

SPACE USE AND EXPLORATORY BEHAVIOUR IN GROWING RABBIT HOUSED IN LARGE PARTITIONED PENS

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ABSTRACT

Housing rabbits in large groups is believed to improve their welfare. We designed large partitioned pens by connecting 4 individual enriched cages (elevated platform, burrow and gnawing wood) through a hatch located at the platform level. The aim of this work was to study the space use, exploring behaviour and mixing of rabbits from different litters in such large partitioned housing system. A total of 222 growing rabbits, from 28 litters of 8 rabbits, were used from 35 (weaning; D35) to 63 days of age. Litters were housed separately with their does in individual cages until weaning. At D35, does were removed and each four adjacent cages were connected together opening the hatches between them. The use of space allowance, burrow and platform as well as mixing of litters within a pen were measured through direct observations made several times a week and a video recording (40 min at D62). The proportion of rabbits staying within their birth cage decreased with time (56% vs 30% in week 1 vs week 5; $P < 0.001$). At D62, 56% of rabbits were in contact in groups of two or more congeners, of which 26% within groups containing 4 or more rabbits. The proportion of rabbits in the burrow increased from 2% (week 1) to 12% (week 5; $P < 0.001$) and at D62 a rabbit entered or left the burrow on average every 15 min. The proportion of rabbits on the platform was stable along the experiment (19%) and at D62, a rabbit reach or left the platform on average every 11 min. These results illustrated the gregarious and exploratory behaviour of growing rabbits. Such a housing system offered perspectives to design new housing that would improve the welfare of growing rabbits while remaining compatible with all-in all-out rabbit farming system.

Key words: *Oryctolagus cuniculus*, littermate, large pens, space use, behaviour.

INTRODUCTION

In current all-in all-out rabbit farming system, reproductive does are housed individually in wire cage with their litter until weaning. After weaning, does are removed and the growing rabbits are kept with their littermates in their "birth" cage until slaughter. Such system is considered to be unfavourable to the rabbit welfare due to small area and no enrichment of living area (Buijs *et al.*, 2011). The rabbit is indeed a gregarious animal living in colonies. It has a diverse behavioural repertoire including jumping, running, gnawing and positive social behaviours such as allogrooming or resting side by side (Coureaud *et al.*, 2015). Housing rabbits in large groups is believed to improve their welfare. Mirabito *et al.* (1999) and Postollec *et al.* (2008) observed that growing rabbits reared in large groups spent less time resting and the frequency of locomotion, exploration and social behaviour were higher than in small groups.

Investigating the distribution of young rabbits housed in combination of four individual units, Matics *et al.* (2004) demonstrated that young rabbits (at 3 weeks of age) huddle together in one of the housing unit regardless of the housing size to achieve a homogeneous distribution after 5-7 weeks of age. However, the authors didn't report how rabbits from different litters mixed together along the time. Social attachment between littermates may exist in mammals (Marr and Lilliston, 1969), it is therefore interesting to know if litters reared separately before weaning quickly mix together and explore enlarged housing area, in space originally occupied by other litters.

We designed large partitioned pens by connecting 4 individual cages by hatches located at the platform level (Huang *et al.*, 2020). We investigated the space use, exploring behaviour and the dynamic of social interactions between litters in such large pens enriched with elevated platform, burrow and wood stick during fattening.

MATERIALS AND METHODS

The experiment received a French agreement (experiment permit number 16330-2018072716211212).

Animal and experimental design

The experiment started at weaning (35 days of age; D35). Before the experiment, 28 litters were housed separately with their mother in individual cage from birth until weaning. Individual cage (102 × 47 × 60 cm, w × l × h) were in wire mesh and contained an elevated platform (38 × 45 cm on the side + 21.5 × 62 cm on the bottom of the cage, w × l) both made with plastic-mesh fixed at 30 cm from the ground. They contained each a 20 cm long pine wood stick to gnaw. The ground was composed by 30% of plastic-mesh and 70% of wire-mesh. The box (28 × 45 × 32 cm, w × l × h) containing the nest before weaning was kept during whole experiment (without the nest) to form a burrow. The day of weaning, the does were took off the housing, the litters were reduced at 8 rabbits and four cages (9 097 cm² of total surface) were connected together opening three connecting hatches between adjacent cages to form large pens (36 388 cm² of total surface; **Figure 1**). A total of 222 growing rabbits (7 pens × 4 litters of 8 rabbits but 2 missing data) were followed until 63 days of age. Rabbits were fed a commercial pelleted feed according to a restriction program (90 to 150 g/d/rabbit from D35 to D63) and had access to fresh water through nipple drinkers.

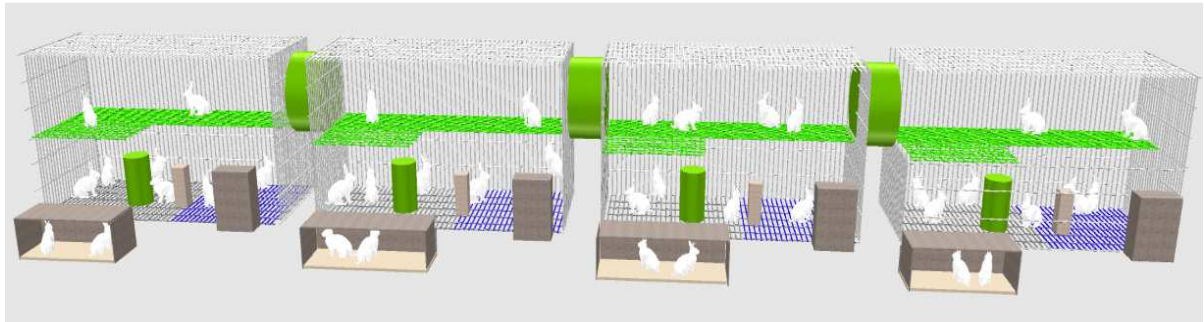


Figure 1. The connection of four individual cages to form a pen.

Measurements

All animals were weighted at D35 and D63. In each pens, rabbits from the 4 different litters were identified with earrings of 4 different colours. This marking highlighted the moving of rabbits from their initial individual housing (also identified with the same colour than rabbits) into the total space of the pen. The spatial position (on ground, on elevated platform, in burrow) of the rabbits was evaluated by direct observation twice a day (around 10 a.m. and 3 p.m.) and two days a week during 5 weeks. For each direct observation, the number of rabbits of each original litter was recorded for each individual cage composing the pen. We calculated the proportion of rabbits staying in their birth cage. The activity rate (% of active and inactive rabbits, dynamic use of the platform and the burrow) as well as the gregarious behaviour (number of rabbits huddled together in a part of the housing and the litter of origin of the rabbits in these groups) were measured through video recording (40 min for each cage) at D62.

Statistical analyses

All analyses were performed by using statistical software R version 3.4.0. Effect of position of cage (lateral or central) in the pen, week (1 to 5) or time of observation (morning or afternoon) on

distribution of rabbit were analysed by linear mixed effects model including litter as a random effect. Other data were the subject of descriptive statistics.

RESULTS AND DISCUSSION

The live weight averaged 974 g at D35 and 2195 g at D63. No obvious fighting was observed during the experimental period and the mortality rate averaged 5.9%. The position of cage within the pen (lateral or central position) influenced the number of rabbits in each cage, more rabbits were observed in the two lateral cages compared to the two central cages in the pen (8.2 vs. 7.4, $P < 0.05$). The number of exit (1 hatches vs 2 hatches in lateral vs central cages) might explain such a result.

The proportion of rabbits stayed in their birth cage averaged 39.9% over the experiment, it was not influenced by the position of the cage in the pen (NS) and the time of observation (NS). The effect of week of observation was significant ($P < 0.001$, Table 1), the proportion of rabbits stayed in their birth cage decreased from 56% (week 1) to 30% (week 5), indicating the progressive exploration of the space. This is in line with Matics *et al.* (2004) who observed that the distribution of rabbits in different housing units became homogeneous after the age of 5.5-7.5 weeks even though they did not precise if rabbits of different litters were reared separately before experiment. Overall the experiment, the number of different litters together in each cage averaged 3.2 but this proportion evolved during the experiment ($P < 0.001$), increasing from 2.7 original litters (week 1) to 3.4 original litters (week 5). Such a result confirmed the increase of social interaction between litters with time. The position of cage (NS) and time of observation (NS) did not affect the social interaction of rabbits from original litters in each cage.

The proportion of rabbits in the burrow was influenced by the week of observation, it increased from 2.0% (Week 1) to 12.1% (Week 5). This result could be explained by the decrease of space allowance relative to the growth of rabbits. Video recording at D62 showed that the use of burrow was dynamic since a rabbit entered or left the burrow on average every 15 min. The proportion of rabbits on the platform was stable along the experiment (18.5%; NS; **Table 1**). Indeed, high proportion of rabbits occupied the platform from the beginning of the experiment. Compared to our previous study ($< 3\%$, Huang *et al.*, 2020), the average proportion of rabbits on the upper floor was greatly higher (18.5%) in the present study. Improved design of platform may explain this difference: the platform area was increased and it was positioned on the side and not in the middle of the housing, although, the proportion of rabbits on the platform tended to be higher in central than lateral cages (20.0% vs. 16.9%, $P = 0.099$). The use of the platform was intense since a rabbit reached or left the platform on average every 11 min.

Table 1. Effect of week of observation on mixing between litters and spatial position of rabbits.

	Week 1	Week 2	Week 3	Week 4	Week 5	SEM	P- value
Rabbits in their birth cage (%)	55.5% ^a	45.6% ^b	35.1% ^c	33.9% ^c	30.3% ^c	1.6%	< 0.001
No. of litters per cage	2.7 ^a	3.1 ^b	3.5 ^c	3.4 ^{bc}	3.4 ^{bc}	0.1	< 0.001
Rabbits in burrow (%)	2.0% ^a	2.4% ^a	7.7% ^b	10.8% ^{bc}	12.1% ^c	0.4%	< 0.001
Rabbits on the platform (%)	19.5%	18.0%	19.8%	18.0%	17.1%	1.3%	NS

Activity and exploratory behaviour

At D63, video recording showed that 25% of rabbits were active (feeding, eating, moving, jumping, grooming) and 75% were resting but on average, at least a rabbit went from one cage to another within the large pen through the hatch every 3 minutes. Rabbits were mainly grouped (in contact): 44% of rabbits were observed alone, 18% were grouped by two, 12% by three, 7% by four, 7% by five and 12% in group larger than 5 rabbits. Direct observations showed that, on average, groups of 4 or more rabbits consisted of rabbits from 3 different litters. This pattern was stable during the experimentation (week 1 to 5). Additionally, among the different litters, a great variability of the proportion of rabbits staying in their birth cage has been observed (range from 22% to 65%). In order to characterize the difference between litters regarding to their exploration activity, the 28 litters of the experiment were ranged according to the mean proportion of rabbits staying in their original cage during the 1st week of

experiment, and then artificially divided into 3 classes of similar size (**Table 2**): Explorer (9 litters), Intermediate (10 litters) and Sedentary (9 litters). The proportion of rabbits staying in their birth cage remained different until the 4th week and became similar during the 5th week. Thus all litters end up mixing with each other but some left their birth cage earlier than others. Live weight was similar among the 3 classes. Further studies are required to better understand the behaviour of growing rabbits in such partitioned housing system.

Table 2. Characterization of litters according to their exploratory activity during the first week.

	Explorer (n=9)	Intermediate (n=10)	Sedentary (n=10)	P-value
Rabbits in the birth cage (%)				
Week 1*	29.5 ^a	56.9 ^b	79.2 ^c	<0.001
Week 2	36.8 ^a	42.4 ^a	57.3 ^b	<0.001
Week 3	29.8 ^a	30.2 ^a	45.1 ^b	<0.001
Week 4	26.3 ^a	30.7 ^a	44.4 ^b	<0.001
Week 5	27.8	30.4	31.9	0.621
Whole period	30.0^a	38.1^b	51.6^c	<0.001
Live weight at weaning (g)	940	975	1005	0.680
Live weight at 63 days (g)	2180	2165	2240	0.654

*The % of rabbits in their birth cage during the 1st week of experiment (D35-D42) was used to artificially create the 3 groups of same litter size (n=9 or 10 litters each): Explorer, Intermediate, Sedentary.

CONCLUSIONS

This study illustrates the gregarious behaviour of growing rabbits showing how weaned rabbits from different litters left their birth cage to explore a larger space allowance and gradually mixed between them. It demonstrates that, just after weaning, growing rabbits huddle together with their littermates. It suggested a variability in exploratory character between litters, some litters being more exploratory as they explore the whole space allowance earlier than others which are more sedentary. The burrow and the platform were frequently used allowing a diversification of the behaviour repertory of the animals (hiding, jumping). Such a housing system offers interesting perspectives to design new housing more favourable to the welfare of growing rabbits while remaining compatible with all-in all-out rabbit farming system.

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