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EFFECT OF LIGHT INTENSITIES ON REPRODUCTIVE PERFORMANCE, NURSING BEHAVIOUR AND PREFERENCE OF RABBIT DOES

MATICS ZS., SZENDRŐ ZS., RADNAI I., KASZA R., GERENCSÉR ZS.

Department of Animal Genetics and Biotechnology, Faculty of Agricultural and Environmental Sciences, Kaposvár University, PO Box 16, 7401, Kaposvár, Hungary.

Abstract: The aim of the experiment was to compare the reproductive performance and nursing behaviour of rabbit does reared under 2 different light intensities and observe the preference of does among cages with different light intensities. Female rabbits were randomly housed in 2 identical rooms, under the same housing conditions in wire-net cages. The 2 rooms only differed in the light intensity; group L: 150-200 lux (n=54 does, 230 inseminations), group D: 10-20 lux (n=54 does, 232 inseminations). Reproduction data from the first 5 consecutive reproductive cycles were evaluated. Nursing behaviour of the does (n = 24) was observed at the 2nd or 4th lactation. The preference of does (n=8) among 4 cages with different light intensities (10, 35, 75 or 155 lux) was examined. There were 6-7% difference between the 2 groups in the number of kits born in total and those born alive (born total: 11.25 *vs.* 10.59 kits, $P<0.1$; liveborn: 10.75 *vs.* 10.00 kits, $P<0.05$; in groups L and D, respectively). Suckling mortality was nearly 2% higher in group D (L: 8.1, D: 10.0%; $P<0.1$), and in consequence the litter size of this group at 35 d of age was lower than that of the L rabbits (L: 8.75, D: 8.45 kits; $P<0.05$). The light intensity did not affect litter and individual weights at 35 d of age. The average numbers of daily nursing events (L: 1.23/d, D: 1.32/d), the length (L: 208±49, D: 213±43 s) and the daily distribution of nursing events were not affected by high light intensity. During the light period of the day, the darkest cage (10 lux) was the most preferred by the does (44.0, 18.6, 17.9 and 19.5% in 10, 35, 75 and 155 lux cages, respectively; $P<0.001$). The lower light intensity had no unambiguously unfavourable effect on the reproductive performance and nursing behaviour of the does. Based on the preference test, a lower light intensity may be advantageous from the point of view of animal welfare.

Key Words: rabbit, light intensity, reproductive performance, nursing behaviour, preference test.

INTRODUCTION

Light and the lighting schedule applied influence the behaviour and production of rabbits in several ways. Rabbit behaviour is deeply influenced by changes in the light and dark periods of the day (Jilge and Stähle, 1984; Piccione *et al.,* 2007). European wild rabbits and domestic rabbits (*Oryctolagus cuniculus*) are active during the dark period, with 2 activity peaks at dusk and dawn. Rabbit fertility increases in spring with increasing day-length and decreases in late autumn and winter periods in Europe (Lebas *et al.,* 1997). Several researchers observed that increasing daily lighting length before insemination can be an efficient biostimulation method to improve the receptivity (Theau-Clément *et al.,* 2008) and kindling rate of the does (Theau-Clément *et al.,* 1990; Mirabito *et al.,* 1994; Gerencsér *et al.,* 2010). The effect of different lighting colours was also studied (Gerencsér *et al.,* 2011). Moreover, according to Seitz (1997) and Selzer (2000), the change in light and dark periods is a signal for the does to nurse their kits. Hoy and Selzer (2002) examined the nursing behaviour of European wild and domesticated rabbits, which occurred most frequently during the first few hours of the dark period. In our observations (Matics *et al.,* 2004), the rabbit does nursed their kits most frequently during the dark period of the day. However, no information can be found in the

Correspondence: Zs. Matics, matics.zsolt@ke.hu. Received *September 2015* - Accepted *November 2015.*
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literature about the connection between the light intensity and reproductive performance of breeding rabbits, except for Besenfelder *et al.* (2004), who examined the effect of light intensity on spermatozoa quality in bucks.

According to Lebas *et al.* (1997) and Schlolaut (1998) in rabbit does, a sufficient level of light intensity is between 30-40 lux or at least 50 lux (EFSA, 2005). This allows the rabbits to have visual contact, investigate their environment and engage in a normal level of activity (EFSA, 2005).

As wild and domesticated rabbits are active during the dark period and spend the lighting hours in the dark warren, using a lower light intensity may be more natural for them and can also be less expensive.

The aim of the experiment was to compare the reproductive performance and nursing behaviour of rabbit does reared under 2 different light intensities and observe the preference of does between cages with different light intensities.

MATERIAL AND METHODS

Experiment 1

Experimental design, animals

The experiment was conducted at the experimental rabbit farm of Kaposvár University. Thirteen-week old crossbred female rabbits were randomly housed in 2 identical rooms, under the same housing conditions in wire-net cages (86×38.5 cm, including the nest box). Drinking water from nipple drinkers, and commercial diet (digestible energy: 11.1 MJ/kg, crude protein: 180 g/kg, crude fibre: 150 g/kg) were available *ad libitum*. The temperature varied with a range of 14-28°C, depending on the season. In both rooms 16L:8D lighting schedule was applied (lighting hours: 6:00-22:00 h) using white coloured fluorescent tubes (specifications: FW 36W, colour code: 830, wavelength: 300-650 nm).

The two rooms only differed in light intensity: Lighter room (L) group: 150-200 lux light intensity, measured in the middle of cages at rabbit head height (n=54 does, 230 inseminations, 180 kindlings); Darker room (D) group: 10-20 lux light intensity (n=54 does, 232 inseminations, 185 kindlings).

Rabbit does were first inseminated at 16.5 wk of age. Artificial insemination (AI) was applied at 11 d *post partum* (42 d reproductive rhythm, single batch system). Cross-fostering was applied within groups with max. 8 kits/litter at first kindling and max. 10 kits/litter at following parities. Rabbit does could nurse their kits freely. The kits were weaned at 35 d of age.

Reproductive performance

Body weight of does at first insemination was compared. Data from the first 5 consecutive reproductive cycles were evaluated. Body weight of does at kindling, kindling rate, litter size (total born, liveborn, stillborn, at 35 d of age), litter weight and individual body weight of kits at 35 d and suckling mortality between 0-35 d of age were examined. Numerical and overall productivities based on the 5 parturitions (the number and the total weight of weaned kits per 100 AI) were calculated on the basis of IRRG recommendations (International Rabbit Reproduction Group, 2005).

Nursing behaviour

Nursing behaviour of the does (n=12 rabbit does/group) was observed continuously between the 4th and 10th day of the 2nd or 4th lactation. Infrared cameras were used for observation. Throughout the total 6480 hour-long observation period, data on 339 nursing events were recorded. The daily number, distribution and length of nursing events were evaluated.

Experiment 2

Preference test

The preference of does among different light intensities was examined in a free choice experiment. Eight non-pregnant, non-lactating does (between the 3rd and 5th parity) originated from commercial farm conditions (light intensity: 70-100 lux; 16L:8D) were examined. A cage block consisting of 4 identical sized cages (61×41×50 cm)

with solid walls was used. The does could move freely among the cages through 20×20 cm holes. Every cage was equipped with a feeder and a nipple drinker. The cages only differed in light intensity: 10, 35, 75 or 155 lux (measured at the height of the does' head in the middle of the cage). The light intensity in the different cages was randomly changed after each doe. From each single housed doe, after a one-day adaptation period, a 5-day video recording was made using infrared cameras. Location of the does was recorded every half hour. A 16L:8D lighting schedule was applied, and the choice of does among cages with different light intensities was evaluated only in the light period.

Statistical analysis

The reproductive traits (fix factors: light intensity [L, D] and parity order [1st, 2nd, 3-5th]) and the length of nursing events were compared by GLM procedure; numerical and overall productivities were compared by T-test; the kindling rate, suckling mortality, distribution of the daily number of nursing events and location of does among cages with different light intensities were evaluated by chi-square test using the SPSS 10.0 software package.

RESULTS AND DISCUSSION

Experiment 1

Reproductive performance

In accordance with the literature (Xiccato *et al.,* 2004; Rebollar *et al.,* 2009; Tůma *et al.,* 2010), the reproductive performance of does was affected by the parity order (Table 1). The kindling rate of primiparous does was lower than that of the nulliparous and multiparous does, which can be explained by the negative energy balance of simultaneously lactating and pregnant primiparous does (Xiccato *et al.,* 1996). The multiparous does had the highest litter size at kindling ($P<0.01$) while the number of weaned kits and the individual and litter weight at 35 d were higher in primiparous and multiparous does compared to nulliparous ones ($P<0.001$). The suckling mortality of multiparous does was higher than that of the younger does ($P<0.05$).

The kindling rate (1-5 reproductive cycles) was independent of the light intensity (Table 1). This result is in contrast to the literature, where a decrease in reproductive performance is assumed under 30-40 lux light intensity (Lebas *et al.,* 1997; Schlolaut, 1998; EFSA, 2005).

With increasing age, the body weight of the does at kindling increased in both groups independently of the light intensity (group L: 3.91, 3.97, 4.01, 4.31, 4.41, 4.37 kg; group D: 3.94, 4.00, 4.20, 4.22, 4.37, 4.42 kg, at the 1st insemination, at the 1st, 2nd, 3rd, 4th and 5th kindling, respectively). The light intensity did not influence the average body weight of the does at kindling (Table 1).

Table 1: Reproductive performance of does housed under different light intensities (1st-5th inseminations).

	Light intensity		Parity order				P		
	L (150-200 lux)	D (10-20 lux)	1st	2nd	3-5th	SE	Light intensity	Parity order	Interaction
Kindling rate (%)	78.3	79.7	88.7^{b}	65.7^{a}	80.5^{b}		0.696	<0.001	
Doe weight at 1st AI (kg)	3.91	3.94				0.32	0.628		
Doe weight at kindling (kg)	4.20	4.22	3.98^{a}	4.11^{a}	4.35^{b}	0.26	0.244	<0.001	0.302
Litter size - born total	11.25	10.59	9.75^{a}	10.54^{a}	11.60^{b}	0.17	0.073	<0.001	0.737
liveborn	10.75	10.00	9.38^{a}	10.03^{ab}	10.96^{b}	0.18	0.042	0.001	0.507
equalised	9.46	9.33	8.00^{a}	9.81^{b}	9.97^{c}	0.05	<0.001	<0.001	<0.001
at 35 d	8.75	8.45	7.45^{a}	9.13^{b}	9.01^{b}	0.07	0.032	<0.001	0.163
Litter weight at 35 d (kg)	8.25	7.98	6.41^{a}	8.71^{b}	8.78^{b}	0.09	0.064	<0.001	0.440
Kits weight at 35 d (g)	942	945	860^{a}	955^{b}	975^{c}	2.49	0.960	<0.001	0.002
Mortality (0-35 d) (%)	8.05	9.96	6.93^{a}	6.96^{a}	9.64^{b}		0.061	0.027	

SE: standard error.

^{a,b,c}Means with different letters in a row differ significantly ($P<0.05$).

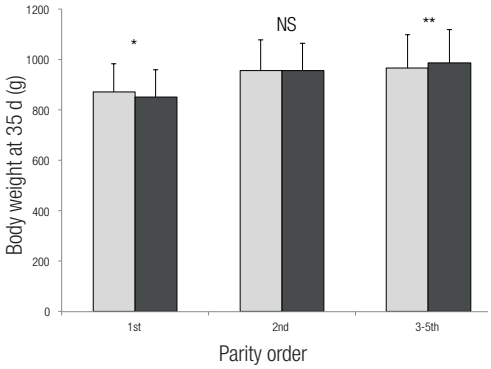

Figure 1: Individual weight of kits at 35 d depending on the light intensity and parity order. L: □; D: ■. NS: non significant; *: $P<0.05$; **: $P<0.01$.

Although there was a 6% difference between the 2 groups in the total number of kits born, the difference was only significant at $P<0.1$ level. The number of kits born alive was 7% lower in group D compared to L rabbits ($P<0.05$). Suckling mortality was almost 2% higher in group D ($P<0.1$), and in consequence the litter size at 35 d of age of this group was significantly lower than that of the L rabbits. The light intensity did not affect the litter and individual weights at 35 d of age.

Significant interaction ($P<0.01$) was found in the body weight of weaned kits (Table 1). The weight of kits in group L was higher in nulliparous does and lower in multiparous does compared to group D (Figure 1).

From the viewpoint of the farmers, the numerical and overall productivities provide valuable information. There were no difference between the groups in the number of weaned kits calculated per 100 AI (L: 685, D: 673; $P=0.725$), and the total weight of weaned kits per 100 AI (L: 646, D: 636 kg; $P=0.753$). As no experimental results were published in this field, the recent data could not be compared with other findings.

Nursing behaviour

On the basis of observations, the nursing behaviour was not affected by the light intensity. Although the frequency of once-a-day nursing was slightly lower (L: 71.7 *vs.* D: 65.9%) and frequency of twice-a-day nursing was a little higher (L: 20.3 *vs.* D: 27.3%) in group D, compared to group L, the average numbers of daily nursing events were not different (L: 1.23, D: 1.32; P=0.635), and was similar to what can be found in the literature (Hoy *et al.,* 2000; Hoy and Selzer, 2002; Matics *et al.,* 2012). Neither the length (L: 208±49, D: 213±43 sec; $P=0.339$) nor the daily distribution of nursing events (Figure 2) were different between the 2 groups. In both groups, half of the nursing events took place during the 8 h-long dark period (L: 50.4, D: 48.7%). The most frequent period of nursing was observed during the 2 h after the lights were switched on, independently of the light intensity.

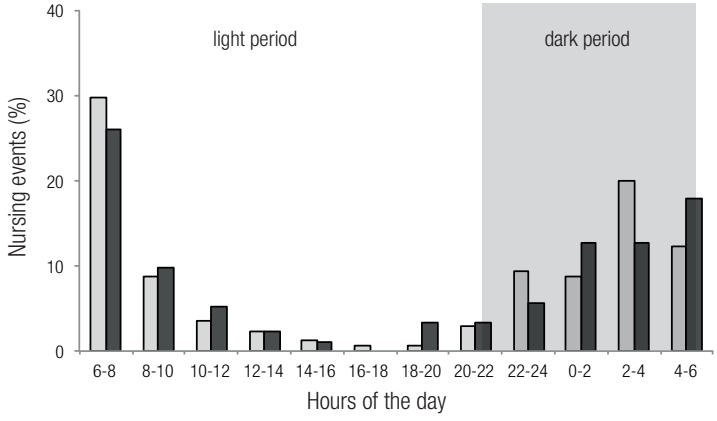

Figure 2: Daily distribution of the nursing events of rabbit does housed under different light intensities (L: 150-200 lux; D: 10-20 lux). L: □; D: ■.

Experiment 2

Preference test

During the light period of the day, the non-pregnant, non-lactating does were found with the same frequency in the 3 lighter cages (18.6, 17.9 and 19.5% in 35, 75 and 155 lux cages, respectively), while the darkest cage (10 lux) was the most preferred by the does (44.0%; $P<0.001$). This result can be explained by the natural behaviour of the rabbits as they stay in the dark warren during the light period of the day and during the active period; moreover, by night the light intensity is very low. Our observations are in contrast to the proposal of Lebas *et al.* (1997), Schlolaut (1998) and EFSA (2005) suggesting minimum 30-40 lux light intensity for rabbit does.

CONCLUSIONS

Based on the results, a lower light intensity than recommended in the literature did not have an unambiguously unfavourable effect on the reproductive performance and nursing behaviour of the does. Based on the free choice of rabbit does, a lower light intensity may be advantageous from the point of view of animal welfare. As the difference in light intensity was high between the 2 groups, further studies are needed before making recommendations to farmers.

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