INFLUÊNCIA DO SISTEMA DE ALOJAMENTO EM PISO COM CAMA SOBRE O ESTADO SANITÁRIO, O DESEMPENHO E AS CARACTERÍSTICAS DE CARCAÇA DE COELHOS EM CRESCIMENTO

INFLUENCE OF PEN HOUSING WITH LITTER ON SANITARY STATUS, PERFORMANCE AND CARCASS TRAITS OF GROWING RABBITS

RESUMO

O objetivo deste estudo foi avaliar o estado sanitário, o desempenho produtivo e as características de carcaça de coelhos em crescimento alojados em piso com cama e em gaiola convencional Aos 35 dias, 54 coelhos mestiços (Nova Zelândia Branco x Botucatu) foram alojados aleatoriamente em piso com cama (6 boxes; 6 coelhos/box; 2,3 coelhos/m²) ou em gaiola (6 gaiolas; 3 coelhos/gaiola; 8,3 coelhos/m²) e mantidos até a idade de abate, aos 77 dias. Para simular as condições de granja, os coelhos alojados em piso não foram previamente submetidos à este sistema, para adaptação. Houve maior intensidade de sujeira e ocorrência de muco nos coelhos alojados em piso no primeiro período, entretanto, esta ocorrência praticamente desapareceu no período posterior. Para o desempenho, os coelhos alojados em gaiola apresentaram maior peso vivo aos 56 dias (1714 *vs.* 1506 g; P<0,001), bem como, maior ganho de peso diário (46,4 *vs.* 36,7 g/d; P<0,001) e melhor conversão alimentar (2,75 *vs.* 3,33; P<0,05), no período de 35 a 56 dias. Entretanto, estes animais não mantiveram (P>0,05) os resultados de melhor desempenho no período posterior (56 a 77 dias). Não houve efeito (P>0,05) de sistema de alojamento para os rendimentos de carcaça referência, gordura dissecável e de pernil. Pode-se sugerir a ocorrência de adaptação dos coelhos ao piso, ao longo do tempo. Portanto, é indicada a adoção do sistema de alojamento em piso com cama para coelhos em crescimento.

PALAVRAS-CHAVE: Bem-estar Animal. Cunicultura. Gaiola. Saúde Animal. Sistema Alternativo.

ABSTRACT

The objective of this study was to evaluate the health status, productive performance and carcass traits of growing rabbits housed in pen with litter and conventional cage. At 35 d, 54 crossbred rabbits (New Zealand White *vs.* Botucatu) were randomly housed in pen with litter (6 pens, 6 rabbits/pen, 2.3 rabbits/m²) or cage (6 cages, 3 rabbits/cage, 8.3 rabbits/m²) and kept until the age of slaughter at 77 d. To simulate farm conditions, the rabbits that were housed in pen housing system have not been previously adapted to the new system. There was greater intensity of dirt and mucus occurrence in the rabbits housed in pens in first period, but the mucus occurrence practically disappeared in the later period. For performance, the rabbits housed in cages had a higher live weight at 56 d (1714 *vs*. 1506 g; P<0.001), as well as BWG (46.4 *vs.* 36.7 g/d, P<0.001) and better FC (2.75 *vs.* 3.33; P<0.05) from 35 to 56 d. However, these animals did not show the best performance (P>0.05) in the posterior period (56 to 77 d). There was no effect (P>0.05) of housing system for carcass yield, dissectible fat and hind leg yield. It may be suggested that rabbits adapt to the floor over time. Therefore, it is indicated the adoption of this system for growing rabbits.

KEY-WORDS: Animal Welfare. Rabbit Production. Cage. Animal Health. Alternative System

INTRODUCTION

Scientists, decision-makers of the food industry and even consumers need information on the effect of alternative breeding systems on animal welfare as well as on meat quality and

52 animal health. To meet the expectations of customers, several researchers have studied the
53 effects of alternative production method on the performance traits of fattening rabbits. One of
54 the most important conclusions of the studies is that breeders have to keep in mind the new
55 trends of animal husbandry which are directed toward a better quality of the whole production
56 process, including the improvement of the life-quality of animals. Many methods of keeping
57 rabbits on deep litter have been examined. From these trials increasingly clear tendencies are
58 emerging (METZGER et al., 2003; SZENDRÖ & MCNITT, 2012).

59 Currently there is great pressure from society to which animals can be breeding with
60 welfare standard. Although some countries as Austria and Belgium have specifics rabbit
61 welfare laws, the European community is needy of protection laws. There is a statement (EFSA,
62 2005) for rabbits and recently the European parliament published a document containing
63 minimum standard for the protection of farm rabbits (EP, 2017).

64 The rabbit breeding on the floor pen covered with litter objectives the use of
65 unproductive areas of the farm, such as shed previously used by other animal species. This
66 alternative housing system can provide more space to the rabbits, contributing to an increased
67 expression of their natural behavior and welfare (DIXON et al., 2010). It can also reduce
68 productive costs considering that cages are not necessary (DAL BOSCO et al., 2002;
69 RAMIREZ et al., 2009; GERENCSÉR et al., 2014)

70 Enhanced knowledge on housing system would be of great value for the advancement
71 of rabbit breeding. It is known that housing systems can influence the growth of animal tissue
72 due to the possibility of mobility and greater social interaction. It can lead to changes in carcass
73 properties, as well as sanitary status (SZENDRÖ & DALLE ZOTTE, 2011). However, the
74 effect of pen housing with litter on those traits is not well known. This study had the objective
75 of investigating the effects of housing systems (pen *vs.* cage) on sanitary status, performance
76 and carcass traits of growing rabbits.

MATERIAL AND METHODS

All procedures were carried out in accordance with established guidelines for the care and use of animals for scientific purposes. The experimental protocol was approved by the Institutional Animal Care and Use Committee (CEUA/XXXXX) and registered under protocol number 28A/2016.

This study was carried out at XXXXXX, from January to February, 2018. The experimental period started at weaning (35 d) and finished at slaughter (77 d).

A total of 54 male and female rabbits, crossbreeds between New Zealand White and Botucatu genetic group, were used in this study. The Botucatu rabbit is a synthetic strain, originated from Norfolk 2000 rabbits. It has 46 years of local adaptation to the Southwestern region of São Paulo state and has been selected for growth rate and litter size since 1992 (MOURA et al., 2001, GARREAU et al., 2004, ZEFERINO et al., 2013).

The rabbits were randomly assigned to groups housed in pen on deep litter (6 pens of 2.0 x 1.3 m each; 6 rabbits per pen; 2.3 rabbits/m²; n = 36, Figure 1) or in cage (6 cages of 0.6 x 0.6 m each; 3 rabbits per cage; 8.3 rabbits/m²; n = 18). The rabbits housed in pens have not been previously adapted to this system.

Throughout the experiment, the lighting schedule was maintained under natural photoperiod (13 h of light and 11 h of darkness) and the averages of environmental temperatures were 18.6 and 30.4°C for the minimum and maximum, respectively.

The average body weight (BW) of the rabbits at the beginning of the experiment (35 d) was the same across both housing system ($P>0.05$, Table 1). Pens were equipped with bell drinkers and tubular feeders used for poultry and the cages were equipped with nipple water drinkers and semi-automatic feeders. A spring wire was added at the base of the feeders to control feed wastage.

The rabbits were allowed *ad libitum* access to water and feed over the entire experimental period. Rabbits of all groups received identical commercial pelleted diet (Total 14®) commonly used in the nutrition and formulated to meet the nutrient requirements (crude protein: 13.7%, ADF: 20.8%, estimated digestible energy: 2200 kcal/kg) of growing rabbits. At 56 d, rabbits received sulfaquinoxaline 0.03% (Vansil®) by drinking water, to prevent coccidiosis.

As bedding material, the 5 cm thick rice straw litter placed on the concrete floor was weekly revolved and after three weeks it was completely changed by a new one. Polyvinyl chloride (PVC) pipe was used for both housing systems as environmental enrichment.

For sanitary status, 18 rabbits of each housing system were evaluated at 56 and 77 d for dirt (0-2 scale: 0 for rabbits without dirt, 1 for rabbits with some dirt and 2 for rabbits with at least 1/3 of the body covered by dirt) and mucus below the nostrils (0-2 scale: 0 for rabbits without mucus, 1 for rabbits with spots and 2 for visible mucus). The rabbits were also inspected for any health problems, especially the occurrence of diarrhea, and mortality was recorded. The occurrence of lesion in the ears or loin was registered.

For performance evaluation, BW was recorded at 35, 56 and 77 d, and body weight gain (BWG), feed intake (FI) and feed conversion (FC) were recorded from 35 to 56 d, 56 to 77 d and 35 to 77 d.

At 77 d, a total of 24 rabbits (12 male and 12 female) were weighed and slaughtered by physical stunning and bleeding. Reference carcass (no head, blood or viscera) and dissectible fat (scapular and inguinal deposits) were weighed and their yield (in percentage) were determined relative to slaughter weight. The hind leg was weighed and the yield (in percentage) was determined relative to the reference carcass weight.

For the statistical analysis, the sanitary status data were compared descriptively. Performance and carcass data were submitted to analysis of variance (ANOVA) using the Statgraphics Centurion software (StatPoint Technologies, Warrenton, VA, USA). Means were

compared by the Scheffe's test and SNK test, at the 5% probability level. The experimental unit for performance was the pen or cage and carcass traits was the individual rabbit.

RESULTS AND DISCUSSION

Sanitary status

According to the sanitary status (Table 1), an average of 91.5% of the rabbits housed in pen showed dirt at the level 1 at 56 and 77 d. It means that the color of the hair from those rabbits was compromised by dirt and it could difficult the skin processing. This fact can also contribute to reduced skin commercial value and also difficulty for commercialization. The location near to the bell drinkers showed higher level of humidity, which contributed to increased number of dirty rabbits.

The presence of mucus at the level 1 was observed at 56 d in 56% of the rabbits raised in pen and 6% of the rabbits raised in cages, however, the mucus practically disappeared at 77 d. Initially, the rabbits adapted to the new housing system, which could have contributed to the reduced immunity and the emergence of disease. After adaptation, the clinical signs disappeared.

Only two lesions in the ears were observed in the group raised in pen, at 77 d. In the period before sexual maturity, fights between animals are less common. However, if the group size is increased, there is higher probability of fights (SZENDRÖ & DALLE ZOTTE, 2011).

There was no occurrence of diarrhea in the rabbits for both housing systems. No mortality was registered over the entire experimental period. It was expected the occurence of diarrhea in rabbits housed in pen, due to direct contact with their feces. However, the replacement of bedding material, as well as, the preventive treatment with sulfaquinoxaline may have contributed to the non-occurrence.

152 ***Performance***

153 Rabbits housed in cages had higher BW (P<0.001), at 56 and 77 d (Table 2) and higher
154 BWG (P<0.001) and better FC (P<0.05), from 35 to 56 d (Table 1). Matics et al. (2018)
155 evaluated the effect of cage and pen housing on the live performance and reported similar
156 results for BW and FC.

157 In the present study there was no effect (P>0.05) of housing system for BWG, FI and FC
158 from 56 to 77 d. The FI was similar (P>0.05) for rabbits from both housing systems over the
159 entire experimental period.

160 It is expected that rabbits housed in pen show higher energy expenditure, and therefore,
161 lower BWG compared to those housed in cages (DAL BOSCO et al., 2002; METZGER et al.,
162 2003). If considered the rabbit behavior, when raised on the floor, these animals present better
163 frequency of locomotor activity and it may be related to the building of fat depots (METZGER
164 et al., 2003; DIXON et al., 2010; MATICS et al. 2018, SANTA INÊS et. al., 2018).

165 The difference in BW between the housing system could also be caused by the
166 consumption of litter material (DAL BOSCO et al., 2000) and it can influence the digestive
167 process. Gerencsér et al. (2014) reported that rabbits raised on the floor with litter showed lower
168 performance at the beginning, but there was a recovery after, as verified in the present study.
169 Another important information is that rabbits prefer wire floor or plastic floor when compared
170 to the floor with straw litter (MORISSE et al., 1999; GERENCSÉR et al., 2014).

171 It is clear that it is still necessary more information about adaptations to the alternative
172 housing system in order to minimize the negative impact on productive performance of rabbits.
173 Similar results were also reported by Santa Inês et al. (2018). However our result is not
174 consistent with Ramirez et al. (2009) who reported higher final BW of rabbits raised in a pen
175 on the floor with density of 5.5 rabbits/m^2.

The performance of growing rabbits in Brazil is lower when compared to the European modern production systems, where environmental conditions are monitored and commercial feed is better adjusted. Considering the regular nutritional quality of the commercial feed used in Brazil, the performance of the animals is within the expected, being similar to that observed by Retore et al. (2012), but better when compared to Klinger et al. (2013) and Santa Inês et al. (2018).

Carcass traits

The reference carcass, dissectible fat, as well as the hind leg yield were not influenced ($P>0.05$) by the housing system. The results are presented in Table 3. These findings are different from those obtained by Dal Bosco et al. (2002), Metzger et al. (2003) and Santa Inês et al. (2018) who reported lower carcass yield and slaughter weight, respectively in rabbits raised in pen. According to Matics et al. (2018) the increased possibility of physical activity of rabbits housed in pens compared to rabbits housed in cages resulted in more developed hind part of the reference carcass, thicker hind leg bones and lower perirenal fat.

Therefore, in our study it was expected higher locomotor activies in rabbits housed in pen and, thus, higher percentage of hind leg and lower dissectible fat. The obtained data set did not confirm these assumptions. Ineffective selection of the twelve animals for slaughter in each treatment may have contributed to the absence of significant results. When few animals are selected from a small group, the randomness in choice may be compromised.

CONCLUSIONS

The pen housing with litter resulted in the occurrence of dirty hair. In addition, it resulted in decreased performance of the rabbits from 35 to 56 d, differently from 56 to 77 d, when there was no influence of the housing system in BWG. Rabbits appeared to have adapted to the pen

housing over time resulting in absence of mucus or diarrhea. Therefore, it is indicated the adoption of this system for growing rabbits.

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279 Figure 1. Growing rabbits raised in pen with litter.

280

281 Table 1 – Descriptive results (%) of sanitary status of rabbits in two housing systems (pen *vs.*

282 cage)

283

Trait	Cage housing			Pen housing		
	0	*1*	*2*	*0*	*1*	*2*
Dirt (56 d)	89	11	0	11	89	0
Dirt (77 d)	100	0	0	06	94	0
Mucus (56 d)	94	06	0	44	56	0
Mucus (77 d)	100	0	0	88.9	11.1	0

284

285 Table 2 – Performance of rabbits housed in two housing systems (cage *vs.* pen) from 35 to 77

286 d

287

Trait	Housing system		EE	P[1]
	Cage	Pen		
Body weight (BW, g)				
35 d	740	735	8	ns
56 d	1714[a]	1506[b]	26	***
77 d	2324[a]	2103[b]	26	***
Body weight gain (BWG, g/d)				
35 - 56 d	46.4[a]	36.7[b]	1.2	***
56 - 77 d	29.1	28.5	1.7	ns
35 - 77 d	37.7[a]	32.6[b]	0.6	***
Feed intake (FI, g/d)				
35 - 56 d	127.2	122.0	4.9	ns
56 - 77 d	157.7	158.8	2.6	ns
35 - 77 d	142.5	140.4	3.1	ns
Feed conversion (FC)				
35 - 56 d	2.75[a]	3.33[b]	0.13	*
56 - 77 d	5.47	5.72	0.42	ns
35 - 77 d	4.11	4.52	0.20	ns

288 [1]ns: P>0.05; *P<0.05; **P<0.01; ***P<0.001. [a,b]Values followed by different letters in a row

289 differ according to Scheffe's test at P<0.05.

290 Table 3 – Mean and standard deviations of the carcass traits of rabbits in two housing systems
291 (cage *vs.* pen), from 35 to 77 d
292

Trait	Cage housing	Pen housing	P[3]
Slaughter weight (g)	2272 (12)[a]	2205 (07)[a]	ns
Reference carcass weight (g)	1190 (10)[a]	1133 (08)[a]	ns
Reference carcass (%)[1]	52.34 (0.26)[a]	51.39 (0.32)[a]	ns
Dissectible fat (%)[1]	1.37 (0.03)[a]	1.41 (0.02)[a]	ns
Hind leg (%)[2]	30.56 (0.31)[a]	31.47 (0.27)[a]	ns

293 [1]Reference carcass (no head, blood or viscera) and dissectible fat (scapular and inguinal
294 deposits): % of slaughter weight. [2]Hind leg: % of reference carcass weight. [3]ns: P>0.05;
295 *P<0.05; **P<0.01; ***P<0.001. [a]Values followed by the same letter in a row are not
296 significantly different (P>0.05) by SNK test.