



Effects of maternal artificial vocalization on hyperprolific lactating sows and piglets behavior

RENNAN H.R. MOREIRA¹, RODRIGO F. DE OLIVEIRA², JORGE Y.P. PALENCIA¹,
MARINA A.G. LEMES¹, MARILANE D. SILVA¹, CESAR A.P. GARBOSA³, MÁRVIO
L.T. DE ABREU¹, GISELLE B. DE MOURA¹ and RONY A. FERREIRA¹

¹Departamento de Zootecnia, Universidade Federal de Lavras/UFLA, Avenida Sul, s/n, 37200-000 Lavras, MG, Brazil

²Departamento de Tecnologia, Faculdade de Ciências Agrárias e Veterinárias de Jaboticabal, Universidade Estadual Paulista Júlio de Mesquita Filho, Via de acesso Prof. Paulo Donato Castellane, s/n, 14884-900 Jaboticabal, SP, Brazil

³Departamento de Nutrição e Produção Animal, Faculdade de Medicina Veterinária e Zootecnia, Universidade de São Paulo, Avenida Duque de Caxias Norte, 225, Jardim Elite, 13635-900 Pirassununga, SP, Brazil

Manuscript received on April 11, 2018; accepted for publication on May 23, 2018

ABSTRACT

The objective of this trial was to evaluate the behavioral patterns and performance of lactating sows and their litters under the effect of artificial vocalization. Twenty-eight sows and their litters were distributed in a completely randomized design in a 2x2 factorial scheme (artificial vocalization x lactation week). The behavior of the animals was monitored during 24 hours on the 7th and 15th days of lactation, analyzing the number, interval, and frequency of nursings. The body condition and performance of the sows were also evaluated. Artificial vocalization promoted higher frequencies of eating for sow and nursing for piglets ($P < 0.05$), increased inactive sow behavior ($P < 0.05$), and reduced sow alert in activity ($P < 0.05$). The number and duration of suckling sessions at the 15th day of lactation were reduced ($P < 0.05$). The use of artificial vocalization did not affect the body condition or milk production of the lactating sows, or the performance of the litter during lactation ($P > 0.05$). The use of maternal artificial vocalization during lactation of sows promoted greater lactation efficiency and longer rest time, favoring the sows' welfare.

Key words: behavior suckling, piglet, swine production, sow grunting, nursing, vocal communication.

INTRODUCTION

Swine production is a dynamic system with several factors that, in synergy, can advance the production efficiency of the herd, as well as improving the welfare of the animals, which consequently progress economic efficiency. The main factors in the animals' development are genetics, nutrition,

environment, and the interaction among animals. This same awareness can be applied to the maternity environment, where sows farrow and nurse their piglets. With respect to this maternity environment, the indexes that most impact the production system are the number of piglets weaned, litter weight at weaning, and mortality.

For these indexes to be achieved, a quiet environment is required, as high frequency of noise, for example, may reduce milk production

Correspondence to: Rony Antônio Ferreira
E-mail: rony@dzo.ufla.br

due to a communication failure between the sow and the litter during suckling (Algers and Jensen 1991), which could possibly affect the productive performance of the sows. The number, duration, and interval of suckling are of fundamental importance for the adequate development of piglets, since milk is the main food source for piglets during this period. However, recent literature on this topic has been only slightly explored, and further studies on nursing behavior are necessary, as the behavior pattern of sows may change during nursing. These changes occur due to constant genetic advancement, which results in females with a greater number of piglets per farrowing and at weaning, as well as females with lower body fat content; it is possible that these factors could alter both milk production and nursing behavior. The opposite is also true: the greater the stimulation nursings instead of feedings, the greater is the milk production. This is influenced by the size of the litter, number and duration of feedings, maternal characteristics (ability), and occurrence of stressors in the maternity environment.

Pigs have the ability to communicate through vocalization; approximately 40 language expressions among litter's members have been reported (Van Putten 2000). Sounds are capable of influencing animal behavior, and can be used as positive or negative reinforcement, which is related to animals' cognitive ability (Sarubbi 2011). Therefore, the use of artificial vocalization of sows may be able to modulate their nursing behavior. The emitted calls can provide information about the emotional state of an animal, and may reflect its psychological need in the absence of individuals who would normally be participating in its social life (Watts and Stookey 2000).

Because of the lack of recent research using continuous recordings of pig vocalization during confinement time, and the lack of evaluation of welfare issues in a productive environment, studies on animal bioacoustics are characterized

as a recent and innovative study with respect to production animals. This is a new global trend related to international requirements, which are increasingly being related to good animal welfare practices (Borges 2013). The aim of the study was to evaluate the behavioral pattern of lactating sows and their litters using artificial vocalization of sows.

MATERIALS AND METHODS

FACILITIES

The experiment was carried out in two maternity barns, located in the municipality of Oliveira, Minas Gerais, Brazil. The farrowing crates instead of maternity stalls had a nipple-type drinker and specific feeders for sows and piglets, with 2/3 slatted floor sand creep area. Heating was provided to the piglets only during the first week of life.

ANIMALS, DIET, AND EXPERIMENTAL DESIGN

The study was approved by the Bioethics Committee of the Universidade Federal de Lavras, filled under registration 70/14. The experiment was conducted using 28 sows and their litters. The sows from the same genetic pattern (DB-90) between the 3rd and 5th parity, were selected from a reproductive history of 12 to 13 piglets born alive. The sow of each treatment were allocated in different barns. The farrowing occurred on the same day. In this way, the design was completely randomized in a 2x2 factorial scheme (artificial vocalization and lactation week). The experimental unit comprised sows with similar body condition and their respective litters. Only the females received feed during the experiment, according to the formula adopted by the farm, based on corn and soybean meal.

EMISSION AND SOUND CHARACTERIZATION

Based on preliminary observations of our research group made to determine the nursing interval during the 1st, 2nd, and 3rd week of lactation, the

interval was reduced in 40% and used as reference for intervals between the sound emission during the experiment. Being played for two minutes and a silence period of 14.5, 17.6, and 19.6 minutes for the first, second, and third week, respectively. During the experimental period, artificial vocalization was performed daily from 6:00 p.m. to 6:00 a.m., to avoid possible interference during the daytime period of greater sound pressure on the farm. The lights remained on during the period.

For sound emission, a sound amplifier (Ciclotron Wattson Cube 60 guitar amplifier, São Paulo, Brazil) was installed in one of the rooms, 6 meters from the nearest crate and 20 meters from the most distant, and at a height of 3 meters from the floor. Control sows were housed in another barn 50 meters apart. No sound of the artificial vocalization was possible to hear in the control barn.

The artificial vocalization used as a stimulus for the females was obtained from a video (<https://www.youtube.com/watch?v=-DBcp6YGi6k>), where the sows vocalized for 2 minutes, about 30 times during the nursing of the piglets. The sound was characterized as bass by Sound Forge Pro 11.0[®] software.

BEHAVIORAL PARAMETERS

The behaviors of the sows and their respective litters were monitored for 24 hours starting at 6:00 am on the 7th and 15th days of lactation. The images were captured by cameras and stored on a DVD recorder (NEOcam, Model H.264DVR, São Paulo, Brazil). The behavioral variables analyzed were number and interval of suckling. Suckling was considered to have commenced when half of the litter started the act with teat in the mouth.

The behaviors evaluated for the sows were feed and visits to the water fountain, stereotyped behavior, biting, inactivity, and inactive alertness were recorded as suggested by Pandorfi et al. (2006).

MEASUREMENTS OF THE SOWS AND LITTERS

The feed was given to the sows in form of mash, in time periods. The daily amount offered during lactation was determined according to the voluntary consumption of each sow. Daily records of consumption and feed waste were evaluated; for this measurement, the first daily supply began at 7:00 a.m., and the leftovers and waste were weighed. The next day's supply was always offered at the same time. Water was supplied *ad libitum* throughout the experimental period. The piglets did not receive feed throughout the sows' lactation period.

Body weight, back fat thickness, and loin depth were used as parameters for the evaluation of body condition, according to the methodology of Souza (2011). On the second day after farrowing and at weaning, the sows and litters were weighed individually. The litters were equal in weight and number of piglets after delivery (12 or 13), and the piglets were assisted to guarantee the first suckling of colostrum. To maintain a microclimate, within the piglets' thermal comfort zone, an incandescent lamp was used inside the creep for each farrowing crate.

The milk yield of the sows was estimated by an equation suggested by Noblet and Etienne (1989).

ENVIRONMENTAL MONITORING

To characterize the environment of the farrowing rooms, a temperature and relative humidity sensor with a data logger function per room was used (Instrutherm, HT-500, São Paulo, Brazil), installed at a height of 1 meter from the females, which collected the data every 10 min throughout the experimental period.

STATISTICAL ANALYSES

Statistical analyzes were performed using the SAS statistical package (9.0). All data were submitted to normality analysis by the Shapiro-Wilk test at the 5% probability level. The data that did not present

normal distribution were normalized through PROC RANK of the SAS statistical package (9.0). The data were compared by the F test. Data that were not normalized after transformation were compared by the Kruskal-Wallis test at the 5% probability level.

RESULTS

ENVIRONMENTAL MONITORING

The average values of temperature (°C) and relative humidity (%) are shown in Figure 1.

BEHAVIORAL PARAMETERS

The use of artificial vocalization did not change the behaviors of drinking, stereotyping, inactive alertness, biting, and rooting on the 7th day of lactation ($P > 0.05$). However, vocal stimulus promoted a higher frequency of eating behavior (mean of 18 minutes more per day) ($P < 0.05$) and nursing (about 66 minutes more per day); however, the sow had less inactive time ($P < 0.05$) (Table I).

At the 15th day of lactation, the use of artificial vocalization did not change the behaviors of drinking, eating, stereotyping, biting, and rooting ($P > 0.05$) (Table II). However, it promoted an increase in inactive behavior (mean of 161 minutes more per day) ($P < 0.05$) and reduction of alert

inactivity (mean of 127 minutes less per day) ($P < 0.05$), as well as less time dedicated to nursing (mean of 31 minutes fewer per day).

Artificial vocalization did not change the number, duration, and suckling interval on the seventh day of nursing ($P > 0.05$) (Table III). However, there was a reduction in the number (8.66 times) and duration (0.9 minutes) of suckling on the 15th day of nursing ($P < 0.05$), resulting in an increase in suckling of about 20 minutes ($P < 0.05$).

PERFORMANCE OF LACTATING SOWS AND LITTERS

The use of artificial vocalization did not affect body condition, milk yield of lactation sows, or litter performance during lactation (Tables IV and V).

DISCUSSION

All sows from the experiment were not in environmentally, especially during the period from 10 am to 7 pm, when the ambient temperature was 30% higher than recommended, which is between 16°C and 22°C (Bragança et al. 1998).

It is likely that the artificially emitted sound was audible for both the sows and for the piglets, since pigs often detect sounds pressure between 40 and 40,000 Hz (Heffer and Heffer 1992). Additionally, the sound reproduced for 2 minutes agreed with the

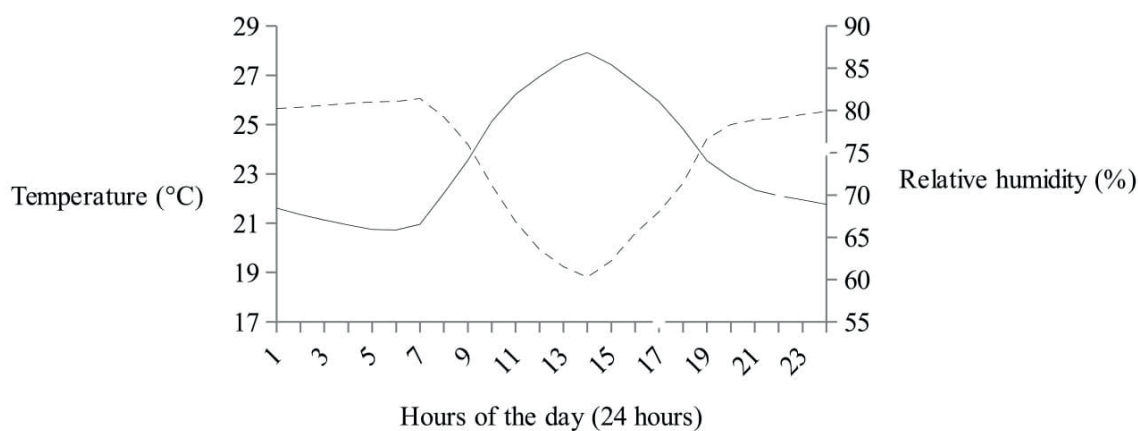


Figure 1 - Temperature (continuous line) and relative humidity of the air (dashed line) verified in the maternity room.

sonorous pattern of the swine at the time of milk ejection according to Whittemore and Fraser (1974), Fraser (1980), and Algers et al. (1985).

Some factors may modulate the behavior of pigs. It is possible that the vocalization emitted in this trial transmitted information to the brain and activated brain regions responsible for the greater intake of food by the sow on the 7th day of lactation (Oliveira Junior et al. 2011). Being more sated, the sow spent more time nursing the piglets. However, these behavioral changes resulting from artificial vocalization did not affect the number, duration, and interval of nursing during the first week of lactation. It is important to consider that piglets prefer the vocalizations produced by their own mothers in comparison with those produced by another sow or artificial sound (Puppe et al. 2003), however, artificial vocalization can modulate the behavior of the sow. This corroborates with the findings of Oliveira Junior et al. (2011), demonstrating that sows spent more than 80% of their time each day nursing or in a lying position.

Newberry and Wood Gush (1984) and Martins et al. (2008) suggested that lactating sows respond to each other's vocalizations. In a study conducted by Šilerová et al. (2013), it was verified

that sows without acoustic or visual contact did not synchronize nursing. The authors found that auditory communication is crucial for the timing of nursing. Other studies have indicated that this synchronization may result in increased frequency of nursing (Spinka et al. 2002, Illmann et al. 2002, 2005).

Changes in cognitive and motor activities in pigs were observed by Jonge et al. (2008) and by Moreira (2012) when stimulated by music, which were positive indicators of welfare.

As lactational age advances, some changes in behavior may be related to the duration of suckling, which becomes shorter as the piglets grow larger (Corassa et al. 2014).

At 15 days of lactation, females who had artificial vocalization spent less time nursing, allowing for a longer rest period (more inactive and less inactive alertness), in an intensive husbandry, this could mean moments of greater tranquility, thus increasing their welfare. In this period, artificial vocalization, despite reducing the number and duration of nursings, did not compromise the performance of the litters, and it may be suggested that the females had better lactation efficiency. Our results are similar to those reported by Fraser and

TABLE I
Behavior average daily frequencies (%) of sows due to the use of artificial vocalization or not at 7 days of lactation.

Variables	Control	Vocalization	P	Standard error	CV ¹
Drinking	0.17	0.52	0.053	0.206	103.28
Eating	0.26	1.48	0.032	0.472	147.52
Stereotyped	0.00	0.00	1.000	0.087	0.00
Inactive	80.64	73.87	0.010	1.812	6.89
Inactive alertness	4.86	5.04	0.243	1.344	65.20
Nursing	14.07	18.66	0.004	2.345	20.96
Biting	0.00	0.00	1.000	0.000	0.000
Rooting	0.00	0.43	0.064	1.802	253.85
Total %	100	100			

¹CV: Coefficient of variation (%). The parameters were compared by the Kruskal-Wallis test at the 5% probability level.

TABLE II
Behavior average daily frequencies (%) of sows due to the use of artificial vocalization or not at 15 days of lactation.

Variables	Control	Vocalization	P	Standard error	CV ¹
Drinking	0.09	0.78	0.096	0.445	192.70
Eating	1.13	0.26	0.077	0.987	141.42
Stereotyped	0.00	0.00	1.000	0.142	0.00
Inactive	72.83	84.03	0.001	2.798	9.61
Inactive alertness	12.07	3.21	0.001	2.673	84.57
Nursing	13.89	11.72	0.014	0.557	13.57
Biting	0.00	0.00	1.000	0.000	0.00
Rooting	0.00	0.00	1.000	0.000	0.00
Total %	100	100			

¹CV: Coefficient of variation (%). The parameters were compared by the Kruskal-Wallis test at the 5% level.

TABLE III
Behavior of suckling piglets due to artificial vocalization.

Suckling	Control	Vocalization	P	Standard error	CV ¹
Number (n)					
7 th day	36.29	37.63	0.388	1.149	7.78
15 th day	33.29 ^a	24.63 ^b	0.001	0.981	18.68
Duration (min)					
7 th day	5.29	6.26	0.100	0.359	15.20
15 th day	5.83 ^a	4.93 ^b	0.003	0.190	11.42
Interval (min)					
7 th day	34.49	31.94	0.081	1.038	8.57
15 th day	37.26 ^a	56.80 ^b	0.001	3.401	26.02

¹CV: Coefficient of variation (%). Means followed by different letters in the line differ by the F test.

Rushen (1991), who reported that nursing occurred at intervals of 40 to 60 minutes, and by Weary et al. (2002), who observed within the first days after farrowing, that sows can nurse 30 min a day.

It has been demonstrated in sheep and humans that newborns develop a preference for their mother's voice (Poindron and Carrick 1976, Decasper and Fifer 1980). According to a study by Walser (1986), 88% of newly born Clun Forest lamb responded exclusively to their mother's voice. It is quite possible that synchronization of nursing is impaired, at least during the first days of life, if piglets at birth are exposed to the grunts of other sows, making it more difficult to identify the

voice of their own mother (Algers 1993). Thus, it is probable that artificial vocalization had effect on the mother, if it made synchronization of feedings possible.

Once the functional structure for lactation is formed, the limiting factor for milk production and maintenance of adequate body condition comes from nutritional contribution to the mammary gland, arising from the sows' body reserves and diet (Hurley 2001). Since the sows did not have significant differences in feed intake and body condition, it was expected that there would also be no difference in milk production, since the only two sources of nutrients for its production are diet

TABLE IV
Performance and body condition of sows due to the use of artificial vocalization or not during lactation.

Variables	Control	Vocalization	P	Standard error	CV ¹
Number of sows	13	15			
Average daily feed intake (kg)	6.472	6.244	0.103	0.055	4.71
Weight of sows (kg)					
2 days	259.00	267.73	0.358	4.511	9.11
20 days	246.00	256.53	0.285	4.635	9.91
Weight loss of the sows (kg)					
2 to 20 days	13.00	11.20	0.892	0.022	276.43
Weight loss of the sows (%)					
2 to 20 days	4.94	3.02	0.686	2.213	307.21
Loin depth at 2 days (mm)	47.38	42.63	0.203	1.297	21.27
Loin depth at 20 days (mm)	58.21	53.46	0.298	1.728	20.82
Backfat thickness at 2 days (mm)	12.55	10.61	0.223	0.542	31.49
Backfat thickness at 20 days (mm)	10.02	8.41	0.160	0.409	29.50
Milkyield (kg day ⁻¹)	8.16	7.49	0.335	0.338	22.25

¹CV: Coefficient of variation (%).

TABLE V
Live weight and daily weight gain of piglets due to the use of artificial vocalization of lactating sows.

Variables	Control	Vocalization	P	Standard error	CV ¹ (%)
Number of litters	12	15			
Piglets/sow at 2 nd day	12.58	11.86	0.058	0.197	8.04
Piglets/sow at 20 th day	10.75	9.86	0.282	0.414	20.16
Weight at 2 nd day (kg)	1.384	1.501	0.230	46.401	16.96
Weight at 20 th day (kg)	5.804	5.864	0.852	149.970	13.60
ADG 2 to 20 days (g)	210.5	207.7	0.839	6.310	15.96

¹CV: Coefficient of variation (%). ADG: Average daily gain.

and body reserves. The performances of the litters are justified by the performance of the lactating sows who received similar husbandry conditions, however, the animals that were stimulated with artificial vocalization led to an improvement in the sows' behavior, indicating improved welfare.

CONCLUSION

The use of maternal artificial vocalization during lactation of sows promoted greater lactation efficiency and longer rest time, favoring their welfare.

ACKNOWLEDGMENTS

We thank Fazenda São Paulo for their support on the trial. This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), FinanceCode 001.

REFERENCES

- ALGERS B. 1993. Nursing in pigs: Communicating needs and distributing resources. *J Anim Sci* 71: 2826-2831.
- ALGERS B AND JENSEN P. 1985. Communication during suckling in the domestic pig. Effects of continuous noise. *Appl Anim Behav Sci* 14: 49-61.
- ALGERS B AND JENSEN P. 1991. Teat stimulation and milk production during early lactation in sows: effects of continuous noise. *Can J Anim Sci* 71: 51-60.
- BORGES MG. 2013. Vocalização de suínos em grupo sob diferentes condições térmicas. Tese de Doutorado, Universidade de São Paulo, 91 p.
- BRAGANÇA MM, MOUNIER M AND PRUNIER A. 1998. Does feed restriction mimic the effects of increased ambient temperature in lactating sows? *J Anim Sci* 76: 2017-2024.
- CORASSA A, DAL MAGROTR, KOMIYAMA CM, MOREIRA PSA, BALLERINI K, BALLERIN IN AND PEREIRA TL. 2014. Comportamento e parâmetros fisiológicos de porcas em lactação na transição Cerrado-Amazônia. *Com Sci* 5: 286-294.
- DECASPER AJ AND FIFER WP. 1980. On human bonding: newborns prefer their mother's voices. *Science* 208: 1174-1176.
- FRASER D. 1980. A review of the behavioural mechanism of milk ejection of the domestic pig. *Appl Anim Ethol* 6: 247-255.
- FRASER D AND RUSHEN J. 1991. Colostrum intake by newborn piglets. *J Anim Sci* 2: 1-13.
- HEFFER HE AND HEFFER RS. 1992. Auditory Perception. In: Phillips C and Piggins D (Eds), *Farm Animals and the Environment*. CAB International, Wallingford, UK, p. 159-184.
- HURLEY WL. 2001. Mammary gland growth in the lactating sow. *Livest Prod Sci* 70: 149-157.
- ILLMANN G, POKORNÁ Z AND SPINKA M. 2005. Nursing synchronization and milk ejection failure as maternal strategies to reduce allosuckling in pair-housed sows (*Sus scrofa domestica*). *Ethology* 111: 652-668.
- ILLMANN G, SMAZALOVÁ Z AND SPINKA M. 2002. Why there is a synchronization in nursing bouts in lactating sows? In: Koene PATSC (Ed), *Proceedings of the 36th International Congress of the ISAE*. Egmond aan Zee, the Netherlands, 2002. Wageningen, the Netherlands, p. 68.
- JONGE HF, BOLEIJ H, BAARS AM, DUDINK S AND SPRUIJT BM. 2008. Music during play-time: Using context conditioning as a tool to improve welfare in piglets. *Appl Anim Behav Sci* 15: 138-148.
- MARTINS TDD, COSTA AN, SILVA JHV, VALENÇA RMB AND LUDKE JV. 2008. Postura e comportamento lactacional de matrizes suínas mantidas sob condições de temperatura ambiente elevada. *Biotemas* 21: 137-145.
- MOREIRA SV. 2012. Neuromusicoterapia no Brasil: aspectos terapêuticos na reabilitação neurológica. *R Bras Music* 12: 18-26.
- NEWBERRY RC AND WOOD-GUSH DGM. 1984. The Suckling behavior of domestic pigs in semi-natural environment. *Behav* 95: 11-25.
- NOBLET J AND ETIANNE M. 1989. Estimation of sow milk nutrient output. *J Anim Sci* 67: 3352-3359.
- OLIVEIRA JÚNIOR GM, DE FERREIRA AS, OLIVEIRA RFM, SILVA BAN, FIGUEIREDO EM AND SANTOS M. 2011. Behaviour and performance of lactating sows housed in different types of farrowing rooms during summer. *Livest Sci* 141: 194-201.
- PANDORFI H, DA SILVA IJO, CARVALHO JL AND PIEDADE SMS. 2006. Estudo do comportamento bioclimático de matrizes suínas alojadas em baias individuais e coletivas, com ênfase no bem-estar animal na fase de gestação. *Eng Rural* 17: 1-10.
- POINDRON P AND CARRICK MJ. 1976. Hearing recognition of the lamb by its mother. *Anim Behav* 24: 600-602.
- PUPPE B, SCHÖN PC, TUCHSCHERER A AND MANTEUFFEL G. 2003. The influence of domestic piglets (*Sus scrofa*) age and test experience on the preference for the replayed maternal nursing vocalization in a modified open-field test. *Acta Ethol* 5: 123-443.
- SARUBBI J. 2011. Bem-estar animal não se restringe às instalações e equipamentos: o uso de novas tecnologias. In: Fórum Integral de Suinocultura: Teoria e Prática do Bem-Estar Animal na Produção de Suínos. Curitiba, Anais, p. 36-50.
- ŠILEROVÁ J, ŠPINKA M AND NEUHAUSEROVÁ K. 2013. Nursing behaviour in lactating sows kept in isolation, in acoustic and visual contact. *Appl Anim Behav Sci* 143: 40-45.
- SOUZA GHC. 2011. Níveis de ractopamina em dietas para suínos em terminação. Dissertação de Mestrado em Zootecnia, Universidade Federal dos Vales do Jequitinhonha e Mucuri, Diamantina, 43 p. (Unpublished data).
- SPINKA M, GONYOU H AND LI Y. 2002. Nursing synchronization and milk ejection success in lactating sows: don't suckle your babies alone. In: Koene PATSC (Ed), *Proceedings of the 36th International Congress of the ISAE*. Egmond aan Zee, the Netherlands, 2002. Wageningen, the Netherlands, p. 67.

- VAN PUTTEN G. 2000. An ethological definition of animal welfare with special emphasis on pig behaviour. Proceedings of the Second NAHWOA Workshop, p. 165.
- WALSER ES. 1986. How early can piglets recognise their sow's voice? *Appl Anim Behav Sci* 15: 177-187.
- WATTS JM AND STOOKEY JM. 2000. Vocal behaviour in cattle: the animal's commentary on its biological processes and welfare. *Appl Anim Behav Sci* 67: 15-33.
- WEARY DM, PAJOR EA, BONENFANT M, FRASER D AND KRAMER DL. 2002. Alternative housing for sows and litters. Effects of sow-controlled housing combined with a communal piglet area on pre- and post-weaning behaviour and performance. *Appl Anim Behav Sci* 76: 279-290.
- WHITTEMORE CT AND FRASER D. 1974. The nursing and suckling behavior and milk ejection. *Br Vet J* 130: 346-356.