EFFECT OF GENOTYPE AND ENVIRONMENTAL CONDITIONS ON THE PRODUCTIVE AND SLAUGHTERING PERFORMANCE OF GROWING MEAT RABBITS

CHIERICATO G. M., RIZZI C., ROSTELLATO V.

Università di Padova, Dipartimento di Scienze Zootecniche, Agripolis, 35020 LEGNARO, (Padova), Italy

Abstract - The aim of the trial was to evaluate the productive and slaughtering data of rabbits belonging to New Zealand White (NZW), Grimaud (G) and Provisal (P) genotypes and reared in two different thermal conditions. The rabbits (35 day-old) were reared for 50 days in two rooms with temperatures of 20°C (Thermoneutrality conditions=TN) and 28°C (Heat stress conditions=HS). The three genotypes exhibited similar final body weight, daily gain, daily feed intake and feed efficiency. The high environmental temperature significantly (P<0.01) decreased the final body weight (2611 vs 2929 g), daily gain (32.6 vs 38.5 g) and daily feed intake (117.2 vs 138.8 g). At slaughter, NZW, G and P rabbits presented a similar dressing percentage. HS rabbits presented a higher dressing percentage (62.16 vs 60.59%) than TN rabbits. The fore part, intermediate part and hind part percentages of the reference carcasses did not differ in the three genetic groups. NZW rabbits presented higher (P<0.05) perirenal fat (3.02%) than G (2.51%); the interscapular fat was similar. HS carcasses had a lower percentage of fore part (28.55 vs 29.47%, P<0.01) and a higher percentage of intermediate (31.45 vs 30.54%, P<0.01) and hind part (36.55 vs 35.75%; P<0.05). HS rabbits presented lower (P<0.01) perirenal (2.53 vs 3.14%) and interscapular (0.92 vs 1.10%) fat deposits.

INTRODUCTION

In meat rabbit production, genotype and environmental temperature represent important rearing factors. The research works concerning the effect of genotype on productive performance often make a comparison between purebreds and local hybrids (OKERMAN *et al.*, 1987; RISTIC and ZIMMERMANN, 1992; BERNARDINI BATTAGLINI *et al.*, 1995). The findings concerning the effect of rearing thermal conditions generally considered the responses of animals kept in environments with extreme temperature levels (LEBAS and OUHAYOUN, 1987; CHIERICATO *et al.*, 1992, 1993).
The aim of the present work is to provide a contribution to the existing knowledge on rabbit meat production by comparing the productive and the slaughtering performance of rabbits of three different commercial genotypes reared in thermoneutrality and heat stress conditions.

MATERIAL AND METHODS

The trial was carried out on 57 male rabbits; the weaned animals were 35 days old and belonged to New Zealand White (NZW), Grimaud (G) and Provisal (P) genotypes. The latter two groups were four-way crossbred commercial type rabbits obtained from crossing two terminal synthetic lines. The rabbits of each genotype were taken from no less than 12 litters obtained from 10 sires; the environmental conditions and the breeding farm characteristics were all similar. The animals were allocated into two rooms: the first with a temperature of 19.9±1.94°C (Thermal neutrality condition=TN) and the second 27.9±1.23°C (Heat stress condition=HS) with relative humidity of 83.2±9.22% and 69.9±5.19%, respectively. The high temperature in the HS room was created by a heating system, while the thermoneutrality conditions were obtained naturally, as was the ventilation provided by windows. The photoperiod was 16L:8D and provided by fluorescent lamps; the light intensity was 38±4 lux. The rabbits were housed individually in a Californian battery-cage system (40x28 cm) without hindering caecotrophy. The feed and water were administered "ad libitum". The commercial pelletted feed (Table 1) was submitted to chemical analysis according to official methods

Table 1. Chemical composition and nutritive value of the diet

Dry matter	*%*	*89.33*
Crude protein (Nx6.25)	% d. m.	17.18
Ether extract	"	3.47
N-free extract	"	56.43
Ash	"	7.50
Crude fibre	.	15.48*
NDF		28.62
ADF	"	20.18
Digestible energy	kcal/kg*	2526
	MJ/kg*	10.57

* as feed basis

(AOAC, 1984). The rabbits were weighed at arrival and then on a weekly basis. The feed intake and state of health were checked daily. The rearing temperature and the relative humidity were continuously recorded by a thermohygrograph (TIG-1TH LSI). The ammonia concentration inside the rooms was checked every 7 days by a Dräger pump and kits, and averaged 6 ppm. At the end of the experiment (85 days of age) the animals for each genotype and thermal condition were first stunned electrically, killed and bled by severing the carotid arteries and jugular veins, and then slaughtered following the procedures of BLASCO *et al.* (1993).
All the data were submitted to variance analysis using the following model (Harvey, 1991):

$$Y_{ijk} = \mu + G_i + T_j + (GT)_{ij} + \varepsilon_{ijk}$$

where: Y_{ijk}=experimental data; μ=overall mean; G_i=fixed effect of -ith genotype (i=1, 2, 3); T_j=fixed effect of -jth thermal levels (j=1, 2); $(GT)_{ij}$=effect of interaction; e_{ijk} =residual random error.

RESULTS AND DISCUSSION

Given that no significant interaction effects between genotypes and environmental temperatures were recorded, the Tables present only the main effects of the treatments.

Growth performance

Table 2 summarized the productive performance of the rabbits observed at the end of the trial. As concerns the genotype, no significant difference was observed between the three groups. NZW, G and P rabbits exhibited similar final body weight, daily gain and daily intake. The feed efficiency values also resulted homogeneous among the genotypes. Very few research works have compared these three genotypes. Similar results were obtained in our previous experiment, in which New Zealand White, Hyla and Provisal genotypes were compared (CHIERICATO and FILOTTO, 1989; CHIERICATO *et al.*, 1993) and also in another trial (OKERMAN *et al.*, 1987).
The rabbits reared at 28°C, a temperature level higher than the thermoneutrality values considered suitable for meat rabbit production (ROCA *et al.*, 1980), showed significantly lower (P<0.01) final body weight, growth rate and feed intake than in TN group, while feed efficiency was the same with both treatments. Similar results were also found in trials where the rabbits were reared in both cold and in heat stress conditions (LEBAS and OUHAYOUN, 1987; SIMPLICIO *et al.*, 1988; CHIERICATO *et al.*, 1992, 1993) but, due to the wider range of temperatures studied, feed efficiency proved to be significantly influenced.

Table 2: Productive performance of the rabbits

		Genotype			Temperature		
		NZW	G	P	HS	TN	s.e.*
Animals	n	21	18	18	29	28	
Initial body weight	g	997	963	1016	980	1005	76
Final body weight	g	2732	2773	2805	2611^B	2929^A	142
Daily gain	g/d	34.7	36.2	35.8	32.6^B	38.5^A	2.7
Feed intake	g/d	124.7	127.6	131.7	117.2^B	138.8^A	10.8
Feed efficiency	g/g	3.60	3.53	3.69	3.58	3.62	0.24

A, B: Values with different superscript differ by P<0.01; *: 51 degrees of freedom

Slaughtering performance

Table 3 provides the slaughtering data. The three groups presented similar body weight at slaughter. As concerns the single carcass parts, NZW rabbits showed similar percentages of skin, distal hind legs and gastrointestinal tract when compared with hybrid rabbits. Significant differences (P<0.01) were found only for distal fore legs that resulted higher in NZW rabbits and lower in P subjects. Therefore, the dressing percentage did not differ among groups with similar values. NZW rabbits presented liver and kidney percentages similar to those of hybrid subjects, while the head resulted higher (P<0.01). These findings substantially agree with our previous works (CHIERICATO and FILOTTO, 1989; CHIERICATO *et al.*, 1993) which compared New Zealand White and Hyla and Provisal rabbits slaughtered at lower weight.

Table 3: Slaughtering data

		Genotype			Temperature		
		NZW	G	P	HS	TN	s.e.*
Slaughter body weight	g	2800	2835	2901	2658^{B}	3033^{A}	132
% slaughter weight:							
- skin		14.01	14.48	14.20	13.95^{B}	14.51^{A}	0.71
- distal fore legs		0.80^{A}	0.78^{AB}	0.75^{B}	0.80^{A}	0.75^{B}	0.05
- distal hind legs		1.73	1.71	1.68	1.82^{A}	1.60^{B}	0.10
- full gastrointestinal tract	16.40	16.30	16.18	15.96	16.58	1.47	
- empty gastrointestinal tract	7.18	7.07	7.01	6.83^{b}	7.34^{a}	0.95	
- dressing percentage		61.12	61.48	61.50	62.16^{A}	60.59^{B}	2.13
% commercial carcass$^{(1)}$:							
- head		8.97^{A}	8.29^{B}	8.05^{B}	8.33	8.54	0.76
- liver		5.06	5.60	5.18	4.99^{B}	5.57^{A}	0.87
- kidneys		0.95	0.98	0.99	0.94^{B}	1.01^{A}	0.11

$^{a, b}$:Values with different superscript differ by P<0.05; $^{A, B}$: Values with different superscript differ by P<0.01; *: 51 degrees of freedom; (1): after chilling for 24 hours in a ventilated room at 4°C

As regards the temperature effect, HS rabbits exhibited lower (P<0.01) body weight at slaughter than the TN subjects. Due to their lower body weight, the HS rabbits presented lower percentage of skin (P<0.01) and empty gastrointestinal tract (P<0.05) and higher (P<0.01) distal fore and hind legs. Similar results were obtained in experiments in which a wider temperature interval was tested (LEBAS and OUHAYOUN, 1987; CHIERICATO *et al.*, 1992, 1993). All the significant differences observed lead to a notably (P<0.01) higher dressing percentage in the subjects reared in HS conditions. This result can be ascribed to the reduced gastrointestinal tract development caused by lower feed intake that occurs in the presence of higher temperatures. Furthermore, the lower incidence of the skin, probably due to lower subcutaneous deposits in the rabbits reared in heat stress conditions must be considered. The higher dressing percentage observed in rabbits reared at high temperature is well-known and confirmed by previous research works (LEBAS and OUHAYOUN, 1987; CHIERICATO *et al.*, 1992, 1993). The rabbits reared in TN conditions had heavier liver (P<0.01) and kidney percentages (P<0.05) than those of HS animals. The head values was not different. A similar effect was observed when cold and high temperatures were compared (CHIERICATO *et al.*, 1992, 1993).

Carcass characteristics

Table 4 summarises the dissection data. As concerns the three genotypes, NZW, G and P presented similar carcass part percentage values per reference carcass. In particular, the shoulders, fore legs and thoracic cage (fore part), loins and flanks (intermediate part) and rump, nates and thighs (hind part) all presented similar values. These findings agree with our previous experiment (CHIERICATO and FILOTTO, 1989) that considered New Zealand White, Hyla and Provisal rabbits. Literature on this topic provides contrasting results (DAVID *et al.*, 1990; OZIMBA and LUKEFHAR, 1990; CHIERICATO *et al.* 1993; BERNARDINI BATTAGLINI *et al.*, 1995). NZW rabbits compared with representatives of the other two genotypes of the same age with similar body weight, presented higher precocity, which was confirmed by more marked adipogenesis: the perirenal fat was higher (P<0.05) than those observed in G subjects, while P animals were intermediate. The interscapular fat was similar among the genotypes. The literature available gives not homogeneous indications on the comparison between hybrid and purebred rabbit fat deposits (Perrier and OUHAYOUN, 1990; DAVID *et al.*, 1990; RISTIC and ZIMMERMANN, 1992). BERNARDINI BATTAGLINI *et al.* (1995) found that cross-breeding with giant buck strains (White Giant and Grimaud Heavy) produced rabbits with lower perirenal fat than those obtained from light sire strain (Grimaud Light).

The temperature had a relevant influence on each carcass part percentage. The fore part was significantly (P<0.01) lower in HS animals compared to the TN rabbits. The intermediate part (P<0.01) as well as the hind part (P<0.05) percentages were significantly lower in TN rabbits than HS rabbits. This result is probably due to the higher fat deposition in the thoracic region of the carcass that occurs in presence of thermal neutrality conditions. TN carcasses, in fact, presented higher percentages of shoulders, fore legs and thoracic cage, as a consequence of a decreased proportion of loins and flanks, rump, nates and thighs characterized by low intramuscular fat deposits (OUHAYOUN, 1991-92). Fat deposition also noticeably differed among the treatments: the TN rabbits exhibited significantly higher (P<0.01) percentages of perirenal and interscapular fat than those observed in HS subjects. These results are probably due to the lower feed intake observed in HS animals. In our previous works, where extreme temperature levels beyond the range of values normally considered thermoneutral were compared, a similar trend was observed (CHIERICATO *et al.*, 1992, 1993). Other authors (LEBAS and OUHAYOUN, 1987) obtained results that agree partially with our experiments.

Table 4: Carcass jointing data

		Genotype			Temperature		
		NZW	G	P	HS	TN	s.e.*
Reference carcass	g	1411	1419	1449	1350^{B}	1503^{A}	77
% reference carcass[(1)]:							
- fore part		28.91	29.24	28.88	28.55^{B}	29.47^{A}	1.13
- intermediate part		31.30	30.62	31.08	31.45^{A}	30.54^{B}	1.12
- hind part		36.28	36.25	35.91	36.55^{a}	35.75^{b}	1.34
- perirenal fat		3.02^{a}	2.51^{b}	2.97^{ab}	2.53^{B}	3.14^{A}	0.67
- interscapular fat		1.04	0.94	1.08	0.92^{B}	1.10^{A}	0.22

$^{a, b}$: Values with different superscript differ by P<0.05; $^{A, B}$: Values with different superscript differ by P<0.01; *: 51 degrees of freedom; (1): following anatomical division

In conclusion, the absence of significant interaction effects between genotype and environmental temperature indicates that these three breeds present a similar capacity for adaptation to the different thermohygrometric levels tested. The purebred rabbits were similar to the hybrid animals in terms of growth, slaughtering and jointing performance. Rabbits reared under higher temperature had lower body gain and feed intake and higher dressing percentage and lower fat deposits than those reared in conditions of thermoneutrality.

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Effetto del genotipo e delle condizioni ambientali sulle prestazioni produttive e di macellazione del coniglio da carne. Con il presente lavoro si è inteso studiare le prestazioni produttive e di macellazione fornite da conigli Bianchi di Nuova Zelanda (NZW), Grimaud (G) e Provisal (P) sottoposti a due differenti condizioni termiche. Gli animali, di 35 giorni di età, sono stati allevati per 50 giorni, in due locali distinti, caratterizzati da circa 20°C (Condizioni di neutralità termica=TN) e 28°C (Condizioni di stress da calore=HS). I tre tipi genetici hanno messo in luce pesi vivi finali, ritmi di crescita, consumi alimentari ed indici di conversione simili. In condizioni di stress termico i conigli hanno fatto riscontrare pesi finali (2611 vs 2929 g), incrementi ponderali (32.6 vs 38.5 g/d) e consumi di alimento (117.2 vs 138.8 g/d) significativamente ($P<0.01$) più ridotti rispetto ai soggetti allevati a 20°C. In sede di macellazione, i tre genotipi hanno fornito rese del tutto simili. Le più alte temperature di allevamento hanno consentito di raggiungere le più alte ($P<0.01$) rese di macellazione (62.16 vs 60.59%). Non si sono riscontrate differenze significative alla dissezione in tagli della carcasse in relazione al genotipo, dato che le porzioni anteriori, intermedie e posteriori delle carcasse dei conigli NZW, G e P hanno fornito valori simili. I conigli NZW hanno presentato una maggiore ($P<0.05$) quantità di grasso perirenale (3.02%) rispetto ai soggetti G (2.51%), mentre il grasso interscapolare è risultato simile fra i tre genotipi. Le carcasse appartenenti al trattamento TN hanno presentato una maggiore incidenza della parte anteriore (29.47 vs 28.55%, $P<0.01$) e minore di quella intermedia (30.54 vs 31.45%, $P<0.01$) e posteriere (35.75 vs 36.55%, $P<0.05$) rispetto ai soggetti HS a seguito di una maggiore adipogenesi. I conigli TN hanno esibito una maggiore ($P<0.01$) quantità di grasso perirenale (3.14 vs 2.53%) e interscapolare (1.10 vs 0.92%).