World Rabbit Science

World Rabbit Sci. 2014, 22: 59-69
doi:10.4995/wrs.2014.1396

EFFECT OF CAGE TYPE ON THE BEHAVIOUR PATTERN OF RABBIT DOES AT DIFFERENT PHYSIOLOGICAL STAGES

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Abstract: Interest in commercially farmed rabbit welfare has increased in recent years. As a result, new alternative housing systems have been developed, although they require evaluation in order to demonstrate their potential for improving welfare. The aim of this trial was to study the behavioural traits of rabbit does housed in 2 different types of cage (TC): conventional *vs.* alternative with an elevated platform, at different physiological stages (PS); lactation and gestation. Behavioural observations were carried out on 12 rabbit commercial does using continuous 24 h video recording. Independently of PS and TC, rabbit does spent most of their time on foot mats (on av. 57.7%). However, due to the use of platforms (on av. 23.0% of time), lactating does spent 36.6% less time on foot mats ($P<0.001$) and gestating does spent 27.0% less time on wire mesh ($P<0.001$) in alternative cages than in conventional cages. Alternative cages allowed for standing posture, but this behaviour was only observed in gestating does (on av. 4.6 times a day). Frequency of drinking was higher in conventional than in alternative cages (24.6 *vs.* 19.1 times a day; $P<0.05$). Gestating does housed in conventional cages reached the highest duration and frequency of interacting with neighbours (276 s/d and 4.6 times/d; $P<0.05$). The frequency of interacting with kits was lower in alternative than in conventional cages (2.4 *vs.* 8.6 times a day; $P<0.01$). Doe behaviour was influenced by the time of day, with less activity during the midday hours. During dark hours, rabbit does more frequently performed restless behaviour such as hyperactivity or nursing, matching the time at which rabbit does spent more time on the platform. The platform was frequently used by rabbit does, regardless of their physiological stage, and during late lactation phase, when mothers were not receptive to nursing, does housed in alternative cages used the platform as a mean to flee from kits trying to suckle. Use of the platform might lead to hygienic problems due to retained faeces on the platform and faeces and urine falling onto animals located in the lower part of the cage. The absence of stereotypies in rabbit does of this trial, suggested that animal welfare was not compromised by the type of housing (conventional or alternative cages).

Key Words: animal welfare, rabbits, platform, behaviour.

INTRODUCTION

Since 1996, the Standing Committee of the European Convention for the protection of animals kept for farming purposes has been preparing recommendations to ensure the welfare of rabbits in commercial farms. According to the report of the scientific panel on Animal Health and Welfare (AHAW) from the European Food Safety Authority (EFSA, 2005) there is a lack of information on the basis of which to establish reliable recommendations to improve rabbit welfare. After this report, most of the published studies have been run with fattening rabbits (Prinz *et al.*, 2008a, 2008b; Ribikauskas *et al.*, 2010; Szendrő *et al.*, 2012) and few studies evaluated behavioural traits in rabbit does under farming conditions.

Regarding the housing system, the EFSA report emphasised the need to provide enough space to ensure the animals an opportunity to move and express their natural behaviour. However, not all naturally occurring behaviour is desirable

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http://dx.doi.org/10.4995/wrs.2014.1396

in farm animals. Behaviour strongly associated with wild rabbits, for example hiding under cover or alertness posture to evade predators (Moreno *et al.*, 1996), have been used as indicator variables for measuring stress of farmed rabbits under different housing conditions. However, differences between wild and domestic behaviour are not necessarily indicative of animal suffering (Dawkins, 1990). Traditionally, alertness behaviour such as sitting on hindlimbs has been considered a natural behavioural trait indicative of improved welfare. Following this, Morton *et al.* (1993) advised the use of sufficiently high cages (75 cm) to allow the rabbit to sit upright without its ears touching the top of the cage (lookout position). However, the importance of this behaviour in the current commercial housing system with a lack of predators is questionable. In fact, Princz *et al.* (2008a) observed that the commonly used 30-35 cm high cages were satisfactory for growing rabbits, although this research has not been performed with adult rabbits where differences in body size and space allowances could affect behavioural activities.

The increase in the available surface of commercial cages to allow animals to express their natural behaviour is the most concerning aspect for farmers, due to the investment required. In farm conditions, reproductive does are usually housed individually in polyvalent cages and the available surface is large, but this varies depending on litter age. One solution for maintaining the number of does while increasing floor surface is to use a two-floor cage including a communicating platform inside and increasing the cage height (Finzi *et al.*, 1996). The increased available surface of these alternative cages could be a way to improve welfare of farmed rabbits. However, there is not enough information to ensure that conventional cages used in commercial conditions impair the welfare of rabbit does.

A comparative study of the behaviour of rabbit does housed in conventional and alternative cages could demonstrate if there is any welfare improvement in alternative cages or if conventional cages are adequate.

The aim of this trial was to study the behavioural pattern of adult rabbit does at 2 physiological stages (late gestation and late lactation), housed in 2 types of cages (conventional *vs.* alternative).

MATERIAL AND METHODS

Animals and housing

All experimental procedures were approved by the Ethics Committee of the Polytechnic University of Madrid and were in compliance with the Spanish guidelines for care and use of animals in research (Spanish Royal Decree 1201/2005).

The study was carried out at the Poultry and Rabbit Research Centre of Nutreco, in Toledo, Spain. A total of 12 multiparous rabbit does (*Oryctolagus cuniculus*) in their fourth reproductive cycle from a hybrid maternal line (Hy-Plus) were used. Animals weighed on average 4.5 kg live weight, and were inseminated 25 d after kindling, being kits weaned 32 d after kindling. All animals were housed in the same artificially lighted room. The light:dark cycle was 15:9 h (light interval from 06:00 to 21:00 h and dark interval from 21:00 to 06:00 h). From the first artificial insemination, half of the rabbit does were individually housed in alternative polyvalent cages (385×995×600 mm) with a wire platform (381×310 mm) raised at 400 mm from the floor. The other half of animals was individually housed in conventional polyvalent cages (385×995×300 mm). All the cages were equipped with a feeder and a nipple drinker placed in the lower level and a foot mat (perforated plastic plate) in the middle of the floor. Heating, cooling and forced ventilation systems allowed the building temperature to be maintained between 20 and 23 °C throughout the experiment.

Feed

Throughout the study, rabbits were fed *ad libitum* with a commercial pelleted diet. Triplicate chemical analysis of feed was performed according to AOAC procedures (2004), and the average composition on as fed basis was: crude protein 18.6%, ether extract 3.8%, starch 22.0%, crude fibre 14.4% and ash 8.2%.

Behavioural observations

The observations were performed on 2 different days with the same does, at the end of the lactation period (24 d after parturition) with 8 kits per litter, and 1 wk before next parturition (3 d after weaning in pregnant not lactating does).

All females' records were captured simultaneously for 24 h. While behaviour was being recorded, nobody entered the room, to avoid disturbing the rabbit does' behaviour. Behaviour was recorded by infrared video cameras (VCB-3380/Sanyo) and a LED infrared reflector (IR-880/12D) placed on bars 2 m above the cages. Video recordings were analysed in their entirety by one trained person viewing at double speed; the data was then entered into the computer using "The Observer XT 8.0" software (Noldus Information Technology, Wageningen). Observations were classified into 3 exclusive categories (location, posture and functional behaviours) and different traits were assigned into each category, according to the ethogram described in Table 1. Frequency and duration performing different behavioural traits per hour were recorded.

Statistical methods

Behavioural measurement effects were analysed in a completely randomised design by using a mixed model with repeated measures, with cage type (TC), physiological stage (PS), time of day (Td) and their interactions as fixed effects and hour of the day as a repeated variable. Rabbit does nested to TC was included in the model as a random effect. When effects were significant, a t-test was used to make pairwise comparisons to separate means of the interaction TC×PS. Values are reported as average duration (seconds per hour and doe) and average frequency (number of times performing an activity per hour and doe) of each of the behaviours studied±standard error. Normal distribution of residuals and variance homogeneity of the data was tested and no transformations were made. All analyses were performed using SAS (2008).

RESULTS

Location

Time spent by does visiting each cage location over a period of 24 h is presented in Table 2. The effect of time of day and its interaction with type of cage and physiological stage is also shown in this table. To further illustrate the interaction, additional information is shown in Figure 1.

Table 1: Ethogram of behaviours used per category (location, posture and functional behaviours).

Location	
On platform (only in alternative cages)	
On foot mats	
On wire mesh	
Posture	
Lying	Trunk on ground, forelimbs and hindlimbs tucked under the body or outstretched
Sitting	Forepaws on ground with the forelimbs straight, the thorax and abdomen visible
Standing	Sitting on hindlimbs with both forepaws off the ground
Hyperactivity	Hopping in circles around itself or quickly running around in the cage
Functional behaviours	
Resting	Sitting or lying without carrying out any activity
Eating	Consumption of feed from the feeder, gnawing the pellet
Drinking	Drinking water from nipple drinker
Caecotrophy	Rabbit doe bowed down, pushed the head between hind legs and ingested caecotrophs (soft faeces) directly from the anus. Afterwards they rose, and chewed intensively for a few moments
Grooming	Licking, scratching or nibbling of the body
Interacting with Neighbours	Physical contact with animals from the adjacent cage by biting, sniffing, licking and removing hair
Interacting with Kits	Physical contact of the rabbit does with the kits by licking or pushing them with the head
Nursing	Rabbit doe lying with belly exposed and kits suckling
Sniffing	Smelling surroundings, with movement of head
Paw scraping	Rapid scratching with the forelegs on the floor or feeder
Gnawing	Biting wire-net, cage and feeder

Table 2: Location of does at 2 physiological stages (lactating and gestating) housed in conventional and alternative cages over a 24h period (mean±standard error).

	Conventional		Alternative		*P*-value					
	Lactating	Gestating	Lactating	Gestating	TC	PS	TC×PS	Td	Td×TC	Td×PS
Platform (s/h)	-	-	903±93	750±86	-	NS	-	<0.001	-	NS
Foot mats (s/h)	2940±55[a]	1893±78[b]	1865±92[b]	1604±84[b]	<0.05	<0.001	<0.001	NS	NS	NS
Wire mesh (s/h)	660±55[c]	1707±78[a]	831±67[c]	1246±87[b]	NS	<0.001	<0.001	<0.05	NS	<0.1

NS: no significant (P>0.10). TC: type of cage; PS: physiological stage. Td: Time of day. Main values are represented in Figure 1. [a,b,c] Means with different superscripts in the same row differ significantly at P<0.05.

Rabbit does spent most of the time on foot mats and subsequently on wire mesh (on av. 57.7 and 30.9%, respectively). These times depended on interaction between TC and PS (P<0.001). In conventional cages, time spent on foot mats by lactating does and on wire mesh by gestating does was relatively longer than in any other combination of treatments. Animals placed in alternative cages spent on average, 23.0% of their time on the platform and this trait was not influenced by PS.

The time spent on platform and wire mesh depended on Td (P<0.001 and P<0.05, respectively). From 17:00 to 01:00 h, rabbit does stayed a longer time on the platform than on wire mesh (35.0 *vs.* 19.6%, respectively), whereas from 08:00 to 15:00 h minimal values (on av. 7.1%) on the platform were reached (Figure 1).

Posture

The effect of TC and PS on duration and frequency of different postures by rabbit does is presented in Table 3. The effect of Td and its interaction with TC and PS is also shown in this table; additional information is given in Figure 2.

Mainly, rabbit does lay (78.4%) and for the remaining time were in the sitting position (21.4%). TC did not affect (P<0.05) any of these postures. On average, lactating does spent 2.8% more time lying and 9.3% less time sitting than gestating does (P<0.05). Frequencies of these postures were also affected by PS (P<0.001), as the values were higher in lactating than in gestating does (7.57 *vs.* 6.25; standard error (SE)=0.20 and 8.20 *vs.* 6.61;

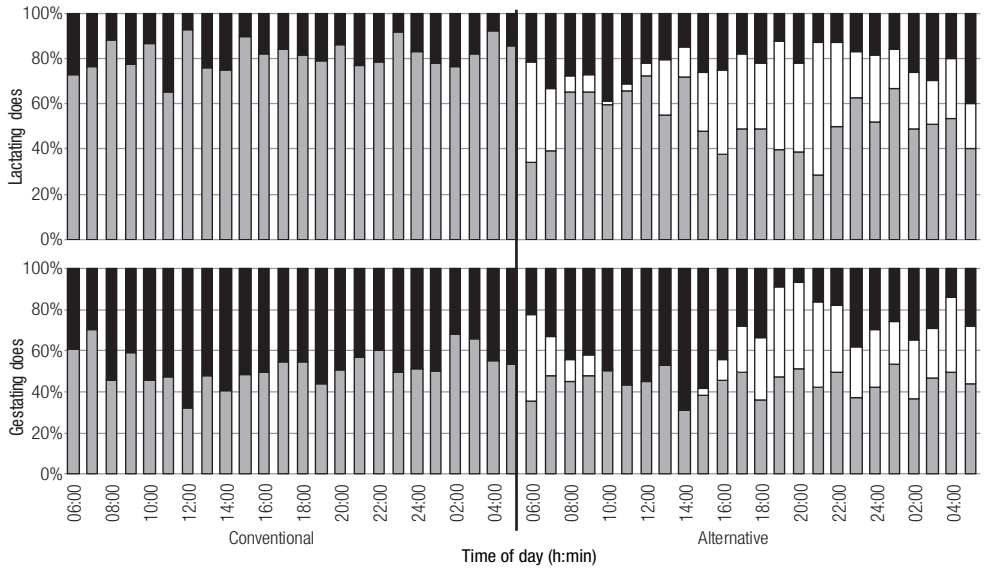

Figure 1: Proportion of time spent by rabbit does in different physiological stages (lactating and gestating) in different locations, wire mesh (▮), foot mats (▯) and platform (▯), housed in conventional and alternative cages throughout the day.

Table 3: Duration (s/h, mean±SE) and frequency (number of times per hour; [n/h]) of different postures performed by rabbit does at 2 physiological stages (lactating and gestating) housed in conventional and alternative cages over 24h period.

	Conventional		Alternative		*P*-value					
	Lactating	Gestating	Lactating	Gestating	TC	PS	TC×PS	Td	Td×TC	Td×PS
Duration (s/h)										
Lying	2829±32	2773±47	2892±29	2794±43	NS	<0.05	NS	<0.001	NS	NS
Sitting	761±32	826±47	701±29	787±42	NS	<0.05	NS	<0.001	NS	NS
Standing	-	-	n.d.	18.3±8.8	-	NS	-	NS	-	NS
Hyperactivity	9.03±2.97	n.d.	5.95±1.51	n.d.	NS	<0.001	NS	<0.001	NS	<0.001
Frequency (n/h)										
Lying	7.69±0.25	6.59±0.23	7.44±0.23	5.89±0.19	NS	<0.001	NS	<0.001	NS	NS
Sitting	8.64±0.31	6.79±0.35	7.76±0.33	6.42±0.34	NS	<0.001	NS	<0.001	NS	<0.001
Standing	-	-	n.d.	0.19±0.05	-	<0.05	-	<0.05	-	<0.01
Hyperactivity	0.24±0.06	n.d.	0.22±0.04	n.d.	NS	<0.001	NS	<0.001	NS	<0.001

n.d.: not detected. NS: no significant (*P*>0.10). TC: type of cage; PS: physiological stage. Td: Time of day. Main values are presented in Figure 2.

SE=0.21 times/h for lying and sitting respectively). The standing posture was not performed in conventional cages and was only observed in gestating does housed in alternative cages with a frequency of 0.19 times/h. Hyperactivity was only observed when rabbit does shared the cage with kits, to flee from kits, with an average value of 0.21% of the day and a frequency of 0.24 times/h.

Most of these postures were dependent on Td (*P*<0.001). Does spent most of their time lying and sitting during light and dark hours, respectively, with the lowest frequencies of these behavioural traits occurring from 10:00 to 16:00 h. Standing and hyperactivity were mainly observed from 19:00 to 22:00 h (Figure 2).

Functional behaviours

Duration and frequency of different functional behaviours that rabbit does demonstrated over a period of 24 h are shown in Table 4 and 5.

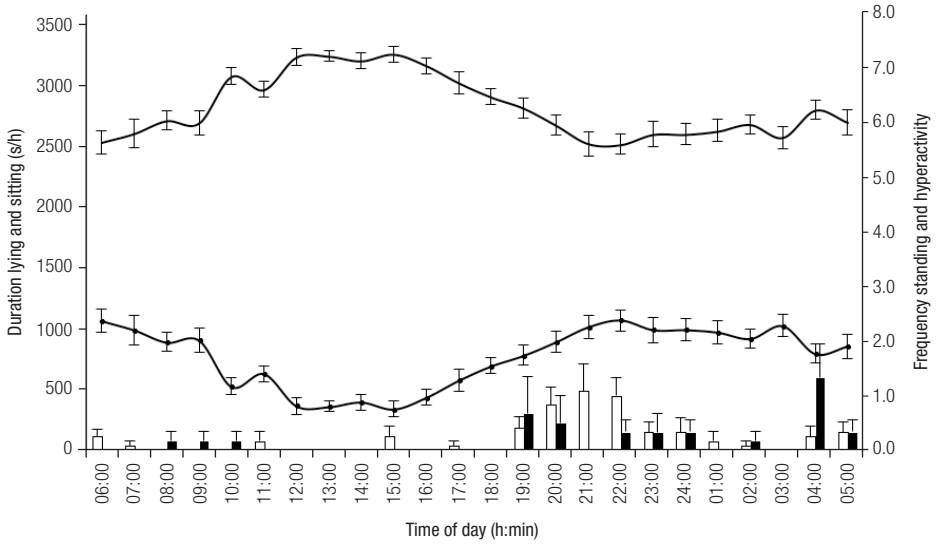

Figure 2: Evolution throughout the day of time (s/h) spent lying (–) and sitting (•) by lactating and gestating does as average. And frequencies performing different postures: hyperactivity in lactating does (▯) and standing (only does housed in alternative cages) in gestating does (▮).

Table 4: Duration (s/h, mean±standard error) and frequency (number of times per hour; [n/h]) of main functional behaviour performed by lactating and gestating does in conventional and alternative cages over a 24 h period.

	Conventional		Alternative		*P*-value					
	Lactating	Gestating	Lactating	Gestating	TC	PS	TC×PS	Td	Td×TC	Td×PS
Duration (s/h)										
Resting	2835±32	2776±47	2942±28	2813±41	NS	<0.05	NS	<0.001	NS	NS
Eating	358±19	304±25	319±19	270±22	<0.1	<0.05	NS	<0.001	NS	NS
Drinking	87.6±6.9[a]	48.1±5.5[b]	56.7±6.0[b]	45.1±5.2[b]	<0.1	<0.01	<0.05	<0.001	NS	NS
Grooming[1]	270±18	414±32	241±17	383±27	NS	<0.001	NS	<0.001	NS	NS
Frequency (n/h)										
Resting	7.84±0.25	6.70±0.23	8.21±0.27	6.18±0.20	NS	<0.001	NS	<0.001	NS	NS
Eating	2.86±0.13	1.56±0.1	2.63±0.14	1.36±0.08	NS	<0.001	NS	<0.001	NS	<0.001
Drinking	1.17±0.08	0.92±0.08	0.87±0.08	0.67±0.06	<0.05	<0.05	NS	<0.001	NS	NS
Grooming[1]	3.60±0.15	3.54±0.19	2.97±0.15	3.38±0.17	<0.1	NS	NS	<0.001	NS	<0.001

TC: type of cage; PS: physiological stage; Td: Time of day. Main values are presented in Figure 3. NS: no significant (P>0.10).
[a,b,c] Means with different superscripts in the same row differ significantly at P<0.05.
[1]Caecotrophy is included.

For most of the time (on av. 78.9%) does were resting (Table 4). Lactating does spent more time resting (P<0.05) and with a higher frequency (P<0.001) than gestating does (2889 *vs.* 2797 s/h, SE=39 and 8.03 *vs.* 6.44 times/h; SE=0.13, respectively). The other main activities performed were eating, drinking and grooming (8.69, 1.65 and 9.08% of the day with a frequency on av. of 2.10, 0.91 and 3.38 times/h, respectively, Table 4). The time spent eating by rabbit does was affected by TC (P<0.1) and PS (P<0.05), with higher values in conventional than in alternative cages (331 *vs.* 295 s/h; SE=12.8) and in lactating than gestating does (339 *vs.* 287 s/h; SE=13.4). Frequency of eating was also higher in lactating than gestating does (2.75 *vs.* 1.46 times/h; SE=0.09; P<0.001). Does spent more time drinking and with a higher frequency in conventional than in alternative cages (by 33.4 and 34.8%; P<0.1 and P<0.05, respectively) and in lactating than in gestating does (by 54.9 and 28.9%, respectively; P<0.01), but the effect of TC on time spent drinking was only significant in the case of lactating animals (87.7 *vs.* 56.7 s/h; SE=7.6). Due to the difficulty in distinguishing between grooming and caecotrophy, both were analysed together and in the present trial these functional behaviours are collectively referred to as grooming. Time spent on grooming behaviour varied with PS (P<0.001), as gestating does reached values 56.0% higher, on average, than lactating does. Does performed grooming behaviour with a higher frequency (P<0.1) in conventional than in alternative cages (3.58 *vs.* 3.18; SE=0.13).

Table 5: Duration (s/h, mean±standard error) and frequency (number of times per hour; [n/h]) of functional behaviours performed by lactating and gestating does housed in conventional and alternative cages over 24h period.

	Conventional		Alternative		*P*-value					
	Lactating	Gestating	Lactating	Gestating	TC	PS	TC×PS	Td	Td×TC	Td×PS
Duration (s/h)										
l.Neighbours	0.34±0.34[b]	11.5±3.08[a]	1.71±0.93[b]	3.84±1.29[b]	NS	<0.01	<0.05	NS	NS	NS
Int. Kits	7.38±1.47	-	7.59±2.52	-	NS	-	-	<0.01	<0.05	-
Nursing	25.3±7.7	-	9.40±3.7	-	NS	-	-	<0.001	NS	-
Sniffing	3.28±1.86	0.07±0.07	2.35±1.06	1.33±0.52	NS	NS	NS	NS	NS	NS
Scraping	n.d(4)	29.2±9.6	n.d	21.8±8.97	NS	<0.01	NS	NS	NS	NS
Gnawing	2.89±1.14[b]	17.2±5.2[b]	9.90±2.84[b]	61.8±13.8[a]	<0.1	<0.001	<0.05	<0.001	NS	<0.05
Frequency (n/h)										
l.Neighbours	0.01±0.01[c]	0.19±0.03[a]	0.04±0.01[bc]	0.11±0.03[b]	NS	<0.01	<0.05	<0.01	NS	NS
Int. Kits	0.36±0.06	-	0.10±0.02	-	<0.01	-	-	<0.01	NS	-
Nursing[1]	0.14±0.03	-	0.05±0.02	-	<0.05	-	-	<0.001	<0.1	-
Sniffing	0.01±0.01	0.01±0.01	0.05±0.01	0.08±0.02	<0.1	NS	NS	NS	NS	NS
Scraping	n.d	0.18±0.06	n.d	0.14±0.06	NS	<0.01	NS	NS	NS	NS
Gnawing	0.10±0.03[b]	0.26±0.05[b]	0.19±0.05[b]	0.57±0.09[a]	<0.1	<0.001	<0.1	<0.001	NS	<0.05

TC: type of cage; PS: physiological stage; Td: Time of day. Main values effects are presented in Figure 4 and 5. NS: no significant (P>0.10). n.d.: Not detected.
[a,b,c] Means with different superscripts in the same row differ significantly at P<0.05. [1] Proportion of does nursing per hour.

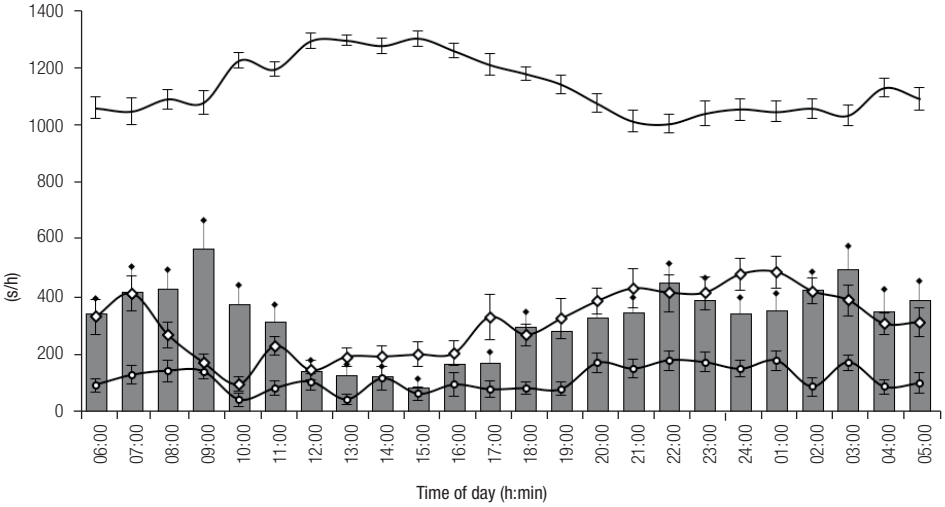

Figure 3: Evolution throughout the day of time (s/h) spent performing different behaviours by lactating and gestating does as average: resting$_{/2.5}$ (—), eating (◇), drinking$_{x2}$ (○) and grooming (▯). In the figure, resting and drinking values were divided and multiplied by 2.5 and 2, respectively.

This group of functional behaviours was affected by Td (P<0.001). Resting behaviour was observed mainly from 10:00 to 19:00 h while other behaviour reached minimum values (Figures 3). Concurrent with the soft faeces intake period, a peak of grooming was observed from 09:00 to 10:00 h.

Other behaviour such as interacting with neighbours and kits, nursing and sniffing were also observed (0.12, 0.21, 0.48 and 0.05% of the day, respectively; see Table 5). Duration and frequency of interacting with neighbours varied

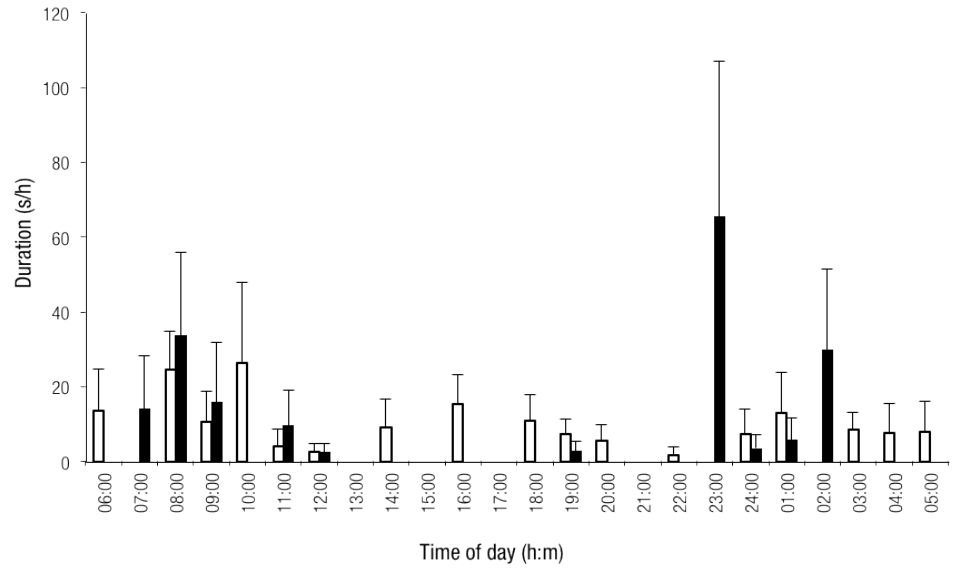

Figure 4: Evolution throughout the day of time (s/h) spent by rabbit does interacting-with-kits in conventional cages (▯) or in alternative cages (▮).

depending on the interaction between PS and TC ($P<0.05$), showing higher values in conventional than in alternative cages (5.92 *vs.* 2.78 s/h; SE=1.62 and 0.10 *vs.* 0.08 times/h; SE=0.03), but this effect was only significant in gestating does. Time spent interacting with kits was not affected by TC, although an interaction of Td with TC was observed ($P<0.01$), as in conventional cages this behaviour was observed during more time throughout the day, except from 23:00 to 03:00 h when higher values in alternative than in conventional cages were observed (Figure 4). The frequency of this behaviour was higher in conventional than in alternative cages (0.36 *vs.* 0.10 times/h; SE=0.06; $P<0.01$). Time spent nursing was not affected by TC; however, TC had effect on proportion of does nursing per hour ($P<0.05$), showing higher values does housed in conventional than alternative cages. This effect depended on Td ($P<0.1$), as both alternative and conventional cages nursing behaviour was mainly observed from 20:00 to 22:00 h, but in conventional cages the period was longer than in alternative cages (see Figure 5). Sniffing behaviour was observed more frequently in alternative than in conventional cages (0.01 *vs.* 0.07; SE=0.01; $P<0.1$) and was not affected by PS.

Behaviours such as paw scraping and gnawing were performed during 0.35 and 0.62% of the day with a frequency on av. of 0.17 and 0.28 times/h, respectively (Table 5). Paw scraping was only observed in gestating does and did not depend on TC. An interaction between TC and PS ($P<0.05$) was observed for time and frequency of gnawing behaviour, with the highest time and frequency of performing gnawing by rabbits housed in alternative cages was only significant for gestating does (17.2 *vs.* 61.8 s/h; SE=10.7 and 0.26 *vs.* 0.57 times/h; SE=0.08, for conventional *vs.* alternative cages, respectively).

DISCUSSION

Under commercial farm conditions, location preference by rabbit does varied depending on housing. Results showed that when a raised platform was available, rabbit does spent 23% of their time, on average, on the platform (Table 2). This result agrees with a previous study using two-floor cages (Mirabito, 2007), where lactating does spent 28% of the time, on average, on the upper floor. A higher value, 53% of the time on the raised platform, was reported by Finzi *et al.* (1996). In the present trial, the time spent by does on the platform was independent of their PS, indicating that use of the platform was not related to the available surface, which is larger in gestating does than in lactating ones due to the presence of the kits. The time that does spent on the platform, which is inaccessible to kits, was higher from 17:00 to 01:00 h and especially between 21:00 to 23:00 h (Figure 1). A peak in nursing behaviour was also observed in this period, being the proportion of does nursing per hour lower in animals housed in alternative than in conventional cages (Figure 5). This is in agreement with Selzer *et al.* (2004), who found that most nursing events occurred between 20:00 and 22:00 h, whereas a decrease in nursing activity was observed in the early morning. They also found that nursing activity tended to decrease moderately with increasing size of cage and with the provision of

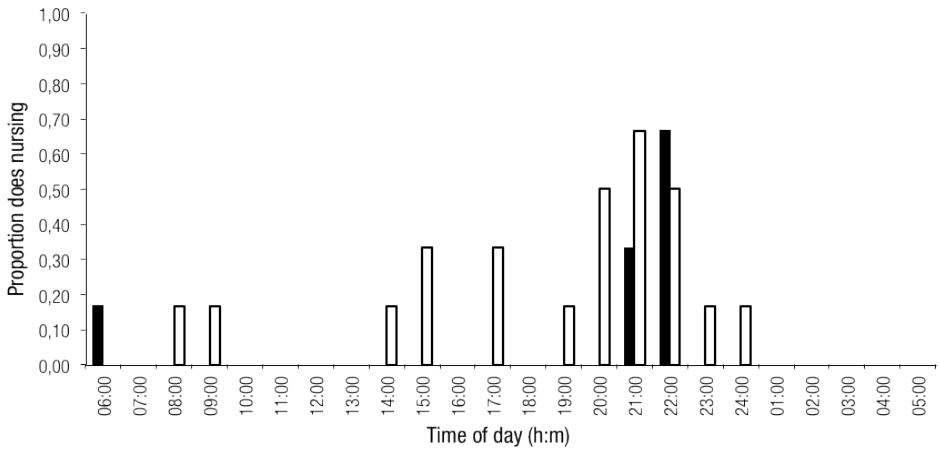

Figure 5: Evolution throughout the day of proportion of rabbit does nursing per hour in conventional (▯) and alternative cages (▮).

enrichment (an elevated seat for the doe in the getaway cage or a tunnel at the entrance to the nest box). During this time which both peak nursing and higher use of platform happened, does exhibited a higher regularity of hyperactivity, a symptom of restlessness (Figure 2). This overlap could be due to the fact that the 24-d-old kits are not satisfied with the milk provided for them and as a result seek more from the mother, and in response the does flee from them. These results and the lower proportion of does nursing per hour observed in alternative suggest that the platform was used as an escape by rabbit does in the late phase of the lactation period, when they are tired and the kits still wanted to suckle. This result is in agreement with Mirabito (2007), who showed that the time spent on the platform by nursing does increased between the 2nd and 4th wk after parturition (from 20 to 35%), in parallel to the emergence of the kits and the removal of the nest boxes.

According to the results obtained, rabbit does showed a clear preference for foot mats above wire mesh floors in conventional and alternative cages, especially when kits close to the weaning age were present (Table 2). Under these conditions, does have less room, competing with kits for the most comfortable place. These results confirm those obtained by Princz *et al.* (2008b), who reported that growing rabbits preferred plastic nets covering wire mesh floors. Moreover, Rosell and de la Fuente (2009) showed a positive relationship between the use of foot mats and animal welfare after finding a significant reduction in the prevalence of sore hocks in farms where foot mats were used. It follows that these findings suggest a higher level of comfort and welfare for rabbit does reared on this type of flooring and with a raised platform at the end of lactation period. Noteworthy: the use of platforms raises hygiene issues due to the accumulation of faeces and subsequently faeces and urine falling onto animals located in the lower part of the cage. Some alternatives to prevent this problem were studied by Finzi *et al.* (1996), who trained animals to excrete in the lower part of the cage by preventing access to the platform during the first 2 days. Drip trays were also used, leading to animals spreading more evenly in the cage without the risk of soiling from above (Szendro *et al.*, 2012).

Frequently, the welfare of rabbits reared under commercial conditions has been evaluated by comparing their functional behaviours with those observed in wild rabbits. However, the natural behavioural repertoire includes activities that are adaptations to adverse conditions, for example, hiding from predators or displaying the alert position (standing on its hindlimbs) considered as indicators for variable or poor welfare (Dawkins, 2008). Under commercial conditions, this position is not possible, as the height of standard cages used in Europe varies between 29 and 40 cm (Trocino and Xiccato, 2006) and, depending on the rabbit's size, a minimum of approximately 75 cm high is required (Morton *et al.*, 1993). In addition, as mentioned by Princz *et al.* (2008a), the relevance of this behaviour in the commercial cage system may be limited due to the lack of predators. Accordingly, in the current trial, height of alternative cages (60 cm) was enough to perform standing posture and it was rarely observed. The individual variation in the standing posture among animals was high, and it was exclusively performed to eat and smell faeces retained on the platform. Martrenchar *et al.* (2001) reported that in cages without enclosed ceilings, animals performed standing behaviour less than 0.7% of the time. However, they concluded that certain behaviours can be important even if they are rarely practised. In an open field study (testing the behaviour of animals that are otherwise housed in different cage systems, compared under the same stimuli and environment), Hansen and Berthelsen (2000) found that rabbits previously housed in the conventional cage system (40 cm of height) performed the standing posture significantly more time (3.4 *vs.* 2.6%) than rabbits housed in alternative cages (80 cm of height). Regarding the height of the cage, Princz *et al.* (2008a) reported that the commonly used height in commercial cages (30-35 cm) was satisfactory for growing rabbits. In the present trial, does housed in conventional (30 cm high) and alternative cages (40-60 cm) showed times spent on comparable postures such as lying and sitting were not significantly different. These results suggest comfort in this posture irrespective of the cage height.

In the current study, rabbit does spent most of their time lying down and the duration of this behaviour was not affected by the TC. Generally when animals were lying down (mainly during the light period, Figure 2) they were resting, and this is the reason why the duration for both types of behaviour was almost the same. Gunn and Morton (1995) and Fernández-Carmona *et al.* (2005) observed that rabbits spent more time resting and sleeping during the light period and were more active during the dark period. In this work, most of the functional behaviours were also observed mainly during the dark period (Figures 3, 4 and 5) and when rabbit does were sitting. Frequency of certain behaviour while sitting was lower in alternative cages, such as drinking, grooming ($P<0.1$), interacting with neighbours (only in gestating does) and with kits, indicating that animals might be more restless in conventional than in alternative cages. Frequent changes of behaviour have been described as a sign of increased stress in animals (Lehmann, 1987;

Hughes and Duncan, 1988), which may show abnormal behaviour, such as bar-biting, excessive grooming or other stereotypic activities (Morton *et al.*, 1993; Love, 1994). Hansen and Berthelsen (2000) found that females were more restless in conventional cages, showing excessive grooming, bar-gnawing and timidity compared to those housed in alternative cages with a platform. However, in the present trial the mean values of these behaviours were not so excessively high, and for example, grooming included caecotrophy behaviour which is a natural behaviour and not a stereotypic activity. The current data showed that duration and frequency of gnawing were higher in alternative than in conventional cages and especially in the gestation phase. An explanation might be based on the fact that rabbit does are more quiet after weaning, but also more bored, so an available platform may lead to distraction such as biting the bars or smelling droppings retained on the platform. In addition, the use of enriching elements such as straw or "toys" could be an option to minimise the stress and boredom of gestating does housed in cages. Similarly, María *et al.* (2005) found an improvement in rabbit does' welfare (enlarging the spectrum of behaviour) through the use of enrichment elements such as wooden toys with different shapes, straw or a tube of PVC. Lidfors (1997) also found that male laboratory rabbits showed less abnormal behaviour when different objects were available in the cage, presenting alternative activity to alleviate boredom.

Contrary to expectation, in the present work lactating does spent more time resting than gestating does (Table 4) the most obvious explanation for this being the less available surface in the lactating phase. Ribikauskas *et al.* (2010) also observed lower activity in growing rabbits housed in wire cages with a higher density than in those housed in pens with more functional space. However, in the current study the shorter resting time in gestating does might also be due to nervousness a result of being close to the parturition date, leading to the prevalence of longer and higher frequency of activities such as grooming, interacting with neighbours, paw scraping and gnawing.

CONCLUSIONS

Rabbit does in commercial conditions will maintain their circadian behavioural pattern depending on their PS and housing system. The platform is frequently used by rabbit does, independently of their physiological stage (with or without kits) or the available space in the cage. Additionally, the platform is used as an escape by rabbit does in the late phase of the lactation period, when they are tired and the kits still wanted to suckle. The PS of rabbit does exerts a stronger influence than the TC on the duration and frequency spent performing functional behaviours. After weaning, rabbit does are more restless than lactating does as parturition day approaches and the addition of enrichment elements could therefore provide extra stimulus during this period. Moreover, conventional cages with 30 cm height seem to be satisfactory for rabbit does, as no stereotypies were observed.

Acknowledgements: The authors wish to thank Dr. Twan Van Gerwe and Dr. Adam Sacranie for a critical reading of the manuscript and Álvaro García and Francisco Linares for technical assistance.

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