

## SHORT COMMUNICATION: ASSESSMENT OF ACTIVITY PATTERNS OF GROWING RABBITS IN A FLUX-CONTROLLED CHAMBER

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**Abstract:** Flux-controlled and metabolic chambers are often used for nutritional and environmental studies. However, the potential alterations of animal behaviour and welfare are so far not fully understood. In consequence, this study had 2 main objectives: to assess potential alterations of animal activity pattern and time budget inside a flux chamber, and to assess the importance of the “rearing up” behaviour. To this end, 10 growing rabbits of different ages (from 1 to 5 wk of the growing period) were housed inside a flux chamber. Their activity was continuously recorded and assessed, determining the frequency and duration of 8 different behaviours: lying, sleeping, sitting, eating, drinking, walking, rearing up and others. Nocturnal rabbit behaviour and time budget were not altered inside the chamber if compared to previously described rabbit activity under conventional cages. In addition, rabbits in this experiment presented a tendency to perform “rearing up” when housed inside the flux chamber.

**Key Words:** rabbit, behaviour, flux chamber, rearing.

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### INTRODUCTION

Flux-controlled chambers are widely used in animal research for nutritional and environmental studies (Farrell, 1972; Piattoni *et al.* 1996; Estellés *et al.* 2009), but it is not known to what extent they may be affecting animal behaviour and welfare and consequently compromising the results obtained in these studies.

Animal behaviour is one of the most important indicators of their welfare, since it reflects the animal's response to an environmental challenge (Webster 2005). Domestic rabbits, despite genetic selection for decades, still present most of the behaviours of wild rabbits (EFSA, 2005). As farm rabbits are usually housed in cages, most of the repertoire of behaviours of wild rabbits cannot be displayed, mainly due to space and stimulus restrictions (Hansen and Berthelsen, 2000). Furthermore, the frequency, intensity and duration of farm rabbit behaviours are strain-specific (EFSA, 2005), so many variations can be found among them.

As prey, wild rabbits are considered nocturnal animals (Jilge, 1991). Nevertheless, it seems that domestic rabbits show higher daily activity than wild rabbits (Trocino and Xiccato, 2006).

One of the main issues regarding animal welfare in rabbit production and laboratory animals is the available space, as well as the quality of the environment (Verga and Luzi, 2006; Zucca *et al.*, 2012). This paper concludes that space allowance is a basic factor in normal behaviour expression in fattening rabbits. This is particularly relevant when conducting experiments in flux-controlled chambers and thus could be questioned in terms of animal welfare. Moreover, in this type of experiments, animals are usually individually housed, which might introduce another source of bad welfare (Princz *et al.*, 2008a). Thus, time budget can be affected by the housing system (Verga *et al.*, 2006), so a detailed analysis of the behaviour in circumstances such as flux-controlled or metabolic chambers is important.

On the other hand, one of the most important alertness behaviours of wild rabbits is the “upright alert position” (Princz *et al.*, 2008b), also known as “rearing up” (hereinafter “rearing”). This behaviour does not usually develop in

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conventional cages, as growing rabbits need roughly 42 cm to rear up (Negretti *et al.*, 2010) but it is not clear whether it poses a real welfare problem. For this reason, the importance of this behaviour in farmed rabbits has often been questioned. In fact, according to Jensen (2002) "if the environment does not promote a specific behaviour, its lack probably will not cause problems regarding animal welfare". Nevertheless, animals are in welfare when they can freely express the behavioural pattern typical of their species (Farm Animal Welfare Council, 1991).

In the light of this information, the main aim of this work is to evaluate whether the behavioural patterns of growing rabbits are affected when they are housed in a flux chamber by assessing potential time budget alterations of different behaviours, in relation to previously reported activity patterns. In parallel, an additional objective was to assess the "rearing up" behaviour inside the flux chamber.

## MATERIALS AND METHODS

A flux chamber (60×40×40 cm, long×wide×high) built in poly methyl methacrylate (see complete description in Estellés *et al.*, 2009), was placed in a growing rabbit room (with around 1800 rabbits) in a farm located at the Universitat Politècnica de València, Valencia, Spain. The experiment was conducted during August and September, 2008. Lighting in the rabbit house followed the natural daylight rhythm without use of artificial lights, with approximately 13 h of light (from 07:00 to 21:00 h). The chamber was equipped with a feeder and a drinker.

Ten female rabbits (line V; Baselga, 2002) between 1 and 5 wk of growing period (weighing between 721 and 1715 g) were used for the study (2 animals per week of growing period). Each rabbit was kept in its home group cage (consisting on a traditional wire rabbit cage of 40×90×35 cm, COPELE, Murcia, Spain) until entering the flux chamber. They were then individually placed in the flux chamber and remained inside for approximately 24 h.

Rabbit activity was continuously recorded during the 24-h period with a video camera (SONY® DCR-HC17E) equipped with an infrared sensor, installed over the chamber. The videos were continuously assessed to determine the behaviour of the animals. The following activities were recorded: lying, sleeping (lying with eyes closed), sitting, eating, drinking, walking, standing up on hind legs (rearing according to Gunn and Morton, 1995) and others (including sniffing, grooming, scratching and caecotrophy). The time at which each behaviour started and its duration were recorded to assess the duration of each bout of activity. Afterwards, the percentage of time dedicated to each activity was calculated. In addition, the number of times (frequency) that each behaviour was performed in one hour was also recorded.

To assess the general activity of the animals during the growing period, an hourly relative activity index including all the observed activities except sitting, lying and sleeping (Estellés *et al.*, 2010) was used. Differences in activity during night and day and the week of the growing period were also considered.

The percentage of time in which animals were active during night and daytime, the percentage of time dedicated to each activity and the mean frequency of each behaviour were analysed by general lineal models (proc GLM) of SAS (2009).

## RESULTS AND DISCUSSION

Activity patterns in the present study during night and day are presented in Table 1. In this case, the age of the animals was not statistically significant for any of the studied behaviours. As shown, the percentage of time active during night and day was  $40.74 \pm 14.6$  and  $24.75 \pm 9.41$ %, respectively ( $P=0.0473$ ), so it can be observed that rabbits were more active during the night period. This effect was also statistically significant in specific behaviours such as sleeping, eating and drinking. It was observed that rabbits ate and drank more during the night, whereas resting behaviours were performed more during the day. Nocturnal patterns of both wild and domestic rabbits housed in cages have been widely demonstrated in the literature (Jilge, 1991; Kennedy *et al.*, 1994; Princz *et al.*, 2008a). Thus, our results suggest that nocturnal habits of rabbits were not affected inside the flux chamber.

Regarding the percentage of time that the animals were performing a specific activity, and the frequency for each of them (Table 1), rabbits spent most of their time resting, including lying, sleeping and sitting (68.09% of the total daily time), followed by the category "others" and eating or drinking. These findings are in agreement with other authors

**Table 1:** Average percentage of time and total daily time dedicated to each activity during day (from 7:00 to 21:00 h) and night (from 21:00 to 7:00 h) inside the flux chamber (average±standard deviation).

	Average percentage of time (%)			Absolute daily time (min)		
	Day	Night	Total	Day	Night	Total
Lying	22.56±8.45	20.57±10.82	21.67±8.42	176.37±65.82	123.40±64.94	299.77±119.11
Sleeping	46.95 <sup>a</sup> ±8.39	33.46 <sup>b</sup> ±9.98	40.87±8.13	364.58 <sup>a</sup> ±51.06	200.78 <sup>b</sup> ±59.89	565.36±100.80
Sitting	5.74±1.57	5.23±1.68	5.55±1.54	45.40 <sup>a</sup> ±14.54	31.35 <sup>b</sup> ±10.09	76.75±23.61
Eating	6.60 <sup>a</sup> ±2.98	13.27 <sup>b</sup> ±4.93	9.56±3.45	52.66 <sup>a</sup> ±25.48	79.63 <sup>b</sup> ±29.60	132.29±48.85
Drinking	2.74 <sup>a</sup> ±1.68	7.37 <sup>b</sup> ±2.64	4.79±1.36	22.10 <sup>a</sup> ±14.98	44.20 <sup>b</sup> ±15.84	66.30±18.71
Walking	0.92±0.24	1.00±0.29	0.96±0.22	7.28±2.19	6.02±1.72	13.30±3.29
Rearing	0.55±0.36	0.69±0.37	0.62±0.30	4.38±2.99	4.16±2.21	8.54±4.28
Others	13.95±4.16	18.41±6.37	15.97±4.95	110.40±35.29	110.45±38.22	220.85±71.03
General activity	24.75 <sup>a</sup> ±9.41	40.74 <sup>b</sup> ±14.60	31.81±6.21	196.81 <sup>a</sup> ±80.93	244.46 <sup>b</sup> ±87.59	441.27±92.49

Means with different letters in the same row and parameter indicate differences statistically significant between day and night ( $P < 0.05$ ).

working with conventional cages and similar conditions such as Princz *et al.* (2008a) and Ribikauskas *et al.* (2010), who found a similar time budget (between 66.9 and 66.2% respectively).

In addition, in our study the category “others” presented the highest frequency and a 15.97% of total time. It must be considered that this category includes self-body care and exploratory behaviours. Self-body care is known to be a time-consuming behaviour (8.48% of time according to Ribikauskas *et al.*, 2010), contributing to increase the frequency of “others”. In addition, exploratory behaviours in the present study can be expected to be higher than previously reported values (e.g. 3% of total time according to Princz *et al.*, 2008a). A possible reason may be that the flux chamber is as a novel environment for the animal, and therefore investigatory behaviours could increase, both due to the need to explore and the escape instinct (Trocino and Xiccato, 2006). Taking all these aspects into account, and considering that anomalous behaviours, which may indicate distress and impaired welfare (Verga *et al.*, 2007), were not found in any animal, we may assume that our experimental conditions in a flux chamber did not alter general behaviour.

Regarding rearing, it can be observed in Table 1 that this was the activity with the least total duration, whereas it showed higher frequencies (Table 2) than drinking, eating and sleeping. Values are in accordance with Martrenchar *et al.* (2001), who stated that rabbits performed this behaviour less than 0.7% of the time.

As described by Seaman *et al.* (2008), rearing can be considered an exploratory or alert behaviour, and both of them are activities which may increase when animals are in a novel environment. Thus, rearing can be observed when rabbits are subjected to an open field test (Verwer *et al.*, 2009; Hansen and Berthelsen, 2000). In addition, alert behaviours such as thump might present short durations (Gunn and Morton, 1995), but they are important for the animals. However, it has been suggested that rearing is not a real requirement of rabbits (Princz *et al.*, 2008b), basing the argument on its low duration. In this sense, attending to the mean duration of behaviours each time that they were performed (Table 2), rabbits devoted 3.27 s to rearing. This duration was slightly lower than sitting events (3.72 s), and longer than walking (1.30 s). This may suggest that not only the frequency or the duration of behaviours should

**Table 2:** Daily average frequency and mean duration of each event of activity inside the flux chamber (average±standard deviation).

	Average frequency (times/h)	Mean duration of each event (s)
Lying	18.4±7.4	41.54±57.96
Sleeping	7.5±3.8	192.52±200.22
Sitting	52.6±27.5	3.72±7.41
Eating	4.9±3.3	78.82±100.69
Drinking	3.7±2.9	68.70±98.08
Walking	26.2±20.0	1.30±0.74
Rearing	8.5±9.2	3.27±3.79
Others	59.6±32.8	9.47±16.50

be considered, but also the combination between them. Consequently, further research is required to determine the need to manifest natural behaviours such as rearing, the tendency to do so and the consequences associated with the inability to perform them.

## CONCLUSIONS

Nocturnal habits and time budget of rabbits placed inside a flux chamber did not present relevant alterations compared to previously reported activity patterns. Therefore, chamber studies with rabbits are acceptable in terms of animal behaviour and welfare if a proper chamber design is considered. Rearing up was found to occur inside the chamber, but rabbits spent a short percentage of their time performing it. However, the relevance of this behaviour should be more accurately investigated in terms of duration and frequency.

## REFERENCES

- Baselga, M. 2002. Line V (Spain). *Options Méditerranéennes, Serie B: Etudes et recherches*, 38: 235-241.
- EFSA (European Food and Safety Authority). 2005. Scientific report "The impact of the current housing and husbandry systems on the health and welfare of farmed domestic rabbit", *EFSA-Q-2004-023, Annex to EFSA Journal*, 267:1-31.
- Estellés F., Calvet S., Blumetto O., Rodríguez-Latorre A.R., Torres A.G. 2009. Technical Note: A flux chamber for measuring gas emissions from rabbits. *World Rabbit Sci.*, 17: 169-179. doi:10.4995/wrs.2009.657
- Estellés F., Rodríguez-Latorre A.R., Calvet S., Villagrà A., Torres A.G. 2010. Daily carbon dioxide emission and activity of rabbits during the fattening period. *Biosyst. Eng.*, 106: 338-343. doi:10.1016/j.biosystemseng.2010.02.011
- Farrell D.J. 1972. Indirect Closed-Circuit Respiration Chamber Suitable for Fowl. *Poultry Sci.*, 51: 683-688. doi:10.3382/ps.0510683
- Farm Animal Welfare Council (FAWC). 1991. Report on the European Commission proposals on the transport of animals. *PB 0687 September 1991. London.*
- Gunn D., Morton D.B. 1995. Inventory of the behaviour of New Zealand White rabbits in laboratory cages. *Appl. Anim. Behav. Sci.*, 45: 277-292. doi:10.1016/0168-1591(95)00627-5
- Hansen L.T., Berthelsen H. 2000. The effect of environmental enrichment on the behaviour of caged rabbits (*Oryctolagus cuniculus*). *Appl. Anim. Behav. Sci.*, 68: 163-178. doi:10.1016/S0168-1591(00)00093-9
- Jensen P. 2002. The ethology of domestic animals. *CABI Publishing, Wallingford, Oxon.* doi:10.1079/9780851996028.0000
- Jilge B. 1991. The Rabbit - A diurnal or a nocturnal animal. *J. Exp. Anim. Sci.*, 34: 170-183.
- Kennedy G.A., Hudson R., Armstrong S.M. 1994. Circadian wheel running activity rhythms in two strains of domestic rabbit. *Physiol. Behav.*, 55: 385-389. doi:10.1016/0031-9384(94)90151-1
- Martrenchar A., Boilletot E., Cotte J.P., Morisse J.P. 2001. Wire-floor pens as an alternative to metallic cages in fattening rabbits: Influence on some welfare traits. *Anim. Welfare*, 10: 153-161.
- Negretti P., Bianconi G., Finzi A. 2010. Rabbit posture and behaviour to determine cage height in relationship with animal welfare. In *Proc.: XXXV Symposium de Cunicultura de ASESCU, May 27-28, 2010, Segovia, Spain*, 1: 54-58.
- Piattoni F., Demeyer D.L., Maertens L. 1996. *In vitro* study of the age-dependent caecal fermentation pattern and methanogenesis in young rabbits. *Reprod. Nutr. Dev.*, 36: 253-261. doi:10.1051/rnd:19960303
- Princz Z., Dalle Zotte A., Radnai I., Biró-Németh E., Matics Zs., Gerencsér Zs., Nagy I., Szendrő Zs. 2008a. Behaviour of growing rabbits under various housing conditions. *Appl. Anim. Behav. Sci.*, 111: 342-356. doi:10.1016/j.applanim.2007.06.013
- Princz Z., Radnai I., Biró-Németh E., Matics Zs., Gerencsér Zs., Nagy I., Szendrő Zs. 2008b. Effect of cage height on the welfare of growing rabbits. *Appl. Anim. Behav. Sci.*, 114: 284-295. doi:10.1016/j.applanim.2008.01.006
- Ribikauskas V., Ribikauskienė D., Skurdenienė I. 2010. Effect of housing system (wire cage versus group-housing) and in-house air quality parameters on the behaviour of fattening rabbits. *World Rabbit Sci.*, 18: 243-250. doi:10.4995/wrs.2010.777
- SAS®. 2009. SAS/STAT User's Guide (Release 9.1). *SAS Inst. Inc., Cary N.C., USA.*
- Seaman S.C., Waran N.K., Mason G., D'Eath R.B. 2008. Animal economics: assessing the motivation of female laboratory rabbits to reach a platform, social contact and food. *Anim. Behav.*, 75: 31-42. doi:10.1016/j.anbehav.2006.09.031
- Trocino A., Xiccato G. 2006. Animal welfare in reared rabbits: a review with emphasis on housing systems. *World Rabbit Sci.*, 14: 77-93. doi:10.4995/wrs.2006.553
- Verga M., Luzi F. 2006. Housing of rabbits in conformity with animal welfare and protection criteria. Behaviour of kits. In: *Maertens L., Coudert P. (ed.). Recent advances in Rabbit Sciences, ILVO, Melle, Belgium*, pp. 83-86.
- Verga M., Luzi F., Szendrő Zs. 2006. Housing of rabbits in conformity with animal welfare and protection criteria. Behaviour of growing rabbits. In: *Maertens L., Coudert P. (ed.). Recent advances in Rabbit Sciences, ILVO, Melle, Belgium*, pp. 91-97.
- Verga M., Luzi F., Carezzi C. 2007. Effects of husbandry and management systems on physiology and behaviour of farmed and laboratory rabbits. *Horm. Behav.*, 52: 122-129. doi:10.1016/j.yhbeh.2007.03.024
- Verwer C.M., van Amerongen G., van den Bos R., Hendriksen C.F.M. 2009. Handling effects on body weight and behaviour of group-housed male rabbits in a laboratory setting. *Appl. Anim. Behav. Sci.*, 117: 93-102. doi:10.1016/j.applanim.2008.12.004
- Webster J. 2005. Animal Welfare: limping towards eden: A practical approach to redressing the problem of our dominion over the animals. *Blackwell publishing, Oxford, UK.* pp. 283. doi:10.1002/9780470751107
- Zucca D., Marelli S.P., Redaelli V., Heinzl E., Cardile H., Ricci C., Verga M., Luzi F. 2012. Effect of environmental enrichment and group size on behaviour and live weight in growing rabbits. *World Rabbit Sci.*, 20: 89-95. doi:10.4995/wrs.2012.1082