CAGE FLOOR ENRICHMENT CONTRIBUTES TO PHYSICAL AND THERMAL COMFORT OF FATTENING RABBITS

Dutra D.[1]*, Villegas-Cayllahua E.[1], Ferrari F.[1], Costa M.[2], Rein A.[2], Silva A.[1], Moraes P.[2], Borba H[1].

[1]Dept. of Animal Science, FCAV, UNESP, Brazil, 14884-900, Jaboticabal, Brazil
[2]Dept. of Veterinary Surgery, FCAV, UNESP, 14884-900, Jaboticabal, Brazil
*Corresponding author: danielrdutra@hotmail.com

ABSTRACT

The aim of the study was to evaluate the effect of enriched cage floor on behavioral and physiological traits of 90-d fattening rabbits. A total of 45 males were individually housed in wire cages. Two types of cage floor enrichment were compared (clay tile *vs* porcelain tile), whereas 15 all-wire floors were assigned as control. Animals could freely choose between tile floor or wire-mesh. Rabbit behavior was observed through 3 days and scanned every 15 minutes, 8 hours daily. Superficial body temperature was determined hourly and respiratory frequency (fR) 3 times a day. Time budgets showed that activity and posture categories were poorly influenced by the type of floor and had no effect on behavior. Although the choice between clay and porcelain tile did not differ significantly, the animals spent more time on the floor tile than on wire-mesh (66% *vs* 34% observation time; $P<0.001$). Overall fR decreased by 10.7% in rabbits kept on the porcelain tile compared to the others ($P<0.01$). In addition, ears and muzzle temperatures were higher ($P<0.01$) in rabbits with no floor enrichment in their cages (ears: $+3.1^{0}$C; muzzle: $+1.9^{0}$C). These results demonstrated that cage floor enriched with tiles, especially porcelain tile, affects positively the thermoregulation and can be used to improve physical and thermal comfort of fattening rabbits.

Key words: Animal behavior, Rabbit production, Resting, Skin temperature, Welfare.

INTRODUCTION

Environmental enrichment was well defined by Newberry (1995) as an improvement in the biological functioning of captive animals resulting from modifications to their environment. However, it is well known that most of the fattening rabbits reared worldwide are still housed in all-wire cages, without any kind of floor enrichment or with few concerns about the animal welfare. Wire net floor can lead to severe consequences in reproducing animals, as foot pad injuries (Rosell and De La Fuente, 2013) and abnormal patterns of behavior such as biting the cage bars and excessive body care (Hansen and Berthelsen, 2000). An effective solution would be the use of flooring material generally used in construction projects, covering the wire-mesh partially. With low porosity and high mechanical strength, they might be used as footrests or bodyrests. This type of floor enrichment would be proposed for fattening rabbits, in this way stimulating rest and physical comfort. A few papers have been published evaluating different types of floor, such as concrete, plastic-mesh, steel-slat, iron-slat, straw layer, wood-slat and elevated platform (Morisse *et al*., 1999; Princz *et al*., 2008; Trocino *et al*., 2008; Abdelfattah *et al*., 2013; Trocino *et al*., 2015; Masthoff and Hoy, 2019; Windschnurer *et al*., 2019). However, as simple as it seems, there is a lack of information about flooring used as body rest and its interaction with the rabbits. Facing this scenario, the objective of our study was to evaluate the effect of two different floor tiles as environmental enrichment in traditional wire cages on behavioral and physiological parameters of fattening rabbits.

MATERIALS AND METHODS

Animals and Experimental Design

Data collection was performed at the Rabbit Production Unit at UNESP, Jaboticabal, SP, Brazil, in an open east-west oriented building. During the experimental period, the average temperature was 21.3°C with 79% of relative humidity. A total of 45 fattening male rabbits at 90 days of age, from *Botucatu* genetic group, were randomly assigned to individual all-wire cages (80 x 60 x 40 cm). *Botucatu* is a synthetic strain reared in Brazil, originated from Norfolk 2000 rabbits. It has five decades of local adaptation and has been selected for growth rate and litter size since 1992 (Moura *et al*., 2001). Two types of cage floor enrichment were compared (clay tile *vs* porcelain tile) and set on the wire-mesh, while 15 all-wire floors were assigned as control with no enrichment (n=15 repetitions/treatment), as shown in figure 1. A set of 5 clay tiles attached to the cage floor made one unit. Tiles were uniform in width and length (60 x 24 x 0.7 cm) and covered 51.4% of the cage floor. Animals could freely choose between tile or wire-mesh. Behavioral observations were carried out directly from 9 am to 5 pm, throughout three days, and scanned by 15 minutes (n = 33 scans per day/animal). An ethogram was designed within three categories: activity (feeding, moving, resting and self-cleaning), posture (sitting, laying and standing) and body position on the enriched floor (front, back, half and whole body). Respiratory frequency (fR) were determined 3 times a day (9 am, 2pm and 5pm) by breathing counting observation on the rabbit flank. Superficial ear and muzzle temperatures were measured with infrared thermometer (Fluke 59 MAX, Fluke Corporations, Washington, EE. UU.). Room temperature and humidity were also checked by hour, using three humidifier-thermometers set. Animals had free access to water and food. All the cages were equipped with nipple drinkers and ceramic feeders on the opposite side of the enriched floor. Rabbits were used to the observers and to the enrichment two days prior starting the trial.

A **B** **C**

Figure 1: Cage floor enrichment evaluated: A) clay tile floor; B) porcelain tile floor; C) no enrichment (control).

Statistical Analysis

The experimental unit was the individual rabbit for all parameters evaluated. Behavioral data were analyzed using Kruskal-Wallis non-parametric test with SAS 9.0 (2002). Data regarding body superficial temperature and respiratory frequency were analyzed with GLM procedure of SAS 9.0 (2002). LSMEANS were compared by Tukey adjustment.

RESULTS AND DISCUSSION

Time Budget

There was no influence of the enriched floors on rabbit's behavior in terms of activity, posture and position on the tiles (P>0.05). Time budget barely changed in response to the treatments, showing that animals spent most of the daytime feeding (44%), resting (31%), self-cleaning (20%) and moving

inside the cage (5%) regardless from the flooring type. However, the animals showed a strong preference for the floor tiles instead of the mesh-wire (66% vs 34% observation time; P<0.001), no matter which tile material was. The majority of the rabbits chose the floor tiles exclusively for resting and no feces accumulation on the surfaces was observed, except for 3 cages (6.66%) where the animals avoided contact with dirty tiles. This issue was easily solved by changing tiles position in the cages. Rabbits kept the same behavioral repertoire and same frequency of their activities, although they stayed more often on the floor tile – just in order to get some physical comfort to their body and feet on a solid and firm floor.

Physiological Traits

Overall, ear temperature was always higher (P<0.01) compared to the muzzle (Table 1), as already seen in other researches (Lukefahr and Ruiz-Feria, 2003; De Lima *et al*., 2013). This pattern is well known, since rabbits have an extensive network of blood vessels in the ears, with relevant role for sensible heat loss (Honda *et al*., 1963).

Table 1: Effect of floor enrichment on body superficial temperature (± standard error) of fattening rabbits.

Body area	Superficial temperature (ºC)			
	Clay tile	Porcelain tile	No enrichment	*Average*
Muzzle	24.0 ± 0.1 Aa	23.8 ± 0.1 Aa	25.5 ± 0.1 Ab	*24.4 ±0.1 A*
Ear	29.0 ± 0.1 Ba	28.6 ± 0.1 Ba	31.5 ± 0.1 Bb	*29.7 ±0.1 B*
Average	*26.5 ±0.1 a*	*26.2 ±0.1 a*	*28.5 ±0.1 b*	

Means followed by different lower-case letters in a row and capital letters on a column differ significantly by Tukey test (P < 0.01).

Ears and muzzle superficial temperatures were higher (P<0.01) in rabbits housed in cages without enriched floors (ears: +3.1°C; muzzle: +1.9°C). It shows that both floor enrichments contributed to the thermoregulation process. Physical contact with the tiles likely helped the animals to exchange heat through the floor surfaces by conduction, and, consequently, decreased muzzle and ears temperature. The diameter of blood vessels that supply bare skin would shrink (vasoconstriction), decreasing blood flow to the ear and muzzle.

Porcelain tile also affected positively the respiratory frequency of the animal (-10.7%) compared to the other two groups (P<0.01) (Table 2). Lower temperatures of ear and muzzle within the porcelain group led to a lower respiratory rate compared to the other groups.

Table 2: Effect of floor enrichment on respiratory frequency (fR) (± standard error) at different hours of the day in fattening rabbits.

Floor enrichment	fR (breathing/min)			
	9h	14h	17h	*Average*
Clay tile	60.2 ± 1.9	63.8 ± 1.9	62.9 ± 1.9	*62.3 ±1.1 A*
Porcelain tile	53.4 ± 1.9	56.7 ± 1.9	60.0 ± 1.9	*56.7 ±1.1 B*
No enrichment	65.1 ± 1.9	63.2 ± 1.9	62.7 ± 1.9	*63.7 ±1.1 A*
Average	*59.6 ±1.1*	*61.2 ±1.1*	*61.9 ±1.1*	

Means with different letters on the same column differ significantly at P<0.01 by Tukey test.

The significative difference for fR, presumably, happened due the thermal characteristics of each floor. With higher density and lower porosity, the porcelain tile is characterized by a higher thermal conductivity than the clay tile (García *et al*., 2010). So, the animal loses heat through the porcelain surface more efficiently, without activating thermoregulatory mechanisms (i.e. increased respiratory rate) to balance his core temperature as the other two groups did (P<0.01).

As the respiratory rate is directly affected by heat loss through the floor surfaces and the animals spent most of their time on the floor tile, our research encourages more studies with alternative materials to be used as floor enrichment for fattening rabbits, in order to contribute to the animal welfare on rabbitries.

CONCLUSIONS

Our results demonstrated that cage floor enriched with tiles, especially porcelain tile, affects positively the thermoregulation and can be used within production systems to contribute to the physical and thermal comfort of fattening rabbits.

REFERENCES

Abdelfattah E., Karousa M., Mahmoud E., EL-Laithy S., El-Gendi G., Eissa N. 2013. Effect of cage floor type on behavior and performance of growing rabbits. *J. Vet. Adv*., 3, 34–42.

De Lima V., Piles M., Rafel O., López-Béjar M., Ramón J., Velarde A., Dalmau A. 2013. Use of infrared thermography to assess the influence of high environmental temperature on rabbits. *Res Vet Sci.,* 95, 802-810.

García E., De Pablos A., Bengoechea M.A., Guaita L., Osendi M.I., Miranzo P. 2010. Thermal conductivity studies on ceramic floor tiles. *Ceram. Int.,* 37, 369–375.

Hansen L.T., Berthelsen H. 2000. The effect of environmental enrichment on the behavior of caged rabbits (*Oryctolagus cuniculus*). *Appl Anim Behav Sci.,* 68, 163-178.

Honda N., Carlson L.D., Judy W.V. 1963. Skin temperature and blood flow in the rabbit ear. *Am. J. Physiol*., 204, 615-618.

Lukefahr S.D., Ruiz-Feria C.A. 2003. Rabbit growth performance in a subtropical and semi-arid environment: effects of fur clipping, ear length, and body temperature. *Livest. Res. Rural Dev.* 15, 1–10.

Masthoff T., Hoy S. 2019. Investigations on the influence of floor design on dirtiness and foot pad lesions in growing rabbits. *Animals,* 9, 354.

Morisse J.P., Boilletot E, Martrenchar A. 1999. Preference testing in intensively kept meat production rabbits for straw on wire grid floor. *Appl Anim Behav Sci.,* 64, 71-80.

Moura A.S.A.M.T., Costa A.R.C., Polastre R. 2001. Variance components and response to selection for reproductive, litter and growth traits through a multi-purpose index. *World Rabbit Sci.,* 9, 77-86.

Newberry R.C. 1995. Environmental enrichment: Increasing the biological relevance of captive environments. *Appl. Anim. Behav. Sci.*, 44, 229-243.

Princz Zs., Nagy I., Radnai I., Gerencsér Zs., Szendrő Zs. 2008. Effect of the floor type and stocking density on the productive performance of growing rabbits. *In: Proc. 9th World Rabbit Congress, 2008 June, Verona, Italy, 1225-8.*

Rosell J.M., De La Fuente L.F. 2013. Assessing ulcerative pododermatitis of breeding rabbits. *Animals,* 3, 318–326.

SAS. 2002. SAS/STAT User's Guide (Release 9.0). *SAS Inst. Inc., Cary NC, USA.*

Trocino A., Filiou E., Tazzoli M., Birolo M., Zuffellato A., Xiccato G. 2015. Effects of floor type, stocking density, slaughter age and gender on productive and qualitative traits of rabbits reared in collective pens. *Animals,* 9, 855–861.

Trocino A., Xiccato G., Majolini D., Fragkiadakis M. 2008. Effect of Cage Floor and Stocking Density on Growth Performance and Welfare of Group Housed Rabbits. *In: Proc. 9th World Rabbit Congress, 2008 June, Verona, Italy, 1251–1256.*

Windschnurer I., Waiblinger S., Hanslik S., Klang A., Smajlhodzic F., Löwenstein M., Niebuhr K. 2019. Effects of Ground Floor Type on Selected Health-Parameters and Weight of Rabbits Reared in Group. *Animals,* 9, 216.