5.83^{ab}	5.76^{b}	5.75^{a}	5.89^{b}	0.03
Meat L*	50.7	50.6	51.2	52.1^{a}	45.5^{b}	0.6
C*	3.4	3.1	4.1	4.4^{a}	2.6^{b}	0.3
H*	27.8	24.1	30.3	41.9^{a}	11.4^{b}	3.7
M. biceps femoris pH	5.91	5.88	5.83	5.85	5.89	0.03
Hind leg						
Moisture percentage	72.6^{a}	72.2^{a}	74.1^{b}	72.9	73.0	0.3
Protein percentage	20.7	21.1	21.2	20.7	21.3	0.2
Fat percentage	4.51^{a}	5.11^{b}	3.44^{c}	4.03^{a}	4.67^{b}	0.18
Meat to bone ratio	4.79	4.76	4.75	4.57	4.96	0.17

^{a,b,c} Row means within factor with different superscripts differ at P<0.05.

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