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The effect of housing system on the behaviour and growth parameters of fattening rabbits

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Abstract

Three housing systems for fattening rabbits were compared using a stocking density of 15 rabbits m^{-2}. The rabbits were housed in large pens (3.67 m^2, 50 rabbits), small pens (0.66 m^2, 10 rabbits) or in conventional standard cages (0.39 m^2, 6 rabbits) from 31 to 72 days of age. Rabbits housed in each small pen or in each cage belonged to the same litter, and the 50 rabbits housed in each large pen were from six or seven litters. At the end of fattening, when rabbits were 72 days old, there was no significant difference in the weight of rabbits from the three different housing systems, even though the rabbits from small pens were slightly heavier in weight compared with rabbits from large pens. The best feed conversion ratio was found in rabbits from cages, but was only significantly different from rabbits housed in small pens. No significant differences were found in the main activities: nutrition, social behaviour, resting, and standing; however, the frequency of runs, hops and consecutive hops was significantly higher in rabbits from large pens compared with rabbits from the two other housing systems. These results confirm that the total surface area available for animals is the most important factor for such locomotory activities. This study did not reveal any significant difference in aggressive behaviours between rabbits from different litters housed in large pens and between rabbits from the same litter housed in small pens or cages.

Keywords: *animal behaviour, animal welfare, fattening rabbits, group size, housing system, pen housing*

Introduction

The housing of animals in intensive breeding units has been increasingly criticised because the animals are housed in a barren and restricted environment in which they cannot perform their species-specific behavioural traits, such as locomotory activities. This is particularly true for species that are housed in wire cages. Since the 1970s, rabbits (*Oryctolagus cuniculus*) are routinely housed in small groups, of 6–9 rabbits, in wire-grid cages.

Improving the welfare of rabbits in intensive breeding systems is a strong demand of society. The Standing Committee of the European Convention for the Protection of Animals kept for Farming Purposes has adopted a recommendation concerning domestic rabbits (Council of Europe): these requirements state that fattening rabbits must be kept in groups, and that the stability of the group should be maintained to minimise aggression and stress. The group must be formed at an early age, and an adequate group size — using related animals or animals that are uniform in size — is recommended. The space allowance for rabbits shall be set by taking into consideration the age, weight and general environmental needs, and in particular the ability to perform natural behaviours, such as getting up, lying down, adopting resting and sleeping postures, hopping and making rapid locomotory movements. Several studies have already been carried out and have shown that some behavioural traits, for example locomotory activities, are performed less in cages, mainly because of a lack of space (Drescher 1992; Rommers & Meijerhof 1998; Morisse *et al* 1999; van der Horst *et al* 1999). Although it is commonly accepted that rearing rabbits in large pens improves their welfare (Martranchar *et al* 2000; Dal Bosco *et al* 2002), animal breeders are still suspicious about the performance and pathology of rabbits housed in groups of more than 50 animals — the same density that is commonly used in breeding units (approximately 18–20 rabbits m^{-2}). Another way to conform to the recommendation and to improve welfare could be the use of an enriched cage without a ceiling (Mirabito 1998), or of a small pen of 10 rabbits or less so that all the rabbits are from the same litter.

The aim of this study was to test the influence of the total space allowed and the size of the group (6, 10 or 50 rabbits) on some welfare and productivity traits of fattening rabbits. The main activities, body lesions and the performance of rabbits were compared in three different housing systems: large pens, small pens and conventional cages. Particular attention was paid to the size of the group. Our hypothesis, referring to the new recommendation, was that rabbits from the same litter reared together from birth to slaughter in a stable and small group of 10 rabbits or less may have better performances and lower agonistic interactions than rabbits from five or six litters reared in a large group of 50 rabbits or more.

Materials and methods

Experimental design

This study involved 378 Hycol rabbits, which were born and bred at the Agence Française de Sécurité Sanitaire des Aliments (AFSSA) experimental farm. The rabbits were 31 days old at weaning, when the study began, and were slaughtered at 72 days old, at the end of fattening. The rabbits were housed in the same building and divided into three housing groups; all animals were grouped together by litter. In the first group, 48 rabbits were housed in eight conventional cages, with 6 rabbits from the same litter per cage. In the second group, 80 rabbits were housed in eight small pens, with one litter of 10 rabbits per pen. In the third group, 250 rabbits were housed in five large pens, with 50 rabbits per pen; therefore five or six litters of 9 or 10 rabbits in each pen. The stocking density was approximately the same in all three groups: 15 rabbits m^{-2}. Stocking densities in this experiment were lower than those used under commercial conditions (18–20 rabbits m^{-2}, 45–50 kg m^{-2}) but higher than the European recommendations on rabbit welfare of approximately 12 rabbits m^{-2} (Council of Europe). In accordance with Morisse and Maurice (1997), a stocking density of 38 kg m^{-2} (approximately 15–16 rabbits m^{-2} at the end of fattening) was considered to be an acceptable compromise between animal welfare and financial concerns for this study.

The conventional cage dimensions were 77 × 50 × 30 cm (length × width × height) with a floor area of 0.385 m^2; small pens were 95 × 70 cm (length × width), with a floor area of 0.66 m^2; and large pens were 1.93 × 1.90 m (length × width), with a floor area of 3.67 m^2. Neither small nor large pens had ceilings and were separated by wire panels 80 cm high. The floors of both cages and pens were made of wire netting with a mesh size of 75 × 12.5 mm (length × width) and a wire diameter of 2.5 mm. Although several studies have accused wire-grid floors of causing footpad injuries (Marcato & Rosmini 1986; Drescher & Schlender-Bobbis 1996; Rommers & Meijerhof 1998), others (Morisse *et al* 1999) have shown that slatted floors were unsatisfactory in terms of hygiene and cleanliness, and that young rabbits did not show a preference for straw litter when offered the choice between straw and a wire-grid floor.

Pens and cages were equipped with manual feeders (one 25 cm long feeder in each cage, one 30 cm long feeder in each small pen, and five 30 cm long feeders in each large pen; that is, 4 cm of feeder per rabbit in cages and 3 cm of feeder per rabbit in pens). Animals were fed a standard diet *ad libitum*. Water was provided by nipple drinkers (one per cage, two per small pen and six per large pen).

Room temperature was controlled by a heating control system and was maintained at 21°C during the first week of fattening and slowly decreased during the fattening period to 14°C during the final week. Lights were on for 16 h per day during the first week and decreased by 2 h per week to a minimum of 8 h per day during the final week. Light intensity was decreased regularly during fattening, from 100 lux in the first week to 20 lux in the last week.

Productivity traits

Animals were individually weighed on the first day of fattening (at 31 days old) and three days before slaughter (at 69 days old). The feed conversion ratio was calculated for each cage and pen. Dressing-out percentages (carcass weight divided by final live weight) were calculated from the data on carcass weight collected at the slaughterhouse.

Lesions and mortality

Rabbits were individually examined when they were weighed (at 31 days and 69 days old), and the frequency and severity of body scratches, lesions or injuries were assessed. Morbidity and mortality were also assessed during the study, and all dead rabbits were subject to a necropsy.

Bone strength

Following slaughter, 15 rabbit carcasses from cages and 15 carcasses from large pens were selected. For technical reasons, the carcasses of rabbits housed in small pens were not available. The right femurs were removed and carefully dissected. Bones were weighed and then broken using a three-point bend tensiometer (400M Test System: MTS Systems, Ivry-sur-Seine, France) to measure breaking strength and elasticity.

Behavioural traits

Behaviour was recorded by direct observations and by video cameras using infrared lighting; the observation unit was the pen. Direct observations consisted of focal and scan sampling (Altman 1974), which were performed during two observation periods: the first in the morning (0800h–1000h) and the second in the afternoon (1600h–1800h). Direct observations were carried out from Monday to Friday each week over the whole fattening period. Scan sampling was used to observe a large number of animals and to record the activities of all rabbits at time 't'. Four scans per treatment were made during each observation period (the total number of scans per day was 24). Activities were classified into five exclusive categories as follows: nutrition (feeding and drinking); social behaviour, including activities related to equipment, such as licking or wire gnawing, and particular behaviours directed towards others (nosing, self body care, stretching, yawning, biting, touching other rabbits, mutual grooming); resting (lying or other resting positions); standing (standing upright); and locomotory activities, involving movement (moving, walking, running, jumping).

Specific attention was paid to certain activities, for example stretching, standing upright on hind legs, performing consecutive hops, and jumping and leaping at high speed. All the rabbits were individually marked and, for each observation period (morning and afternoon), six focal samplings were performed. For each focal sampling, two rabbits from each treatment were observed and all the activities that were performed during 10 min were recorded by two trained operators; the observed animals were rabbits that were already performing an activity when the observer started their observation. All activities and postures, as well as their frequency, were recorded; however, the time spent in each was not recorded.

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Table 1 The effect of housing system on parameters of fattening performance and slaughter measurements; mean values (± SD) for each cage or pen.

Parameters	Housing system		
	Cage	Small pen	Large pen
Number of weaned rabbits	48	80	250
Number of slaughtered rabbits	48	78	241
Weaning weight (g)	745.5 ± 66	722.6 ± 74	718.9 ± 96
Final weight (g)	2417 ± 182	2444 ± 178	2361 ± 180
Weight gain (g day^{-1})	42.8 ± 4.0	44.1 ± 3.6	42.1 ± 3.2
Feed conversion ratio	2.65 ± 0.1	2.86 ± 0.1^{b}	2.80 ± 0.1^{ab}
Chilled carcass weight (g)	1370 ± 72	1380 ± 70	1360 ± 72
Dressing-out (%)	56.7	56.5	57.6

Activities

In addition to direct observations, instantaneous scans were carried out using the video recordings to study the rabbits' activities over 24 h. Four cameras, with infrared lighting, were used throughout the study. Activities were determined by instantaneous scans of 1 min at 15 min intervals; that is 96 video-scans per day. Video recordings were used to study feeding behaviour and the space distribution of the rabbits. Video recordings were not used for more particular activities, for example grooming or running, because these activities were not easy to determine using the instantaneous scan technique on the video recordings. During the first and last week of fattening, the cameras were moved to each cage and pen in order to record all groups at least once. During the intervening weeks, camera positions were fixed: one camera for the eight cages, one for two small pens and one camera in each of two large pens.

Statistical analyses

For all the variables, the statistical unit was the housing unit: eight cages, eight small pens and five large pens. The performance data were calculated as the mean for each housing unit within each of the three housing systems. The feed conversion ratio was calculated on the basis of the feed consumed in each cage and each pen. For behavioural observations (scan sampling), the means for all animals in a pen or in a cage were calculated and treated as a single data point; means are given with the standard deviation. All the residuals were tested for normality using the Kolmogorov-Smirnov test and for equality of their variances within each treatment using the Bartlett test. Because the variances of residuals were not equal for six out of the nine variables, the non-parametric Kruskall-Wallis test was used. If the Kruskall-Wallis test revealed significant differences, a Mann-Whitney U test was performed to compare the pairwise treatments; the level of significance was $P < 0.05$.

Results

Productivity traits

At the end of the study, a total of 368 rabbits were slaughtered; six rabbits died during the study and four rabbits did not reached the minimum fattening weight of 2 kg.

The productivity results are given in Table 1. The final weight and weight gain per day were highest for rabbits reared in small pens; rabbits reared in large pens had the lowest final weight and weight gain per day, but these were not significantly different. The best feed conversion ratio was found in rabbits reared in cages, but the difference was only significant between cages and small pens.

The chilled carcass weight at slaughter was not affected by housing system or group size. The highest dressing-out percentage was for rabbits reared in large pens; however, there was no significant difference between dressing-out percentage and housing system.

Lesions and mortality

The frequency and the severity of scratches and injuries were assessed three days before slaughter. No severe lesions were found; the total number of rabbits with superficial lesions was: 1 out of 48 (2.08%) in cages, 11 out of 80 (13.92%) in small pens and 33 out of 250 (13.45%) in large pens ($P = 0.079$). Most of these injuries were on the head and ears. No aggressive encounters were observed during the scan or focal observations. The general mortality rate was less than 2%, and no effect of group size or housing system was observed.

Bone strength

Bone strength was tested on the femurs of 30 rabbits (15 rabbits from cages and 15 rabbits from large pens). Although not significant, the breaking strength was a little higher in rabbits housed in large pens (cages: 278 ± 12 N; large pens: 307 ± 13 N; $P = 0.204$).

Behavioural traits

Data were collected over the total fattening period. Two-hundred and thirty-six focal samplings (83 in cages, 79 in small pens and 74 in large pens) were performed, and the total number of different rabbits observed at least once during a 10 min period was 42 in cages, 53 in small pens and 62 in large pens. Because of the number of rabbits in each housing unit, and the fact that the observed rabbits were not pre-selected, some rabbits were observed more than once. The maximum number of times that the same rabbit was observed was six in the cages, four in the small pens and three in the large pens.

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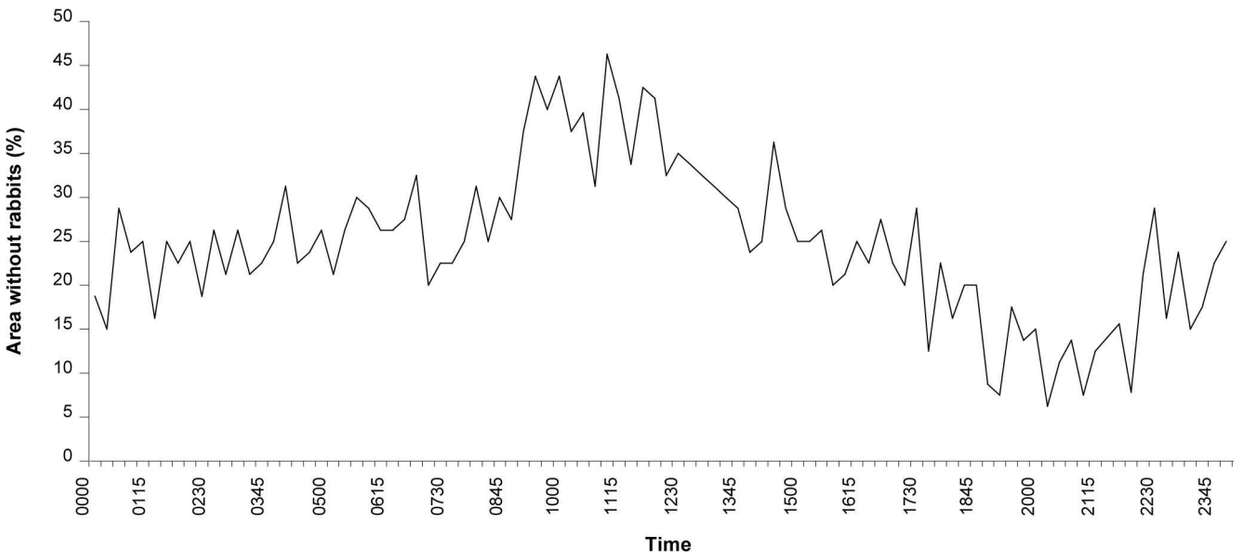
Figure 1



Percentage of the total surface area that was free of rabbits during a 24 h period in the large pens (mean percentages for the second week of fattening).

Table 2 Comparison of the main activities of rabbits housed in cages or in pens. Values are mean percentages (± SD) from scan sampling with one data point per observation unit.

Parameters	Housing systems		
	Cage	Small pen	Large pens
Nutrition	12.3 ± 2.68	10.6 ± 3.11	10.1 ± 0.78
Social behaviour	11.1 ± 4.04	12.0 ± 2.55	13.8 ± 1.08
Locomotory activities	4.2 ± 1.56[a]	2.6 ± 0.86b	5.2 ± 0.57[a]
Standing	14.8 ± 4.67[a]	9.95 ± 2.64[b]	10.6 ± 1.57[ab]
Resting	57.7 ± 1.17[a]	64.8 ± 2.59[b]	60.3 ± 1.20[a]

Space distribution

The occupancy of the total surface area available in large pens was studied using the video recordings and the position and distribution of the animals were recorded. During resting, rabbits were in close contact with one another and grouped together in a small area. The video recordings revealed that up to 50% of the total surface area of the large pens, at a certain time of the day during the second week of fattening, was free of rabbits (Figure 1).

Activities

On the basis of direct observations using scan sampling, rabbit activities were classified into five categories: nutrition, social behaviour, locomotory activities, standing, and resting (Table 2). Observations revealed that the most frequent activity was resting in all three housing systems. There was no significant difference between rabbits housed in cages or in large pens regarding the main activities. However, the number of rabbits resting in small pens was significantly higher than in either cages (57.7% versus 64.8%, $P = 0.01$) or large pens (64.8% versus 60.3%, $P = 0.01$), and the number of animals performing locomotory activities in small pens was significantly lower than in either cages (2.6% versus 4.2%, $P < 0.001$) or large pens (2.6% versus 5.2%, $P < 0.001$).

Analysis of the number of rabbits feeding over a 24 h period showed similar numbers of animals feeding at similar times of the day in all three housing systems (Figure 2).

Focal recordings revealed that the number of jumps and runs was different in the three housing systems. The number of rabbits performing at least one jump or one run over a 10 min period was significantly higher in large pens than in small pens (50% versus 10.13%, $P < 0.001$) and cages (50% versus 15.66%, $P < 0.001$); there was no difference between small pens and cages.

Postures

Observations by scan sampling revealed a significant difference in the number of rabbits standing upright between the three housing systems, with a higher percentage in large pens than in small pens or cages. For the total fattening period, the mean percentage of rabbits standing upright out of the total number of rabbits in the pen or in the cage was 20.0% in large pens, 10.4% in small pens and 4.6% in cages; differences were significant between all housing systems ($P < 0.001$).

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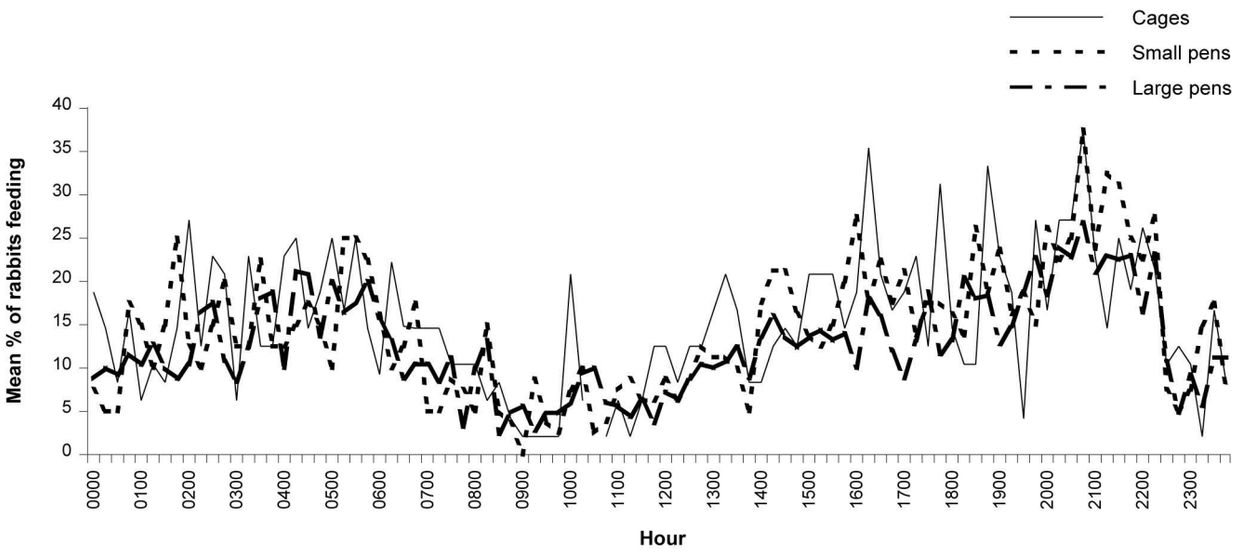
Figure 2



Mean percentage of rabbits feeding over a 24 h period for all three housing systems (data collected during the whole period of fattening).

Discussion

Regarding the performance of the rabbits, only the feed conversion ratio was significantly different between the cages and the small pens: rabbits from cages had a better feed conversion ratio than rabbits from small pens. As with Maertens and van Herck (2000), and Maertens and van Oeckel (2001), this study observed that rabbits reared in large pens had a lower weight at the end of fattening, but the difference was not significant. This study did not find any major influence of group size or of total surface area availability on the performance of fattening rabbits. Compared with rabbits housed in large groups (of 50 animals) in large pens, rabbits from the same litter reared in smaller groups (of 10 animals) in small pens did not have a significantly better growth rate, and actually had the poorer feed conversion ratio. There is no clear explanation for these results, particularly with regard to the similar feed conversion ratio observed in the small and large pens. Contrary to what was expected, the rearing of rabbits from the same litter in one small pen did not produce better results than the rearing of five or six litters in one large pen. This may be attributable to the rabbits experiencing fewer disturbances when resting (in relation to their spatial distribution) and the additional space allowing their spatial and social requirements to be met more completely by a greater total area available with the same density of animals. Furthermore, it is possible that a rabbit's choice to only perform a minimum level of activity could have a beneficial effect on its husbandry, compared with a rabbit housed in too small an area in which it cannot move sufficiently and is not in an optimal physiological environment. It appears, that under good husbandry conditions (eg clean cages or pens, the correct temperature, good ventilation), rearing rabbits in a large group is possible without any significant economic impacts.

Contrary to the results found in previous studies (Roiron *et al* 1992; van der Horst *et al* 1999; Dal Bosco *et al* 2000; Milisits *et al* 2000; Dal Bosco *et al* 2002), this study did not reveal any influence of group size on the dressing-out percentage, and heavier rabbits did not have a higher dressing-out percentage. Although Metzger *et al* (2003) state that the difference between body weights could be caused mainly by different locomotory activities, we do not think that locomotory activities significantly decreased the dressing-out percentage in this study. Furthermore, van der Horst *et al* (1999), Dal Bosco *et al* (2002) and Metzger *et al* (2003) report that locomotory activities may have a beneficial effect on some carcass traits, such as perineal fat or weight of the hind part (the saddle and hind legs).

The mortality rate was low even though no dietary or drinking water treatments were given. Mortality only occurred in the small and large pens and was due to respiratory diseases. Because of the low mortality rate and the limited number of animals in cages, no group size effect was found on penned animals, but an increased infection pressure attributable to the large group size cannot be excluded (Maertens & van Herck 2000).

According to Lambertini *et al* (2001) a group housing system on litter raises some important questions regarding pathology (mainly with regard to coccidiosis) and growth parameters. This study was carried out using cages and pens with wire-grid floors and the results were satisfying in terms of the pathology and growth parameters; therefore, the findings of this study do not support those of Lambertini *et al* (2001). Furthermore, if group size is important, then the quality of the litter, and perhaps the type of floor itself, are also important factors that must be taken into account, particularly regarding pathology.

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The effect of group size on the occurrence of aggressive behaviour in rabbits up to 72 days old was also investigated. As reported by Lehmann (1987), and by Mykytowyc and Dudzinski (1972), aggressiveness is largely related to sexual behaviour, which generally does not occur before 11–12 weeks of age. In this study, very little aggressive behaviour was observed and no differences were found between rabbits reared in large or small groups. Furthermore, we think that the occurrence of aggression is largely related to breeding conditions and the housing atmosphere. If the rabbits are in quite good health and maintained under good conditions (low level of gazes, good ventilation, no drafts, good temperature) the occurrence of aggression will be low. This appears to be as important as the group size or composition.

The results of this study also confirm that rabbits spend most of their time at rest, as shown in previous studies (Morisse & Maurice 1997; Morisse *et al* 1999; Martranchar *et al* 2000). The various activities related to nutrition or social behaviours were not significantly different between the three housing systems. In particular, as shown by the number of rabbits feeding, it appears that the main activities of rabbits, and the frequency of their activities, are not significantly affected by group size or by the total size of the area available.

When studied as a whole, locomotory activities did not appear to be significantly affected by the size of the cage or pen: rabbits that performed less locomotory activities were housed in small pens, but there was no significant difference between rabbits reared in cages or large pens. Nevertheless, observations using focal sampling revealed that the frequency of runs, hops and successive hops was higher in large pens than in cages or small pens. These results confirmed that even though the total amount of time spent performing locomotory activities was not significantly different in large pens, the total surface area available in large pens was very important in allowing rabbits to perform some punctual activities (activities performed during a very short time, eg a jump or a run) that could not be performed in a small pen even with no ceiling. This study also revealed that a small pen, adapted for 10 rabbits at a common stocking density, did not provide sufficient available space to perform activities like running and jumping. It was obvious that rabbits that had sufficient space performed activities that were impossible for rabbits to perform in a more restricted area. Even if these activities remain punctual and are performed only for a short time, they are a natural and essential behaviour for rabbits. This study also shows that group size or total space availability has a very low affect on the main activities, such as nutrition or resting.

The importance of the total surface area available was also shown by the postures adopted by the rabbits. Even in the absence of ceiling, the upright posture was observed more frequently in large pens than in small pens. Another result of this study was the occupancy of the total surface area. Rabbits are gregarious and highly social, and the rabbits housed in the large pens tended to lie down close to one another; consequently, resting rabbits may then feel more secure and less disturbed by other rabbits performing locomotory activities.

Conclusion

On one hand, the results of this study revealed that rearing fattening rabbits at a density of 15 rabbits m^{-2} in large pens (approximately 4 m^2) and in large groups (50 animals) appeared possible and led to satisfactory fattening performances (2.36 kg at 72 days). On the other hand, rearing rabbits together from the same litter in a small pen, at the same density of 15 animals m^{-2}, did not appear to provide the optimal group size regarding welfare, aggressiveness or zootechnical performances. The total surface area available appeared to be the most important parameter for improving locomotory activity. No environmental enrichment was tested in this study and further investigations would be necessary to determine the most appropriate enrichment materials, but it is most likely that large pens, with a large total surface area of floor space would be most appropriate for providing various enrichment elements, for example platforms or hiding places.

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