EFFECT OF HOUSING AND ENRICHMENT ON BEHAVIOUR AND PERFORMANCE OF GROWING AND REPRODUCING RABBITS

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ABSTRACT

One way to improve rabbit welfare is to enable rabbits to express their natural behaviours. The aim of this study was to investigate the effect of housing and enrichments on behaviour, performance and mortality of growing rabbits (trial 1, n = 294), does and their kits (trial 2, n = 40 females over 2 cycles). The modifications concerned size of housing (length to allow jumping, height to allow standing up), enrichment (gnawing or scratching materials, platform for jumping, burrow for hiding), floor type (wire or plastic mesh) and/or group size. These modifications were implemented separately each other or together. The productive performance of growing rabbits and reproductive does was not influenced by the housing system. In trial 1, behaviours such as standing up, gnawing, jumping and walking were rarely observed (< 5%), but the burrow was frequently occupied (35%). In trial 2, inclusion of gnawing blocks increased gnawing activity. The platform permitted standing and jumping of does, but the proportion of time spent for this activity remained low (0.1%). On the floor, does were more often on plastic-mesh than on wire-mesh (62 *vs*. 38 % of observations; $P < 0.001$). The frequency of does on plastic-mesh decreased from 68% the week of parturition to 60% at weaning ($P < 0.05$), related to increased area occupation by suckling kits ($P < 0.001$). We confirmed that the enrichments tested allow rabbits to express or increase the frequency of natural behaviour.

Key words: *Oryctolagus cuniculus*, housing size, platform, floor type, behaviour

INTRODUCTION

Under conventional housing system, rabbit cannot express some of their species-specific behaviours, such as running, jumping, rising up, gnawing, scratching etc. Moreover, poor environment could even give rise to abnormal behaviours or stereotypies such as wire mesh biting or chewing, aggression or apathy (Verga et al., 2007). Wire-mesh floor could also cause pododermatitis or discomfort in reproducing does (Rosell and de la Fuente 2009). It is therefore necessary to propose innovations enabling rabbits to promote the expression of their natural behaviours, while preserving the health and performance of animals. The objective of this study was to investigate the effect of housing modification and/or enrichment on behaviour of growing rabbits (trial 1) as well as does and their kits until weaning (trial 2). The frequency of animals on plastic-mesh or wire-mesh floor was also analysed. The innovative housing systems were designed as part of a participatory approach bringing together actors from the rabbit industry (famers and production supply chain), consumers and associations for defence of animal welfare (Living Lab Lapins, 3L, consortium) to ensure that the proposed innovations remain compatible with the profitability and acceptable working conditions of the farmers.

MATERIALS AND METHODS

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

Animal and experimental design

Trial 1 (growing rabbits). After weaning (35 d), 294 growing rabbits were divided in 6 groups corresponding to 6 housing systems: **1) Control** (8 dual purpose cages with 6 rabbits each), without particular enrichment, similar to that used in "standard" French farms (3420 cm², 38 × 90 × 30 cm, w

× l × h); **2) Pen** (6 pens of 6 rabbits each), enlarged surface (13 680 cm² with 30 cm h); **3) Burrow** (7 replicates with 6 rabbits each), with same dimension of the pen with a bottomless box (21 × 50 × 21 cm) with an opening on the side (15 cm diameter) laid on wire mesh floor; **4) Platform** (7 replicates with 6 rabbits each), with same ground surface than the pen but with a platform composed of 50% plastic-mesh and 50% wire-mesh, installed 30 cm above the floor in the middle of the housing (21 cm width and 3,360 cm²); 5) **Combination LD** (6 replicates of 6 rabbits each, Low Density, 4.4 animals/m^2, with same ground surface of the pen including platform, burrow and gnawing block (compacted forage with 80% alfalfa); INZO, Château Thierry , France)**; 6) Combination HD** same living environment as Combination LD but higher number of rabbit (4 replicates of 32 rabbits each; High Density, 23.4 animals/m^2). In each housing system, the floor was composed by 30% of plastic-mesh and 70% of wire-mesh. Growing rabbits were fed a commercial pelleted feed and had *ad libitum* access to fresh water through nipple drinkers. Rabbits were weighted at weaning (31 d) and at 70 d of age. The health status and mortality were also recorded daily.

Trial 2 (rabbit does). The experiment was performed for two reproductive cycles, which started at parturition (0 d) and ended at weaning of kits (35 d). For each cycle, 40 multiparous rabbit does were housed individually (with litter) and allocated to 5 groups differing on housing enrichment (n = 16 does per group since females changed group between cycles): 1) **Control** without any enrichment; 2) **Scratching**, the Control with a PVC frame (15 × 25 cm) containing a black scratch card (which leaves a trace of color in case of scratching) fixed inside the housing; 3) **Platform**, including a platform made with plastic-mesh (25 × 45 cm w × l; 1125 cm²) fixed at 30 cm above the floor; 4) **Gnawing**, including a compacted forage block (80% alfalfa), a 20 cm long hardwood stick and a 20 cm long softwood stick; 5) **Combination**, including enrichment of both Scratching, Gnawing and Platform groups. In all groups, housing measured 102 x 47 x 30 cm (w × l × h) and the floor consisted of half of wire-mesh and half of plastic-mesh. The does were fed *ad libitum* a commercial pelleted feed adapted to reproducing females and access to fresh water. They were weighed at insemination (-31 d) at parturition (0 d) and weaning of litters (35 d). Individual feed intake was monitored (females and litter where appropriate). The litter size was evaluated at birth and at weaning (35 d). Mortality was recorded daily.

Behavioural evaluation

In trial 1, the rabbits were identified using color marking for behavioural evaluation (only 6 out of 32 in Combination HD). Behaviour was evaluated by 2 min of direct observation twice a week, both in the morning and in the afternoon of same day, during 6 weeks. The location of rabbits in the different areas of housing (wire, plastic-mesh floor or platform) was evaluated 3 times per week during 6 weeks. **In trial 2,** behaviour (6 obs. during 2 min) and position of does and their kits (from 14 days of age) in the housing system were evaluated by direct observation 4 times per week during each reproductive cycle. The location of doe in the housing system and the number of kits in each area (wire-mesh, plastic-mesh, platform, and nest) was also evaluated. The forage blocks were weighted to evaluate their use. The use of wood and scratch cards were evaluated using a 3-point scale (0: not used; 1: less than 1/3 used; 2: 1/3 to 2/3 used; 3 more than 2/3 used). In both experiments, the behaviours recorded were: resting, eating, sitting, standing, gnawing, jumping and walking (Gunn and Morton, 1995).

Statistical analyses

All analyses were performed by using statistical software R version 3.4.0 (R Core Team, 2017). Quantitative data were analysed using a linear model and qualitative data (mortality, frequency on each floor type, behaviour) were analysed using logistic regression. Data were not transformed and models included housing system, week of observation and their interactions as fixed effect (trial 1), as well as parity, reproductive cycle and animal as random effect (trial 2).

RESULTS AND DISCUSSION

Trial 1 (growing rabbits). The housing system did not influence performance of growing rabbits: body weight (2320 g at 70 d; NS); morbidity rate (6%; NS); mortality (7%; NS) in agreement with Farkas et al. (2016) and Matics et al. (2018) who reported no effect of housing enrichment on growth performance of growing rabbits. No injuries were observed. Maertens et al. (2004) reported higher

weight gain in enriched pens with lower stocking density compared to barren pens during the first 2 weeks after weaning. On the contrary, Trocino et al. (2019) observed decreased growth (-2. 2g/d) of rabbits in pens enriched with a hiding tube and more injured rabbits (+8.9%) in pens with platforms.
Whatever the housing system, rabbits were resting for most of the observations (76% of the total observation time), followed by eating (15%) and sitting (5%). Behaviours such as standing (<1%) gnawing (<1%) jumping and walking (<2%) were rarely observed. Also, rabbits were rarely observed on the platform (<3%) in current study. Since growing rabbits might spend more time on the platform during night than during daytime (Lang and Hoy, 2011), the use of platform by rabbits might be underestimated during our observation which took place during daytime. Its position, in the middle of the housing system, could also have been detrimental for its use. The burrow was used by rabbits both inside (7%) or above (8%). Occupation was higher ($P < 0.001$) in the Burrow system (13% inside and 11% above), than in the Combination LD (4% inside and 6% above) or HD (4% inside and 8% above). Other enrichments in the Combination groups might have attracted attention of rabbits or the space available was sufficient to avoid the need to hide. Contrary to results of Princz et al. (2008), in the present study frequency of rabbits was similar on plastic-mesh or wire-mesh floor.

Trial 2 (rabbit does). In line with Rommers et al. (2014), production performance of does were not influenced by the housing system (NS): body weight averaged 4943 g and 4931 g at the beginning and the end of experiment; the litter size was 9.1 alive at birth and 8.2 at weaning; the feed intake averaged 487 g/d.

Table 1: Effect of housing system on behaviour of females (trial 2).

	Control (n=288)	Scratching (n=298)	Platform (n=300)	Gnawing (n=286)	Combination (n=320)	SEM	*P*-value
Resting	69.70%	72.60%	71.30%	73.60%	73.60%	0.86%	0.212
Grooming	14.20%	11.70%	16.10%	10.90%	10.50%	0.57%	0.039
Feeding	11.40%	10.10%	8.00%	8.30%	8.90%	0.50%	0.242
Walking	2.00%	1.80%	1.60%	1.00%	1.40%	0.16%	0.288
Gnawing	1.50%	2.30%	1.30%	4.50%	4.70%	0.28%	<0.001
Interacting	0.90%	1.30%	1.80%	1.70%	0.90%	0.17%	0.47

Resting include Lying, sitting and standing; Feeding include eating and drinking; Scratching was rarely observed, statistical analysis was not performed

The does were mostly lying during observations (60% of total observation time), followed by grooming (13%), sitting (12%), eating (7%), gnawing (3%), drinking (3%) and interacting with their kits (1%). The behaviours such as standing (12 of the total records, average 0.1% of observation time), jumping (7 records) and scratching (5 records) were rarely observed whatever the group (NS). Gnawing of hard wood was not observed at all, which confirmed the preference of rabbits for soft than hard wood as observed by Princz et al. (2007). As expected, gnawing behaviour was more frequent in Gnawing and Combination housing systems than in other groups (4.5% and 4.7% *vs* <3%; $P < 0.05$) as confirmed by the consumption of compacted forage blocks (23 ± 14 g and 29 ± 15 g in Gnawing and Combination groups, NS). The gnawing behaviour was rarely observed (only 0.2% of total observations for does in the Combination housing systems). However, evaluation of soft wood sticks at the end of the experiment showed that they were fairly used by does from Gnawing and Combination groups (average score: 1.7 ± 1.0 *vs*. 1.5 ± 1.0, $P = 0.54$). The decrease of stereotypes by the inclusion of gnawing sticks has been previously reported (Princz et al., 2007). .

The platform provides more opportunities for movement and exercise. It also offers does the possibility of escaping from their kits once they leave the nest box (Mirabito et al., 1999; Mikó et al., 2014). In our study, standing and jumping were observed in Platform (0.3% of observation time) and Combination housing systems (0.3% of time), but at a low rate. Does were observed more often on the floor (98% of 1352 records) and rarely on the platform (1.6%) or in nest box (0.6%). According to Mirabito et al. (1999) and Mikó et al. (2014), does spend more time on the platform when kits begin to leave the nest box but, when kits start to jump up onto the platform, does spend more time on the floor. Scratching was scarcely recorded at the direct observation (<0.1% of observation time). However, the scratching cards were regularly (changes along experiment) and finally highly used (average score 2.5 ± 0.9 *vs*. 1.9 ± 1.2 in Scratching and Combination housing systems, *NS*). This means that some behaviours take a very short time and are difficult to be observed with direct diurnal observations ..

The use of a plastic foot-rest on the wire net floor is recommended to provide a comfortable resting area and to avoid footpad injuries (Rosell and de la Fuente, 2009). In our study, when does were on the floor (data on platform excluded), 62% were on plastic-mesh (P <0.001). This preference for plastic-mesh was influenced by experimental group (P < 0.001) being the most used in Control group (71%) and the least used in Scratching (58%) and Gnawing groups (55%). Frequency of does on plastic-mesh also decreased over observation weeks (P < 0.05), from 68% (week 1) to 60% (week 5). This could be explained by increased area occupation of growing kits that limited the choice of does. In fact, when does were observed on wire-mesh, 67% of kit were on plastic-mesh; when does were observed on plastic-mesh only 62% of kits were on plastic-mesh (P < 0.05). Kits were mainly observed on the floor (471 of 493 records) and, when on floor, more often on plastic-mesh (65%, P < 0.001).

CONCLUSIONS

Housing modification and enrichment did not affect performance of both growing rabbits and reproductive does. The enrichment allowed the expression of several natural behaviours of rabbit (gnawing, scratching or hiding) but these behaviours were sometimes difficult to measure using direct diurnal observation (gnawing and scratching) for a low amount of time. Enrichment use could be affected by their spatial structure (platform position) or interaction between the different enrichments or animal density (use of burrow in low and high density combination system). Further studies would be necessary to compare different position and size of enrichments such as platforms and burrows.

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REFERENCES

Farkas T.P., Dal Bosco A., Szendro Zs., Filiou E., Matics Zs., Odermatt M., Radnai I., Paci G., Gerencser Z. 2016. Production of growing rabbits in large pens with and without multilevel platforms. *In Proc. 11th World Rabbit Congress, 2016 June, Qingdao, China, 663–666.*

Gunn D., Morton D.B. 1995. Inventory of the behaviour of New Zealand White rabbits in laboratory cages. *Applied Anim. Behav. Sci., 45, 277-292.*

Lang C., Hoy S. 2011. Investigations on the use of an elevated platform in group cages by growing rabbits. *World Rabbit Science, 19, 95-101.*

Maertens L., Tuyttens F., Van Poucke E. 2004. Group housing of broiler rabbits: performances in enriched *vs* barren pens. *In Proc. 8th World Rabbit Congress, 2004 September, Puebla, Mexico, 7-10.*

Matics Zs., Farkas T.P., Dal Bosco A., Szendrő Zs., Filiou E., Nagy I., Odermatt M., Paci G., Gerencsér Z. 2018. Comparison of pens without and with multilevel platforms for growing rabbits. *Ital. J. Anim. Sci., 17, 469-476.*

Mikó A., Matics Zs., Gerencsér Z., Odermatt M., Radnai I., Nagy I., Szendrő K., Szendrő Zs. 2014. Performance and welfare of rabbit does in various caging systems. *Anim., 8, 1146-1152.*

Mirabito L., Buthon L., Cialdi G., Galliot P., Souchet C. 1999. Effet du logement des lapines en cages rehaussées avec plate-forme: Premiers resultats. *In Proc. 8èmes Journées de la Recherche Cunicole, 1999 November, Paris, France, 67-70.*

Princz Zs., Dalle Zotte A., Radnai I., Bíró-Németh E., Matics Zs., Gerencsér Z., Nagy I., Szendrő Zs. 2008. Behaviour of growing rabbits under various housing conditions. *Applied Anim. Behav. Sci., 111, 342-356.*

Princz Zs., Orova Z., Nagy,I., Jordan D., Štuhec I., Luzi F., Verga M., Szendrő Zs. 2007. Application of gnawing sticks in rabbit housing. *World Rabbit Sci., 15, 29-36.*

Rommers J.M., Bracke M., Reuvekamp B., Gunnink H., de Jong I.C. 2014. Cage-enrichment: rabbit does prefer straw or a compressed wooden block. *World Rabbit Sci., 22, 301-309.*

Rosell J.M., De la Fuente L.F. 2009. Effect of footrests on the incidence of ulcerative pododermatitis in domestic rabbit does. *Anim. Welfare, 18, 199-204.*

Trocino A., Zomeño C., Filiou E., Birolo M., White P. Xiccato G. 2019. The Use of Environmental Enrichments Affects Performance and Behavior of Growing Rabbits Housed in Collective Pens. *Animals, 9, 537.*

Verga M., Luzi F., Carenzi C. 2007. Effects of husbandry and management systems on physiology and behaviour of farmed and laboratory rabbits. *Hormon. Behav., 52, 122-129.*