BEHAVIOR, PERFORMANCE AND PHYSIOLOGICAL PARAMETERS OF PIGS REARED IN DEEP BEDDING

FABIANA R. CALDARA[1], POLIANA S. G. ROSA[2], RONY A. FERREIRA[3], NAYANA M. DE O. REIS[4], IRENILZA DE A. NÄÄS[5], IBIARA C. DE L. A. PAZ[6], RODRIGO G. GARCIA[7], VIVIANE M. O. DOS S. FERREIRA[8]

ABSTRACT: An experiment was conducted to evaluate the behavior, performance and physiological parameters of pigs in different production systems. Twenty four animals in the growth phase were distributed in a randomized block design in three treatments: T1 - concrete floor, T2 - deep bedding with wood shaving, and T3 - deep bedding with coffee husks. The behavioral study was carried out by observing the animal behavior for an uninterrupted period of eight hours throughout seven weeks. The proportions of time spent in each behavior were characterized using the frequency histogram composition. Environmental (IBGTH), physiological (rectal and skin temperature and respiratory rate) and performance (weight gain, feed intake and feed conversion) parameters were measured in animals during the period. The production systems of deep bedding showed higher values of IBGTH. There was no effect of production systems evaluated on the performance parameters. Rectal temperature was higher in animals reared on deep bedding with coffee husks in relation to the concrete floor. The use of deep bedding benefited the behavior of piglets in the growth phase and it reduced the agonistic behavior among individuals.

KEYWORDS: environment, animal welfare, coffee husks, wood shaving, swine production.

COMPORTAMENTO, DESEMPENHO E PARÂMETROS FISIOLÓGICOS DE SUÍNOS CRIADOS EM CAMA SOBREPOSTA

RESUMO: Foi conduzido um experimento para avaliar o comportamento, desempenho e parâmetros fisiológicos de suínos, em diferentes sistemas de produção. Foram utilizados 24 suínos em crescimento, distribuídos em delineamento casualizado, nos tratamentos: T1 - piso de concreto; T2 - cama sobreposta com maravalha; T3 - cama sobreposta com casca de café. Realizou-se observação do comportamento animal, por oito horas ininterruptas, ao longo de sete semanas. Foram caracterizadas as proporções de tempo dedicadas a cada comportamento, utilizando a composição de histograma de frequência. Foram mensurados parâmetros ambientais (ITGU), fisiológicos (temperatura retal e de superfície e frequência respiratória) e de desempenho dos animais (ganho de peso, consumo de ração e conversão alimentar) durante o período. Os sistemas de produção sobre cama proporcionaram maiores valores de ITGU. Não houve efeito dos sistemas avaliados sobre os parâmetros de desempenho. A temperatura retal foi superior nos animais criados sobre cama de casca de café, em relação ao piso de concreto. O uso de camas sobrepostas beneficiou o comportamento de leitões em fase de crescimento e reduziu o comportamento agonístico entre indivíduos.

PALAVRAS-CHAVE: ambiência, bem-estar, casca de café, maravalha, suinocultura.

[1] Professora Adjunta Universidade Federal da Grande Dourados (UFGD), Faculdade de Ciências Agrárias (FCA), Dourados - MS.
[2] Estudante de Zootecnia, Universidade José Rosário Vellano (UNIFENAS), Alfenas - MG.
[3] Professor Adjunto, Universidade Federal de Lavras, Lavras - MG.
[4] Estudante de Medicina Veterinária, Universidade José Rosário Vellano (UNIFENAS), Alfenas - MG.
[5] Professora Visitante Senior, Universidade Federal da Grande Dourados (UFGD), Faculdade de Ciências Agrárias (FCA), Dourados - MS.
[6] Professora Adjunta, Universidade Federal da Grande Dourados (UFGD), Faculdade de Ciências Agrárias (FCA), Dourados - MS.
[7] Professor Adjunto, Universidade Federal da Grande Dourados (UFGD), Faculdade de Ciências Agrárias (FCA), Dourados - MS.
[8] Mestranda do Programa de Pós Graduação em Zootecnia, Faculdade de Ciências Agrárias (FCA), Universidade Federal da Grande Dourados (UFGD), Dourados, MS.
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INTRODUCTION

In recent decades, the Brazilian swine production has undergone to major changes with regard to production systems, such as constant innovations in the areas of genetics, nutrition, management and health. On the other hand, environmental laws are becoming increasingly stringent, and agricultural sectors need to adapt to these requirements, both in the maintenance of environmental quality in areas where the productions are focused, and on international requirements, in which the environmental impact of productions may be a condition to the opening of foreign markets.

Currently, the system of swine production in Brazil is based on animal rearing on compact or ripped floor, requiring the use of storage or treatment systems for the proper handling of liquid waste. The intensive farming of pigs in deep bedding was developed as an alternative to solve the problem of environmental pollution, and it may also improve the living conditions and welfare of animals (ZHANG & HE, 2006).

The pig production systems on deep bedding are developed at low cost when compared to conventional production systems on concrete floor, in terms of deployment of the facilities (MORRISON et al., 2003; DALLA COSTA et al., 2008). Besides, they promote greater welfare of the animals (BRACKE & HOPSTER, 2006; MORRISON et al. 2007; STUDNITZ et al., 2007), they are systems that are environmentally sustainable, of low environmental impact (WANG & WANG, 2010), eliminating the need for sewage lagoons, and the substrate of the bedding can be used as natural fertilizer (MORRISON et al., 2003).

The production systems of pigs on deep bedding provide to the animal the ability to select and modify their own environment, through the handling of the bedding (HÖTZEL et al., 2009). This system offers more opportunity of occupation for animals when compared to traditional intensive systems, and those animals raised on deep bedding may have similar performance when compared to traditional systems and present more physical activity and less anti-social behavior, not interfering with the quality of the carcass (MORRISON et al., 2007). However, some records indicate that growing pigs from two weeks old to slaughter, reared in bedding system, have showed performance problems, compared to the pigs conventionally housed (DALLA COSTA et al., 2008), due to worse environmental conditions provided by the heat produced in the fermentation process of the bedding.

The objective of this research was to study the behavior, the performance and the physiological parameters of pigs reared on deep bedding system with different substrates, comparing them to conventional production system, in order to assess the welfare of animals under this alternative production system.

MATERIAL AND METHODS

The experiment was conducted in the Department of Swine Production of the Experimental Farm, Faculty of Zootechnics - UNIFENAS, in the city of Alfenas, located in the southern region of the state of Minas Gerais, Brazil, latitude 21°25'44" S and longitude 45º56'49" W. The region lies in the southern outskirts of the inter-tropical zone, under the influence of high altitude (888 m). The climate is tropical mesothermal type. The average annual temperature is 19.6 °C. In relation to rainfall, the climate is humid, with average annual rainfall of 1,590 mm.

The experiment lasted seven weeks, corresponding to the length of growing pigs.

To characterize the thermal environment, the black globe and dry bulb temperatures and the relative humidity were recorded. The black globe temperature was obtained by placing a mercury thermometer inside a copper black globe, with 0.15 m diameter and 0.5 mm thick, painted externally with fresh dull paint. The dry bulb temperatures and relative humidity were obtained by means of an analog thermo-hygrometer. The dew point temperature was obtained through the program Psicrom® (RORIZ, 2003).

The measurements were performed weekly at 2 pm at 0.4 m from the floor, in each stall, during the entire experimental period. The indexes of black globe temperature and humidity (IBGTH) were calculated using the equation proposed by BUFFINGTON et al. (1981):

$$IBGTH = Tbg + 0.36\ Tdp - 330.08 \quad (1)$$

In which,

T*bg* - black globe temperature, K, and

T*dp* - dew point temperature, K.

Animals, housing and management

It was used 24 male castrated crossbred pigs (Large White x Landrace), ten weeks old and initial weight of 30 ± 0.53 kg. The animals were housed in a growing and in a finishing shed, built in masonry, with ceiling height of 2.8 m, ceramic tiling, in six stalls of 14m^2 (4 animals/stall) equipped with semi-automatic feeders and drinkers like pacifier. The diets fed to the animals were identical for all farming systems and formulated based on nutritional requirements for growth stages recommended by ROSTAGNO et al. (2005). Water and feed were provided ad libitum.

The animals were weighed individually before the housing and marked for identification with earrings. At the end of the experiment, the animals were weighed individually to determine the weight gain. The feed intake was recorded weekly.

The stalls used for the conventional farming system was cleaned and washed daily to remove feces.

Experimental Design

The animals were distributed in a completely randomized design with two replications and four animals/plot, in the following treatments:

T1: Rearing in the conventional system (compact floor);

T2: Rearing in deep bedding system with wood shavings as substrate;

T3: Rearing in deep bedding system with coffee husks as substrate.

In treatments with bedding, they were implanted with 0.3 m deep, with the back of the stall area consisted of a concrete floor in which were located the feeders and drinkers.

Behavior Data

The behavioral study was performed once a week through direct observation of each animal every five minutes during a continuous period of eight hours (from 7 am to 3 pm), over seven weeks, according to the methodology adapted as described by MARTIN & BATESON (1986).

The observation of the animals was performed in a directed form (FERREIRA, 2005), not affecting the natural behavior of the animals. They were monitored simultaneously by two observers positioned strategically, serving a scale previously established with the aid of digital clocks, where the beginning of an activity determined the end of the previous one.

The observations were used to compose the frequency histogram, characterizing the proportions of time devoted to each behavior: eating, drinking, sleeping (animal lying with eyes open or closed), interacting (positive interactions with other group members) and digging (bed, floor, other animals and elements of the stall), to characterize the behavioral profile. Each animal was considered as an experimental unit.

Physiological Data

Every other day to behavioral assessment, physiological measures were weekly taken, of rectal temperature, skin surface temperature and respiratory rate in four randomly chosen animals per treatment.

To obtain the respiratory rate, the movements of the flank of each animal were monitored in 15 seconds and multiplied by four to obtain the number of movements per minute.

After evaluation of respiratory rate, rectal temperature was obtained by digital thermometer inserted into the rectum of each animal with an audible alarm to identify the constancy of temperature.

The skin surface temperature measurements were taken using digital infrared thermometer with laser sights, with a focus directed to 0.2 m, obtained in the neck, shoulder and leg of the animal.

Statistical Analysis

Ambience, performance and physiological variable analysis (rectal temperature, respiratory rate and surface temperature) were performed using the computer program SISVAR adopting the Scott-Knott test at 5% significance level. It was conducted a descriptive analysis of behavioral data to obtain the frequency distribution of behavioral activities, and the frequencies compared using the chi-square test.

RESULTS AND DISCUSSION

The values of black globe temperature and relative humidity differ among production systems evaluated, resulting in lower IBGTH calculated in the treatment of concrete floor (70.44), followed by the deep bedding with wood shavings (74.36) and with coffee husks (77.72), followed by the deep bedding with wood shavings and the concrete floor (Table 1). The indices found in production systems on deep bedding, regardless of substrate used, were above the maximum of 72, recommended by TURCO (1997) for pigs in the growing and in the finishing phase.

TABLE 1. Mean values of dry bulb temperature (T*db*), relative humidity (RH), black globe temperature (T*bg*), dew point temperature (T*dp*) and index black globe temperature and humidity (IBGTH) assessed during the experimental period.

	T*db* (^{o}C)	RH (%)	Tbg (^{o}C)	T*dp* (^{o}C)	IBGTH
Concrete floor	24.9	51	24.4	13.1	70.44
Wood shaving bedding	29.6	33	29.0	10.9	74.36
Coffee husks bedding	32.7	28	32.0	11.9	77.72

T*dp*- calculated by Psicrom program

The highest rates observed in systems with bedding were probably caused by heat generation caused by the normal composting process. In addition, the concrete floor has a lower thermal inertia and retains less heat and, because it is washed daily, it loses excess heat by evaporation.

However, the worst weather conditions of the environment for animals reared in a system of deep bedding did not resulted in differences in animal performance (Table 2). These results agree with those obtained by CRUZ et al. (2009), who found that the performance of growing pigs, reared in different types of bedding, were similar to those reared in the traditional system.

TABLE 2. Daily weight gain mean (DWGM), daily ration consumption mean (DRCM) and feed conversion (FC) of growing swine reared on compact floor and distinct types of bedding.

Floor type	DWGM (kg/day)	DRCM (kg/day)	FC
Wood shaving bedding	0.671	1.655	2.46
Coffee husks bedding	0.674	1.662	2.46
Compact floor	0.702	1.696	2.41
C.V. (%)	17.12	7.43	5.69
P *value*	0.939	0.688	0.364

Comparing the performance of pigs reared on compact floor, deep bedding with wood shavings and with rice husks, CORDEIRO et al. (2007) found no differences in animal performance in the growth phase. However, in the finishing phase, animals kept in the conventional system (concrete floor) obtained better results for weight gain, feed intake and feed conversion. The authors explain that this fact is probably because the concrete floors have lower surface temperature, providing animals the possibility to relieve heat stress in warm periods, encouraging feed intake, weight gain and biological efficiency in the rearing system. However, DALLA COSTA et al. (2008) noted that pigs housed in conventional system during the growing-finishing phases had a higher (827g) DWGM ($p < 0.05$) than pigs housed in a bedding with sawdust (787 g), rice husks (760 g) and wheat straw (696 g).

Evaluating the performance and behavior of pigs of 60 days old to slaughter reared on a concrete floor, bedding with wood shavings and rice husks during the summer, HÖTZEL et al. (2009) observed that the temperature of the floor and the skin surface temperature were 2.2 and 3.9% higher, respectively, in the stalls with bedding than in the concrete floor, resulting in moderate effect on swine meat performance and quality, in favor of the traditional system.

It is known that in growing and finishing pigs, by being heavier, are more sensitive to the effects of heat stress caused by high temperatures ambient, and worsening performance observed in these animals is mainly due to reduced feed intake and energy costs associated with thermoregulation processes (MANNO et al., 2006). In this study, animals kept in systems with bedding, although subject to the condition of heat stress, as noted by the indexes of black globe temperature and humidity, do not show reduction in feed intake and performance. It is assumed that the stress they have been submitted, it was not enough for these parameters were significantly affected. This may be related to the limited variation in physiological parameters recorded (Table 3).

TABLE 3. Mean values of respiratory frequency, rectal and surface temperature of growing swine reared on compact concrete floor and distinct types of bedding.

Floor type	Respiratory frequency	Temperature (°C)			
		Rectal	Neck	Shoulder	Leg
Wood shaving bedding	68.2	39.3 ab	33.4	33.0	33.3
Coffee husks bedding	69.2	39.5 a	33.4	32.9	32.8
Compact floor	69.7	39.0 b	33.8	33.1	33.4
CV (%)	12.01	0.68	4.29	3.72	3.83
P *value*	0.9505	0.0260	0.8891	0.9218	0.7002

The temperature of the neck, the shoulder and the leg were similar ($p > 0.05$) between the compact floor and the different types of bedding used. The respiratory rate did not differ between treatments and remained above the threshold range considered normal for the species at this stage of rearing (REECE, 2008). Rectal temperature was higher ($p < 0.05$) in the treatment where the animals were raised on coffee husks, in relation to the concrete floor, corroborating the greatest IBGTH observed for this treatment. However, in none of the treatments, the values exceeded the limits considered normal for the species, which range from 38.7 to 39.8 °C (REECE, 2008).

The combination of high temperatures and relative humidity can reduce the amount of heat dissipated in latent form, leading to heat stress. Then reducing feed intake and increasing animal respiratory rate and rectal temperature (MANNO et al., 2006). Since the thermal comfort indices in the stalls with bedding were above the recommended for growing pigs, it was expected that the physiological parameters related to the thermoregulatory system of the pigs had a more expressive change. TINÔCO et al. (2007) consider that animals kept on concrete floors can be privileged by the management of cleaning and washing, which can reduce the temperature of the microenvironment and, consequently, the body temperature of animals.

In contrast, CORRÊA et al. (2000), evaluating the use of floors with the addition of bedding, did not observe differences in the thermal conditioning environment and animal response in relation to the variables of weight gain, feed and water intake and carcass characteristics of animals.

The choice of material used as bedding should also be considered. This material shall have suitable characteristics as the softness, absorbency and release of heat and humidity, low cost and, especially, the ease of obtainment by producers. In this study, no difference was observed between the two types of bedding assessed with respect to physiological parameters.

The piglet behavioral repertoire (Figure 1) shows that, regardless of the rearing system, the animals spent most of their time sleeping/lying down, which is longer in the bedding with coffee husks, followed by wood shavings and concrete floor.

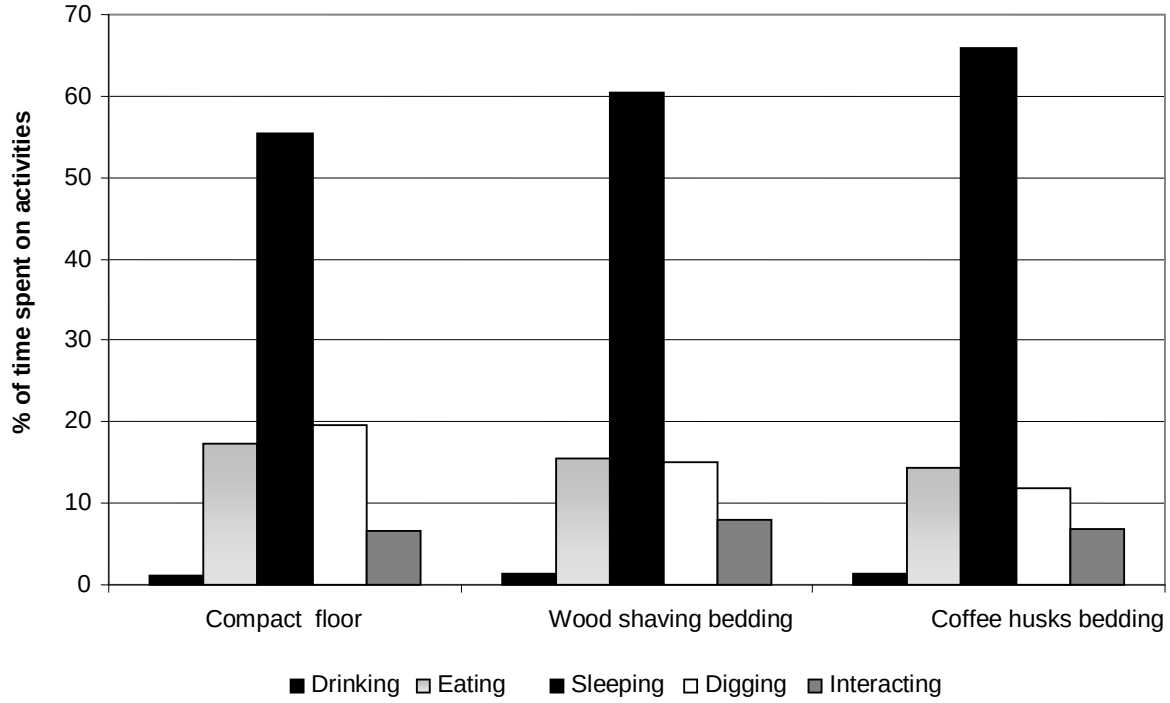

FIGURE 1. Behavioral repertoire of growing swine reared on compact concrete floor and distinct types of bedding.

The digging behavior, characteristic of animals reared in their natural habitat, was higher in the concrete floor ($p < 0.05$). Given the fact that the characteristics of the bedding system are closer to the natural conditions of rearing, this behavior would be expected to be present more frequently in treatments with bedding. However, on collection of behavioral data, for animals raised on bedding was considered only the act of digging into the substrate, while for animals raised in conventional system, the behavior "dig the other" and "dig the floor and other elements of the stall" was included in the experimental ethogram as a "dig" behavior. This may explain the higher frequency of the act of digging of the animals kept in compact floor compared to other treatments, since the animals of this treatment spent much time digging up the floor of the stall and their companions, clearly demonstrating a stereotyped behavior.

The deprivation of environmental stimuli (monotonous environment, lack of substrates or insufficient space) leads to frustration, which may reflects on anomalous or stereotypes behaviors (BRAGA et al., 2006) and increased negative interactions among group members, as noted in this experiment. The greater availability of resources reduces the need for aggression in pigs reared on deep bedding, since their attention is diverted from stall companions to bedding (HEMSWORTH & BARNETT, 2001).

The behavior of positive interaction between the animals was higher in the floor of wood shavings, followed by coffee husks floor and, finally, the concrete floor ($p < 0.05$). The presence of bedding increased the positive interactions between animals and reduced the number of agonistic interactions and vices, as the act of digging the stall fellow and the floor. According to LAY et al. (2001), finishing pigs in bedding system had fewer abnormal behaviors and had more positive interactions with each other than those ending in confinement without bedding system. Pigs housed in the system of deep bedding spent more time interacting with the environment, with higher exploratory behavior (MORRISON et al., 2007) compared to conventionally housed pigs.

When evaluating elements of the behavior of pigs reared on bedding, such as playing activity and manipulation of the substrate, HÖTZEL et al. (2009) found improvement in the welfare of pigs on bedding, concluding that environmental enrichment can affect the behavior of pigs; increasing the time they interact with their environment and reduce behaviors directed to its stall fellow.

The time devoted to water intake did not vary between treatments ($p > 0.05$), unlike CORDEIRO et al. (2007) findings who, while studying the volume of water ingested, detected variation in intake by pigs kept in different types of floor. The time spent on food intake was higher in the concrete floor, followed by floor of wood shavings and of coffee husks ($p < 0.05$); however, this did not influence the amount of food consumed, showing that animals reared in conventional system made more visits to conventional feeder without, however, eating food. This may be related to lack of other stimuli in their environment, for animals to develop other activities. These results agree with MORRISON et al. (2007), who found that pigs kept in deep bedding spent less time at the feeder and had less feeding events.

Despite not having been the object of observation in the behavioral ethogram, it was noted that animals kept in deep bedding with coffee husks showed intake of the substrate, which may have contributed to the occurrence of diarrhea in some animals. The ingestion of wood shavings also occurred, but with less intensity.

Under the evaluated conditions, there was no effect of the use of bedding in the rearing of growing pigs on performance and physiological parameters, and apparent benefits to the behavior of animals. Thus, this system can be a viable option for sustainable production of pigs. Both substrates studied were effective, however, one should assess its economic viability, taking into account their availability and cost in the region.

CONCLUSIONS

The use of deep bedding using coffee husks or wood shavings as a substrate in the rearing of growing pigs did not affect the performance and physiological parameters, and benefited the behavior of growing pigs in increasing positive interactions between individuals of the group and in reducing stereotyped behaviors such as dig the companions and other elements of the stall.

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