GROUP HOUSING OF GROWING RABBITS: EFFECT OF STOCKING DENSITY AND CAGE FLOOR ON PERFORMANCE, WELFARE, AND MEAT QUALITY

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ABSTRACT

Three hundred twenty rabbits weaned at 29 d (LW: 618 ± 65 g) were housed in group to evaluate the effect of stocking density and type of cage floor on behaviour, health status, growth performance, carcass and meat quality. Rabbits were put in groups of 8 in 40 cages of two sizes (110 x 60 cm and 100 x 50 cm) allowing two stocking densities (D12, 12.1 rabbits/m^2 *vs* D16, 16.0 rabbits/m^2). Within density, two types of cage floor were compared (wire net *vs* slat) according to a 2 x 2 factorial arrangement with ten replications (cages). The rabbits were fed one single diet (CP: 17.6% DM, ADL: 5.7% DM, DE: 10.7 MJ/kg DM). No antibiotic was added to feed or water. Rabbit reactivity was controlled by tonic immobility and open-field tests at 51 and 66 d of age. Rabbit behaviour was video-recorded at 57 and 68 d of age for 24 h. Rabbits were slaughtered at 71 d to evaluate carcass and meat quality. The dimensions and the resistance to fracture of femur and tibia were measured. Sanitary status and growth performance were highly satisfying in all treatments. Mortality was 1.6% during the trial. Daily growth rate averaged 48.5 g/d and live weight at 71 d 2655 g, with a feed efficiency of 0.327. Carcass and meat quality, and bone fracture resistance were unaffected by housing system. The highest stocking density stimulated daily weight gain during the first two weeks of trial (51.4 *vs* 52.9 g/d in D12 and D16 rabbits; $P<0.05$) but tended to reduce feed intake in the last two weeks (185 *vs* 179 g/d, $P=0.06$). Video recording, however, showed no difference in behaviour between stocking densities. Although stocking density had no overall effect on final weight or feed intake, feed efficiency was higher in D16 rabbits ($P=0.05$). During the open field test, the D16 rabbits spent more time moving than the D12 rabbits ($P=0.04$), whereas no difference in rabbit reactivity was observed during the immobility test. The effect of the type of cage floor was weak and limited to a slight reduction in feed intake during the last two weeks of trial, and therefore an improvement in feed efficiency throughout the study ($P=0.01$), by rabbits reared on the wire net floor in comparison with rabbits reared on the slatted floor (179 *vs* 185 g/d; $P=0.08$). During the open field test, rabbits reared in cages with wire net floor showed higher exploration activity ($P<0.01$) without any difference in reactivity during the immobility test.

Key words: stocking density, cage floor, welfare, growth performance, meat quality.

INTRODUCTION

Increasing public attention to the welfare of intensively reared animals has recently stimulated discussion on rabbit breeding as well (VERGA, 2000; COMBES and LEBAS, 2003). Since 1996, the Standing Committee of the European Council for the protection of Animals kept for intensive purposes has been working on specific recommendations for the welfare of domestic rabbits. Different aspects of cages or pens (dimensions, type of floor, enrichment, etc.) are considered in the Recommendations in order to increase animal comfort and welfare during rearing. The trend is to substitute the individual or bicellular cages used in some Countries (e.g. Italy) with group cages or pens to permit social interaction and to increase the space available per animal to enable natural behaviour. Some studies show that group housing at high stocking densities negatively affects growth performance and favours animal aggressiveness especially with increasing age (AUBRET and DUPERRAY, 1992; BIGLER and OESTER, 1996; MORISSE and MAURICE, 1997). Growing rabbits also show greater preference for wire net floors rather than straw bedded floors that soil their fur and facilitate disease transmission (MORISSE *et al*., 1999; DAL BOSCO *et al*., 2002). Carcass and meat quality is not always affected by the group housing system, however (COMBES and LEBAS, 2003). The objective of our study was to evaluate the effect of stocking density and type of cage floor on behavioural pattern and reactivity, growth performance, carcass and meat quality of group-housed rabbits.

MATERIAL AND METHODS

Three hundred twenty Grimaud rabbits of both sexes were weaned at 29 d (LW: 618 ± 65 g) and put in 40 cages by groups of 8 animals each. One half of the cages had a surface of 6.600 cm^2 (110 x 60 cm) and the other a surface of 5000 cm^2 (100 x 50 cm), therefore allowing two stocking densities: D12 (12.1 rabbits/m^2; 825 cm^2/rabbit) and D16 (16.0 rabbits/m^2; 625 cm^2/rabbit). Within stocking density, the cages had two types of floor: wire net (N: galvanized wire net of 2.5 mm diameter forming grids of 7.5 x 1.5 cm) or slat (S: galvanized steel bars of 2 x 2 cm section and 1.5 cm span). The cages had two 80 cm-high sides made of galvanized steel, a wire net back side, a large wire net front door for inspection and no ceiling. Two nipple drinkers were placed on the back side and two 20 cm-wide manual feeders on the front side. The rabbits were fed an experimental diet for growing rabbits (CP: 17.6% DM, ADL: 5.7% DM, DE: 10.7 MJ/kg DM) during the entire experiment. No antibiotic was administrated in feed or water. Individual live weight and cage feed intake were recorded three times a week. Health status was controlled daily. The budget time was measured in 16 cages (128 animals in total) by video-recording at 57 and 68 d of age for 24 h (MORISSE *et al*., 1999). The tonic immobility test and the open-field test were performed at 51 and 66 d of age on 48 rabbits (3 rabbits per video-recorded cage) (FERRANTE *et al*., 1992). One hundred twenty rabbits (3 per cage) were slaughtered at 71 days in a commercial slaughterhouse according to international scientific protocols (BLASCO *et al*., 1993). Cold carcasses were evaluated for conformation, fatness and colour. After 24 h, pH and colour were assessed on the *longissimus lumborum* and *biceps femoris* muscles (XICCATO *et al*., 1994). Carcasses were dissected to separate hind leg and dissectible fat. Meat to bone

ratio, cooking losses (80°C for 2 hours) and meat shear press force were measured on hind leg. The dimensions and resistance to fracture of femur and tibia were measured as described by XICCATO *et al*. (1999). Performance data were analysed by means of the GLM procedure of SAS (1991), considering the cage as the experimental unit and stocking density, cage floor and their interaction as the variability factors. Individual data of carcass and meat quality were analysed including in the model the effect of the cage. Behavioural and reactivity data were first submitted to the Kruskal-Wallis and Mann-Whitney tests to assess the normal distribution of data. Non-normal data were analysed by means of PROC NPAR1WAY (SAS, 1991).

RESULTS AND DISCUSSION

Rabbit growth performance (average cage data) from 29 to 71 d of age are reported in Table 1. Average performance showed group housing to be compatible with the full expression of growth capability of these commercial rabbit hybrids that reached a mean live weight of 2655 g at only 71 d of age. Final live weight, daily weight gain and feed intake were unaffected by the experimental treatments. D16 rabbits showed higher feed efficiency than D12 rabbits (P=0.05). When performance was analysed week by week (data not reported), the higher stocking density stimulated daily weight gain during the first two weeks of trial (51.4 *vs* 52.9 g/d in D12 and D16 rabbits; P=0.05). In the last two weeks, the higher stocking density tended to reduce feed intake (185 *vs* 179 g/d; P=0.06) probably due to the reduced space available for movement, as observed also by MORISSE and MAURICE (1997). In the same period, feed intake was also reduced in wire net floor cages compared to slatted floor cages (179 *vs* 185; P=0.08) probably because the heavier rabbits were less comfortable moving on the wire net than the slat floor. Behaviour video recording however did not show statistical difference between D12 and D16 rabbits in the time spent eating, moving or resting (Table 2).

Table 1. Growth performance from 29 to 71 d of age.

	Density			Cage floor			
	D12	D16	Prob.	Wire net	Slat	Prob.	RSD[1]
Cages, no.	20	20		20	20		
Initial LW, (g)	616	620	n.s.	621	615	n.s.	39
Final LW (g)	2646	2664	n.s.	2664	2647	n.s.	102
Daily weight gain (g/d)	48.3	48.7	n.s.	48.6	48.4	n.s.	2.0
Feed intake (g/d)	149	148	n.s.	147	150	n.s.	6.4
Feed efficiency	0.324	0.329	0.05	0.330	0.323	0.01	0.007

[1]Residual standard deviation

In previous group-housing studies, reducing stocking density from 20-23 to 15-16 rabbits/m^2 significantly improved growth performance and a maximum loading of 38-40 kg/m^2 at slaughter was suggested (AUBRET and DUPERRAY, 1992; MORISSE and MAURICE 1997). In our study however, a reduction from 16 to 12 animals/m^2 did not further improve growth performance and had only weak effects on animal behaviour. During the immobility test, the number of attempts necessary to induce immobility and the duration

of immobility, both of which are considered positively correlated with fear towards humans (VERGA, 2002), were not affected by the experimental treatment (data not reported). In the open field test, which measures reactivity to new environmental conditions, the time spent moving was significantly higher (P=0.04) in rabbits reared at the highest density (Table 2). In contrast, FERRANTE *et al*. (1997) observed a reduction of movements in rabbits reared in pens at a high density (17 *vs* 12 animals/m^2) and associated this with the more stressful conditions that reduced animal interactions with the environment.

Table 2 Main behavioural activities recorded by video and open-field reactivity (average data of two ages).

	Density			Cage floor			
	D12	D16	Prob.	Wire net	Slat	Prob.	RSD
Behavioural recording (%)							
Eating	11.0	10.3	n.s.	10.6	10.7	n.s.	2.9
Self-grooming	18.3	17.3	n.s.	17.8	17.8	n.s.	3.1
Resting	64.5	66.7	n.s.	65.6	65.7	n.s.	4.2
Movements	2.5	1.9	n.s.	2.3	2.1	n.s.	1.7
Open-field test							
Latency (sec)	15.4	14.6	n.s.	16.5	13.4	n.s.	11.1
Movements (sec)	59.0	69.8	0.04	63.2	65.5	n.s.	25.4
Exploration (sec)	401	411	n.s.	422	395	<0.01	48.9
Alert (sec)	5.6	5.6	n.s.	6.5	4.7	n.s.	6.0
Grooming[1] (sec)	4.8	3.5	n.s.	4.0	4.4	n.s.	-
Escape[1] (n)	0.6	0.4	n.s.	0.7	0.3	0.10	-

[1]Non parametric analysis of variance

Behavioural pattern data showed no difference between type of floor, thus indicating a similar degree of rabbit comfort on both types of floor. During the open-field test however, rabbits reared in cages with slatted floor showed lower exploration activity (P<0.01), which may be considered positively as natural adaptive behaviour (MEIJSSER *et al*., 1989). Other authors ascribe a positive value to exploration as an active reaction towards a new environment. In fact, the reasons for the same behaviour may be very different and the interpretation of results may also differ according to various factors (RUSHEN, 2000). The most important data on carcass and meat quality are reported in Table 3. No significant difference between treatments was measured in the traits recorded. Cold dressing percentage averaged 58.8%, a good result despite the relatively young age of rabbits at slaughter. At the commercial evaluation for conformation, colour and fatness, carcasses of group-housed rabbits were judged very valuable and similar to those taken from rabbits kept in bicellular cages usually processed in the slaughterhouse. Previous studies reported better carcass and meat quality in rabbits reared in individual or bicellular cages than that of group-reared rabbits, while few differences ascribed to housing conditions were reported among group-reared rabbits (MAERTENS and VAN OECKL, 2001; DAL BOSCO *et al*., 2002). Bone traits may be used to detect abnormal skeletal development in animals kept under unsuitable housing systems (DRESCHER, 1996). In our study, tibia and femur dimensions and resistance to

fracture were unaffected by stocking density or cage floor, while tibia diameter tended to increase with lower stocking density (P<0.01) in a previous study (XICCATO *et al.*, 1999).

Table 3 Carcass and meat quality at 71 d of age.

	Density			Cage floor			
	D12	D16	Prob.	Wire net	Slat	Prob.	RSD
Rabbits, no.	60	60		60	60		
Cold dressing out (%)	58.7	58.9	n.s.	58.8	58.7	n.s.	1.4
Separable fat (% carcass)	3.3	3.2	n.s.	3.2	3.2	n.s.	0.8
Muscle to bone ratio	7.98	7.89	n.s.	7.96	7.91	n.s.	0.70
Shear press force (kg/cm^2)	1.78	1.82	n.s.	1.75	1.84	n.s.	0.28

CONCLUSIONS

Group housing of rabbits permitted optimum sanitary status and growth results to be obtained regardless of stocking density and type of floor. During the final weeks of trial however, the decreased feed intake observed at the highest density and in wire net cages led to a higher feed efficiency. Housing conditions did not substantially affect animal behaviour, reactivity, or hind leg bone characteristics. Similarly, carcass and meat quality were not compromised by higher stocking density or variation in type of floor. The relatively young age of rabbits at slaughter (71 d) that prevented the aggressiveness among animals and the moderate maximum stocking density (16 animals/m^2) might partially explain the absence of significant effects on the variables recorded. The reduction of stocking density below the current value of 16 animals/m^2 or the use of a slatted floor did not produce any appreciable modification of animal welfare.

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