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Evaluation of reproductive and animal welfare parameters of swine females of different genetic lines submitted to different reproductive management and housing systems during pregnancy

[*Avaliação de parâmetros reprodutivos e de bem-estar animal de fêmeas suínas de diferentes linhagens genéticas submetidas a diferentes sistemas de manejo reprodutivo e de alojamento durante a prenhez*]

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ABSTRACT

The aim of this study was to evaluate swine females of different genetic lines submitted to different reproductive management and housing systems during pregnancy on reproductive performance and animal welfare parameters. After artificial insemination protocol, 524 females were divided into two gestation housing systems: PEN1=animals housed in individual stalls during the breeding and after group-housed; PEN32=animals housed in individual stalls from breeding until 32 days of pregnancy and after group-housed. The number of piglets born, and the pregnancy and farrowing rates were evaluated. Welfare parameters related to the pregnancy phase were used. Females who weaned more piglets in the previous farrowing had a higher number of piglets born at the next farrowing. The pregnancy rate was affected by the number of semen doses. The farrowing rate was not influenced by the evaluated parameters, with average value of 91.36%. There was no effect of the gestation housing system and the genetic lines on pregnancy and farrowing rates, with values above 90.0%. The animal welfare indicators showed more compromised parameters in PEN1 system. PEN1 system did not impair the reproductive performance although it presented more compromised animal welfare parameters.

Keywords: group-housed, individual stalls, pregnancy phase, sow

RESUMO

O objetivo deste estudo foi avaliar fêmeas suínas de diferentes linhagens genéticas submetidas a diferentes sistemas reprodutivos de manejo e alojamento durante a prenhez sobre parâmetros de desempenho reprodutivo e bem-estar animal. Após o protocolo de inseminação artificial, 524 fêmeas foram divididas em dois sistemas de alojamento de gestação: PEN1=animais alojados em baias individuais durante o protocolo de inseminação artificial e, depois, alojados em grupo; PEN32=animais alojados em baias individuais desde o protocolo de inseminação artificial até 32 dias de prenhez e, depois, alojados em grupo. O número de leitões nascidos e as taxas de prenhez e parto foram avaliados. Parâmetros de bem-estar relacionados à fase gestacional foram utilizados. As fêmeas que desmamaram mais leitões no parto anterior tiveram um maior número de leitões nascidos no próximo parto. A taxa de prenhez foi afetada pelo número de doses de sêmen. A taxa de parto não foi influenciada pelos fatores avaliados, com valor médio de 91,36%. Não houve efeito do sistema de alojamento gestacional e das linhas genéticas sobre as taxas de prenhez e parto, com valores acima de 90,0%. Os indicadores de bem-estar animal mostraram parâmetros mais comprometidos no sistema PEN1. O sistema PEN1 não prejudicou o desempenho reprodutivo, embora tenha apresentado parâmetros de bem-estar animal mais comprometidos.

Palavras-chave: alojamento coletivo, baias individuais, fase da gestação, porca

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INTRODUCTION

The European Union (EU) has been a pioneer in the development of many measures to improve animal welfare in the production system, and since 2013 it has become mandatory to abolish individual pen for sows and gilts after 28 days of pregnancy and obligated to use group-housed after this period (Knox *et al*., 2014; Dias *et al*., 2018).

As in the EU, Canadian swine producers are also in the constantly seeking to reconcile animal welfare and productivity as well as food security. For this, swine females when housed in individual stalls may remain for only 28 days after the last breed, and an additional period of up to 7 days, if necessary, to manage regrouping (Code…, 2014). In New Zealand, another country concerned with animal welfare relations and productivity, the recommendation is the removal of sows and gilts from pregnancy stall soon after breeding, with a maximum tolerance of 7 days after artificial insemination (AI) to transfer to a group-housed system (New Zealand, 2018). The current scenario of the Brazilian consumer market demands improvements regarding the housing and rearing methods of these animals (Yunes, *et al*., 2017).

The use of pregnancy pen has always been aimed facilitating the management and to optimize the distribution of the animals as well as to increase available space on farms, reduce hierarchical disputes and standardize supply and consumption of feed. However, swine are gregarious animals, which require constant social contact and interaction in a friendly way more often than aggressively (Fraser, 1999). According to Held and Spinka (2011), their interactive capacity is given by jokes and disputes for objects made available through environmental enrichment. However, when the animals are individually pen housed, there is a partial commitment or impairment of their communicative capacity and, consequently, of their freedom to express their natural behavior. Also, the little capacity of movement due to the restriction of space can predispose locomotor and genitourinary problems (Silva *et al*., 2008).

The adoption of new housing systems for sows, such as group-housed, presents a series of challenges to the pig industry and the appropriation of an animal welfare system may affect the current performance of the farms, such as the number of weaned piglets per sow per year (Spoolder *et al*., 2009). Horback and Parsons (2016) observed that behavioral differences were responsible for the variation of up to 60% of the data obtained, such as aggressiveness, fear of humans and active/exploratory animal when taking into account collective housing, due to the personality of each pregnant sow housed in large groups.

The group-housed system still presents contradictory results regarding pregnancy rate and litter size. Studies showed that group-housed females after AI may result in a decrease in the reproductive performance (Estienne *et al*., 2006; Karlen *et al*., 2007; Munsterhjelm *et al*., 2008) probably due to stressors in the embryo fixation period that occurs between the 17th and 24th pregnancy days (Alvarenga *et al*., 2013) that could result in embryonic and gestational losses. In spite of other factors such as genetic line and reproductive management traits i.e. parity order, lactation length in the previous parturition, number of weaned piglets in the previous farrowing, artificial insemination (AI) method and number of AI doses can influence the reproductive and animal welfare parameters of swine females. Therefore, the aim of this study was to evaluate swine females of different genetic lines submitted to different reproductive management and housing systems during pregnancy on reproductive performance and animal welfare parameters.

MATERIAL AND METHODS

Animal care procedures throughout the study followed protocols approved by the Ethics Committee for Animal Use (CEUA) at Instituto Federal Catarinense, number 180/2016. The experiment was carried out in a commercial farm, located in Pouso Redondo city (27º15'29" S and 49º56'02" W), in Santa Catarina state. A total of 524 females (49 gilts and 475 sows) were used in the evaluation of the reproductive performance and 166 sows were used in the evaluation of the animal welfare indicator parameters.

During the pre-breeding the females were feed with lactation diet used to provide *flushing*, containing 87.89% of dry matter, 20.55% of crude protein, 3,400kcal of metabolizable energy and

1.15% of digestible lysine. The pregnancy diet contained 85.60% of dry matter, 15.96% of crude protein, 3,150kcal of metabolizable energy and 0.82% of digestible lysine. All females received the same diet with the same ingredients and storage period, offered twice a day with water provided *ad libitum*.

From the first day after weaning the sows were submitted to tolerance reflex to the mature boar once a day in the morning. After estrus identification the females were inseminated the first time and after an interval of 24hs until the end of the tolerance reflex to the boar (1; 2; 3; ≥ 4 number of AI doses). Artificial insemination (AI) in gilts were performed with homospermic doses with volume of 80ml at the concentration of de 3.0 x 10^9 spermatozoa. For sows post-cervical AI were performed using homospermic doses with volume of 45ml at the concentration of 1.5 x 10^9 spermatozoa.

The female distribution occurred randomly to one of the following housing systems after AI protocol: PEN1=295 females (21 gilts and 274 sows) housed in individual stalls during the breeding and after group-housed, and PEN32=229 females (28 gilts and 201 sows) housed in individual stalls from breeding until 32 days of pregnancy and after group-housed. Gilts and sows were grouped in separate groups. The females were housed in groups of 11 females per pen with a floor space allowance of approximately 1.81m^2 per female. The pen floor was partially slatted, with drinking nipple and automated drop feeders.

The body condition score (1 to 5 scale) and the size of the animals were the criteria used to group the 11 females in the same pen. Females were classified according to the following parameters: gestation housing system (PEN1; PEN32); parity order (≤2; 3 to 5; 6 or more), lactation length in the previous parturition (0 (gilts); ≤ 21 d; 22 to 27 d; ≥ 28 d), genetic line (Agroceres *Camborough 25;* F1Pamplona; Penarlan; TOPIGS TN70), number of weaned piglets in the previous farrowing (0 (gilts); 1 to 11; 12 to 14; ≥15), artificial insemination method (intracervical; post-cervical), and number of AI doses (1; 2; 3; ≥ 4).

On the 25th day after the AI protocol, the pregnancy rate was obtained by a real-time ultrasound examination using a transducer of 2.90Mhz (Welld Ultrasound Scanner, China). During farrowing, the number of piglets born were obtained through Agrosui® software (*Agromanager Sistemas*®, Brazil). Removal records by locomotor problems as well as death, were kept throughout the experimental period. During the experiment period three *dataloggers* (Asko, Brazil) were allocated to record the temperature and humidity within pregnancy building, with records every 30 minutes. The average temperature ranged from 21.3°C to 23.0°C, being the maximum temperature ranging from 36.2°C to 34.4°C and the minimum from 7.4°C to 19.5°C. The average relative humidity of the air recorded ranged from 52.2% to 82.0%.

To evaluate the welfare parameters the indicators of the Welfare Quality® (2009) protocol were considered and adapted, with the parameters related exclusively to the pregnancy phase (Table 1). Each indicator was scored with “0” attributed to the observations in which well-being was considered good or “1” well-being was compromised or severely compromised (Dias *et al*., 2018), except for the body condition score indicator that was only observed individually in a 1 to 5 scale. The females of both groups (PEN1 and PEN32) were visually and individually observed during 40 to 60 seconds at two different times throughout the experiment, before 35 days of pregnancy (between 7 and 20 days) and after 35 days of pregnancy (between 42 and 65 days), when all the females were group-housed. The observation of all the indicators was made in constant contact with the animal, with the hand under head, ceilings, paws and other parts according to the Welfare Quality® (2009) protocol. Females resistant to contact that remained running away were considered committed due to human presence. The same animal could have no compromised welfare parameters, one, two, three or more, regardless of the degree of commitment.

Table 1. Parameters of welfare of swine females during gestation

Parameter	Parameter type	Evaluation
Absence of prolonged hunger		
Body condition score	Based on animal	Individual
Comfort in relation to rest		
Bursitis	Based on animal	Individual
Shoulder injuries	Based on animal	Individual
Feces adhered to the body	Based on animal	Individual
Thermal comfort		
Panting	Based on animal	Individual (>28RMM)
Absence of injury		
Claudication	Based on animal	Individual
Body wounds	Based on animal	Individual
Vulvar lesions	Based on animal	Individual
Absence of disease		
Cough	Based on animal	Individual
Sneeze	Based on animal	Individual
Dispymia	Based on animal	Individual
Rectum prolapse	Based on animal	Individual
Diarrhea score	Based on animal	Group
Metrites	Based on animal	Individual
Mastitis	Based on animal	Individual
Uterine prolapse	Based on animal	Individual
Skin condition	Based on animal	Individual
Ruptures and hernias	Based on animal	Individual
Local infections	Based on animal	Individual
Expression of appropriate social behavior		
Social behavior (positive/negative)	Based on animal	Individual
Proper expression of other conduits		
Stereotypes	Based on animal	Individual
Exploratory behavior	Based on animal	Group
Positive Human-Animal Interaction		
Human fear	Based on animal	Individual

RMM: respiratory movement per minute

The data were analyzed using the Statistical Analysis System software (SAS Inst. Inc., Cary, NC, v.9.4). Each individual female was considered an experimental unit. The total number of piglets born was analyzed using the NPAR1WAY procedure and the effect of housing system, genetic line, parity order, total weaning, lactation length in the previous farrowing, insemination method and total doses of semen was compared by the Kruskal-Wallis test. The number of compromised welfare parameters was analyzed by the same procedure and the effect of housing system was compared by the Kruskal-Wallis test.

For the variables with a binary response (pregnancy rate and farrowing rate), the analysis was performed using a binary distribution (GLIMMIX procedure). In this model housing system, genetic line, parity order, total weaning, lactation length in the previous farrowing, insemination method and total doses of semen were considered as fixed effect and the replicates as random effect. Significance was set as $P \leq 0.05$ for all tests and P values between 0.05 and 0.1 were considered a statistical trend.

RESULTS

Females who weaned more piglets in the previous farrowing had a higher number of piglets born at the next farrowing (P=0.0012) (Table 2). The females housed in the PEN1 system tended to have a higher number of piglets born than the females housed in the PEN32 system (P=0.0696), 15.27 and 14.55 respectively. The same trend (P=0.0557) was also observed for the artificial insemination method, in which post-cervical artificial insemination method resulted in a higher number of piglets born (15.03) than the intracervical AI method (14.35).

The pregnancy rate (Table 2) was affected by the total doses of semen (P=0.0378). Females inseminated with three doses of semen had a higher pregnancy rate (95.58%) than females inseminated with two (88.99%) or one (87.50%) dose of semen. The farrowing rate was not influenced by the evaluated factors, with average value of 91.36%. The frequency of compromised welfare parameters up to 35 days of pregnancy (P=0.0085) and above 35 days of pregnancy (P=0.0184) were influenced by the housing system (Table 3). In general, the PEN32 housing system resulted in smaller numbers of compromised parameters than the PEN1 housing system.

Table 2. Effect of the gestation housing system, genetic line, parity order, total weaning, lactation length, insemination method and total doses of semen on the reproductive parameters of swine females

	Number of piglets born	Pregnancy rate, %	Farrowing rate, %
Gestation housing system			
PEN1	15.27	92.86 (273/294)	91.50 (269/294)
PEN32	14.55	91.70 (201/229)	91.23 (208/228)
Pr>F	0.0696	0.8216	0.8438
Genetic line			
Agroceres	14.73	93.24 (276/296)	92.20 (272/295)
F1Pamplona	14.92	92.86 (26/28)	92.86 (26/28)
Penarlan	15.55	91.08 (143/157)	89.81 (141/157)
Topigs	14.44	90.48 (38/42)	90.48 (38/42)
Pr>F	0.1180	0.5172	0.9105
Parity order			
≤ 2	14.72	92.36 (278/301)	91.69 (276/301)
3-5	15.43	93.82 (167/178)	92.66 (164/177)
≥ 6	14.62	86.36 (38/44)	84.09 (37/44)
Pr>F	0.1173	0.4762	0.4844
Total weaning[1]			
0 (gilts)	14.05[c]	91.30 (42/46)	89.13 (41/46)
1-11	14.52[bc]	94.87 (185/195)	93.33 (182/195)
12-14	15.44[a]	91.60 (229/250)	90.76 (226/249)
≥15	15.35[ab]	84.38 (27/32)	87.50 (28/32)
Pr>F	0.0012	0.1216	0.0874
Lactation length[1]			
0 (gilts)	14.05	-	89.13 (41/46)
≤ 21	14.38	87.38 (90/103)	83.93 (47/56)
22-27	15.03	93.55 (145/155)	93.26 (180/193)
≥ 28	15.21	94.52 (69/73)	92.07 (209/227)
Pr>F	0.0768	0.3728	0.3730
Insemination method			
Intracervical	14.35	90.48 (57/63)	90.48 (57/63)
Post-cervical	15.03	92.56 (423/457)	91.45 (417/456)
Pr>F	0.0557	0.5593	0.8112
Total doses of semen			
1	16.42	87.50 (7/8)[b]	87.50 (7/8)
2	14.71	88.99 (202/227)[b]	88.94 (201/226)
3	15.15	95.58 (238/249)[a]	94.38 (235/249)
≥ 4	14.79	92.31 (36/39)[ab]	87.18 (34/39)
Pr>F	0.4832	0.0378	0.0984

PEN1: females housed in individual stalls during the breeding and after group-housed; PEN32: females housed in individual stalls from breeding until 32 days of pregnancy and after group-housed; Pr>F: Probability; [a-b]: Values within a column with different superscripts differ (P<0.05); [1]data of the previous parturition of the female.

Table 3. Frequency of compromised animal welfare parameters according to the gestation housing system of swine females up to and after 35 days of gestation

Gestation housing system	Committed Parameters[1]					Pr>F
	0	1	2	3	4	
Up to 35 days of gestation						
PEN1	40.49 (66/163)	39.26 (64/163)	15.34 (25/163)	4.29 (7/163)	0.61 (1/163)	0.0085
PEN32	56.45 (70/124)	37.10 (46/124)	5.65 (7/124)	0.81 (1/124)	0.00 (0/124)	
After 35 days of gestation						
PEN1	38.55 (64/166)	43.37 (72/166)	13.86 (23/166)	4.22 (7/166)	-	0.0184
PEN32	57.89 (44/76)	30.26 (23/76)	11.84 (9/76)	0.00 (0/76)	-	

PEN1: females housed in individual stalls during the breeding and after group-housed; PEN32: females housed in individual stalls from breeding until 32 days of pregnancy and after group-housed; Pr>F: Probability; [1]Bursitis, Shoulder injuries, Feces adhered, Claudication, Body injuries, Vulvar lesions, Cough, Metritis, Mastitis, Skin conditions, Local infections, Social behavior, Stereotypes, Exploratory behavior and Fear of humans.

DISCUSSION

In this study we evaluated the effects of transferring females to collective pens in different moments post AI on reproductive performance and animal welfare parameters. A trend effect of the housing systems on the number of piglets born was observed, with a difference of 0.72 more piglets born in PEN1, being in agreement with results observed by Perini (2017). Although in collective pens pregnant sows can undergo diverse stress situations such as feed restriction, social conflicts, mixing fight events, and bad handling techniques, which can result in pre-farrowing stress in part mediated by cortisol (Barbazanges *et al*., 1996), these possible stressor events seem not to have been strong enough to negatively affect the number of piglets born in the present study.

The pregnancy rate at 25 days post-breeding and the farrowing rate were above 90% in both housing systems, an index that is within the standards of the TOP50 best farms in Brazil managed by Agriness S2® (2017). This good index is a result of the movements and allocations to regroup the females occurring before the embryo implantation interval, as suggested by Alvarenga *et al*. (2013) and the knowledge about the establishment and maintenance of pregnancy (Spencer *et al*., 2004). Also, it is believed that the good relation between animal and man in the farm and the constant presence of the attentive people in the pregnancy stall may have avoided hierarchical disputes followed by prolonged fights between the females, contributing positively to the reproductive indicators.

In group-housing system, animals need a more intensive management for stimulus and diagnosis of estrus, detection of estrus return and diagnosis of pregnancy (Coleman *et al*., 2000). Even so, farms able to intensify assistance to sows and gilts may present favorable results (Perini, 2017). The results obtained in the study indicate that it is possible to combine welfare with the productive parameters, considering that the farrowing rate and the number of piglets born were above the Brazilian average of 91.0% and 14.50, respectively (Agriness S2®, 2017).

Females who weaned more piglets in the previous farrowing had a higher number of piglets born at the next farrowing, corroborating with the data observed by Lucia *et al*. (2000). Also, females who received three doses of semen in the AI protocol had a higher pregnancy rate than those who received two and one doses. This effect may be associated with the protocol used in the farm since the first IA is performed immediately after the detection of estrus, thus, females with long estrus duration will receive a higher number of doses of semen. As in swine the highest frequency of ovulation occurs in the final third of estrus (Soede and Kemp, 1997), females with long estrus received a higher number of doses of semen resulting in higher pregnancy rate.

The frequency of compromised welfare parameters up to 35 days of pregnancy and after 35 days of pregnancy demonstrated that the housing system affected the welfare of the swine females. Less compromised welfare parameters up to 35 days of pregnancy observed in the PEN32 system may be due to the females still being in the individual stall with little movement or physical contact with the other sows, reducing the chances of injury. Less compromised welfare parameters after 35 days of pregnancy, when all females were grouped collectively, observed in the PEN32 system may be due to the females being familiarized with each other, since they stay lodged side by side with sows with similar body score and size, conditions used in the training of the animals that remained together in the same pen.

PEN1 system females were more susceptible to injuries and fights since they stayed longer in group housed situations. Usually group housed animals present higher numbers of body injury (Cunha *et al*. 2018), due to territorial disputes and post-breed stress that may impair in welfare indicators, however, without influencing fertility (Jansen *et al*., 2007). This can be justified, since the stressing factors of the regrouping have effect in the first 48 hours, stabilizing after this period (Anil *et al*., 2006).

Aggression among swine females in pen occurs predominantly because of competition for food or to establish social hierarchy. Generally, competition for food is short-lived, but very frequent (Maes *et al*., 2016). Aggression related to establishing hierarchy is less frequent, but may be more intense, so these groups require more attention. Also, factors such as large pen, dynamic groups and pen with station system feeding (SSF), predispose the aggression among females of the same group (Anil *et al*., 2006). The present study was carried out with static groups with a maximum of 11 females per pen, with automatic feed through drops trying to minimize aggressions among females.

In addition, the selection of less aggressive animals could be beneficial for the general productivity of the herd, since this characteristic presents high heritability (Koketsu and Lida, 2017). Therefore, the individual behavior of each female should be taken into account, since they can develop different behavioral strategies when group-housed. Thus, to streamline the investigative measures in order to facilitate these grouping forms, minimizing the aggressive individual attitudes that compromise the welfare of the females housed in stalls was very relevant (Horback and Parsons, 2016).

CONCLUSION

Group housing after breeding, genetic line, parity order and lactation length in the previous farrowing did not impair the number of piglets born, the pregnancy and the farrowing rate parameters. However, the higher frequency of compromised animal welfare parameters in group-housed after breeding females, adaptation will be inevitable in order to comply with Brazilian legislation and to seek the best quality for animals and products within the reality of the production chain.

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