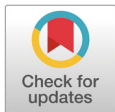


Effects of a nursing sound stimulus on performance of lactating sows and litters

Jung Hwan Jeon¹ and Doo Hwan Kim^{2*}

¹National Institute of Animal Science, Rural Development Administration, Wanju 55365, Korea

²Department of Animal Resources Technology, Gyeongnam National University of Science and Technology, Jinju 52725, Korea



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*Corresponding author

Doo Hwan Kim
Department of Animal Resources
Technology, Gyeongnam National
University of Science and Technology,
Jinju 52725, Korea.
Tel: +82-55-751-3284
E-mail: dhkim@gntech.ac.kr

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ORCID

Jung Hwan Jeon
<https://orcid.org/0000-0001-9725-547X>
Doo Hwan Kim
<https://orcid.org/0000-0002-4986-8439>

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Abstract

The goal of this study was to determine an effective interval of playing a nursing sound stimulus. One hundred forty four lactating multiparous sows (Landrace; parity range: 2 to 7) and their litters (Landrace × Yorkshire) were divided into 3 block (48 each), each of which was randomly assigned to one of the four treatment groups including control which had no call stimulus (n = 12 each). The call of nursing and suckling, plus a click sound, were used as a nursing sound stimulus that was played in the intervals of 35 min (T35), 40 min (T40) and 45 min (T45) right after the first parturition in each experimental group until the day of weaning. Nursing sound stimuli did not affect the sow feed intake and back fat thickness loss. No differences were detected among treatments in the percentages of sows returning to estrus within 5 days after weaning and sows without crushed piglets. However, the piglets' weaning weight and daily weight gain in T35 and T40 groups was greater ($p < 0.01$) than the controlled piglets. These results suggest that a nursing sound stimulus can improve the performance of suckling piglets, and that 35 or 40 min interval of playing a nursing sound could be the effective sound stimulus for nursing sows.

Keywords: Litters, Nursing grunt, Stimulus, Sows

INTRODUCTION

A high piglet weaning weight is important because there is a strong positive relationship between the weaning weight and post-weaning growth of piglets. Heavier piglet weaning weight requires fewer days to reach 105 kg more than lighter-counterparts [1]. This can contribute to the feed conversion.

Suckling piglets respond to grunting of their own sow or unfamiliar sows [2]. Jeon et al. [3] reported that playing an artificial nursing and suckling call effectively induced nursing behavior in sows and suckling behavior in piglets. In addition, Cronin et al. [4] reported that piglet growth was improved by playing the grunting call. This response of sows and piglets to the artificial nursing grunt stimulus may result in an increased piglet weaning weight.

Crushing by sows is a major cause of piglet death [5,6]. If an artificial nursing sound stimulus can reduce unsuccessful piglet suckling, it may also reduce crushing of piglets by sows. In sows, the average interval from weaning to estrus is about five days, but this can vary considerably with temperature, nu-

advice in preparation of the manuscript.

Availability of data and material

Upon reasonable request, the datasets of this study can be available from the corresponding author.

Authors' contributions

Conceptualization: Jeon JH, Kim DH.
Data curation: Jeon JH.
Formal analysis: Jeon JH, Kim DH.
Methodology: Jeon JH, Kim DH.
Software: Jeon JH.
Validation: Jeon JH.
Investigation: Jeon JH.
Writing - original draft: Jeon JH.
Writing - review & editing: Jeon JH, Kim DH.

Ethics approval and consent to participate

This article does not require IRB/IACUC approval because there are no human and animal participants.

trition, social stress, illness [7], lactation length [8,9], and number of suckling piglets [10]. Since the number of suckling piglets (suckling intensity) is one such factor, a nursing sound stimulus during the lactation period may affect the sow weaning to estrus interval.

This study was conducted to determine an effective interval of playing a nursing sound stimulus.

MATERIALS AND METHODS

Animals, housing, and management

One hundred forty four lactating multiparous sows (Landrace × Yorkshire; parity range: 2 to 7) and their litters ((Landrace × Yorkshire) × Duroc) were housed in farrowing crates (210 × 60 cm) located in pens (240 × 160 cm) within four compartments (one per treatment) of a windowless building. Fans provided a maximum ventilation rate of 14.655 cmm / sow & litter [11]. An infrared lamp (250 W) was installed above each creep area. It was turned on when temperature in the farrowing was below 29°C during the experimental period.

All sows were moved into the experimental farrowing house approximately seven days prior to farrowing and were fed a standard ration of commercial concentrate twice a day (Table 1), at 07:00 and 18:00 h. They had free access to water throughout the study. Piglets were cross fostered before they were 24 h old.

All piglets had their teeth clipped and tail docked at 1 day of postpartum, the male piglets were

Table 1. Composition of diets fed to lactating sows

Ingredient	%
Corn	52.39
Soybean meal	29.00
Wheat	7.83
Wheat bran	2.00
Tallow	5.00
Lysine (95%)	0.20
Methionine (50%)	0.05
Limestone	0.83
Tricalcium phosphate	1.90
Salt	0.30
Vitamin-mineral mix ¹⁾	0.40
Antibiotics	0.10
Total	100.00
Chemical composition	
ME (kcal/kg)	3,437.80
Crude protein	18.59
Crude fat	7.78
Crude fiber	4.79
Crude ash	6.53
Lysine	1.19
Methionine	0.31
Calcium	0.90
Phosphorus	0.73

¹⁾Composition per kg of mix: vitamin A, 2,750,000 IU; vitamin D₃, 220,000 IU; riboflavin 1,450 mg; d-pantothenic acid, 11,000 mg; niacin, 11,000 mg; choline, 110,000 mg; vitamin B₁₂, 11 mg; menadione, 1,100 mg; ethoxyquin, 2.2 g; vitamin E, 11,000 IU; contained 20% Zn, 10% Fe, 5.5% Mn, 1.1% Cu, 0.15% I.

castrated at 3 days old, and they were conventionally supplied with creep feed after ten days of age [12; Table 2].

Experimental design

The call of nursing and suckling, plus a click [3], was used as a nursing sound stimulus. The nursing and grunting sound were recorded with microphone and camcorder in the farrowing room. Sound editing and digitalizing were done by using Cooledit Pro (Syntrillium software, 2003).

Tanaka et al. [13] reported that the sow's grunting was about 75 dB, therefore, the call stimulus was played by using a computer and speaker which were set at an average of 75 dB. A sow's glands get filled with milk 35 min after the last milk has been released [14,15]. According to Bøe [16] and Jensen et al. [14], nursing frequencies of individual sows during the first week of lactation vary from 30 to 70 min. Hartman et al. [17] reported that an average nursing interval was about 52 min, while according to Götz [18], nursing intervals over four weeks varied from 35 to 41 min.

Based on these data, the stimulus call was played at intervals of 35 min (T35), 40 min (T40) and 45 min (T45). The sows and their litters were divided into 3 blocks (n = 48 each). Sows and their litters within each block were randomly assigned to one of the four treatment groups including the control which had no call stimulus (n = 12 each). The call stimulus was played to the experimental group immediately after its first parturition, and it was continuously played until the day of weaning. The piglet weaning age was twenty-one days. The computer program written in Labwindows/CVI (National Instruments, Austin, Tex., USA) language was used to play the nursing sound according to schedule.

Measurements

The feed intake of all sows, and creep feed intake of all litters were calculated based on the difference between the feed allowance and leftover food.

The back fat thickness of each sow was measured ultrasonically (Aloka SSD-500V, USA) before

Table 2. Composition of diets fed to suckling piglet (%)

Ingredient	Creep
Total	100.00
Corn	55.61
Soybean meal	27.04
Dried whole whey	15.00
Defluorinated phosphate	0.93
Limestone	0.77
Salt	0.30
Vitamin-mineral mix ¹⁾	0.35
Chemical composition	
ME (kcal/kg)	3,300.00
Protein	25.23
Lysine	1.48
Methionine	0.38
Calcium	0.55
Phosphorus	0.46

¹⁾Composition per kg of premix: vitamin A, 1,760,000 IU; vitamin D₃, 176,000 IU; riboflavin, 1,760 mg; d-pantothenic acid, 8,800 mg; niacin, 8,800 mg; choline chloride, 195,800 mg; vitamin B₁₂, 8.8 mg; menadione, 200 mg; d-biotin, 176 mg; vitamin E, 4,400 IU; Contained 15% Zn, 17.5% Fe, 6% Mn, 1.75% Cu, 2% I.

farrowing and at weaning stage at the level of the last rib and 65 mm from the dorsal midline [19,20].

The number of crushed piglets was recorded every day, and estrus detection was carried out every 12 h after 3 days of weaning until the end of estrus. Occurrence of estrus was defined according to the standing reflex in front of a boar and through the reddening and swelling of vulva.

Litter weight and litter size were recorded on the day of birth (d 0) after cross-fostering, and on day 21 (weaning).

Statistical analysis

Out of the 144 sows and their litters, four sows and their litters were excluded because of its problems with mammary glands. Some piglets were also excluded because of stillbirth, disease, non-viability, or a birth weight of 800 g or less [21]. All data with the exception of crushing piglets, estrus interval, feed intake and creep feed intake were statistically analyzed using the SAS GLM procedure (SAS Inst. Inc., Cary, NC, USA). Post hoc analysis was conducted by using Duncan's multiple comparison test.

Chi-square analysis [22] was used to determine significant differences in percentage of sows not crushing piglets, and the sows returning to estrus within 5 days after weaning because most sows come into estrus within 5 days following weaning [21]. The feed intake of the sows and the creep feed intake of piglets were analyzed with the repeated measures ANOVA (SAS Inst. Inc., Cary, NC, USA).

RESULTS AND DISCUSSION

No difference was found in parity and feed intake of sows among treatment groups ($p > 0.05$; Table 3). The loss of back fat thickness in sows was not different among treatment groups ($p > 0.05$; Table

Table 3. Effects of a nursing sound stimulus on performance (mean \pm SD) of lactating sows and suckling piglets

Variables	Treatment ¹⁾				p-value
	Control	T35	T40	T45	
Sows					
No. of sows	35	34	35	36	
Parity	3.5 \pm 2.6	3.4 \pm 2.1	3.9 \pm 1.9	3.5 \pm 2.2	0.8032
Feed intake (kg/d)	6.4 \pm 1.2	6.8 \pm 0.7	6.7 \pm 1.0	6.3 \pm 1.3	0.5906
Back fat thickness (mm)					
Before farrowing	26.3 \pm 5.71	27.9 \pm 2.6	26.2 \pm 5.2	25.9 \pm 3.3	0.7403
At farrowing	22.2 \pm 5.54	23.8 \pm 3.3	23.0 \pm 6.1	21.3 \pm 4.4	0.6041
Back fat thickness loss	4.0 \pm 2.8	4.2 \pm 2.1	3.2 \pm 2.7	4.6 \pm 1.7	0.2318
Piglets					
Litter size (piglets/litter)					
At day 0 postpartum ²⁾	10.2 \pm 1.0	10.3 \pm 1.0	10.4 \pm 0.9	10.4 \pm 0.8	0.7986
At weaning	9.4 \pm 1.3	9.7 \pm 0.8	9.4 \pm 1.0	9.4 \pm 1.4	0.6600
Creep feed intake (g/litter/d)	766.1 \pm 42.4	772.1 \pm 39.5	772.0 \pm 36.8	771.2 \pm 42.4	0.9674
Average birth weight (kg)	1.4 \pm 0.2	1.5 \pm 0.3	1.5 \pm 0.2	1.5 \pm 0.2	0.2981
Average weaning weight (kg)	6.2 \pm 0.8 ^b	6.8 \pm 0.5 ^a	6.8 \pm 0.7 ^a	6.4 \pm 0.7 ^b	0.0004
Average daily gain (g)	237.7 \pm 32.3 ^b	252.7 \pm 19.6 ^a	255.1 \pm 34.0 ^a	233.5 \pm 26.9 ^b	0.0054

¹⁾T35, T40, and T45 = 35, 40, and 45 min nursing sound stimulus interval, respectively.

²⁾After cross-fostering.

^{a,b}Different superscripts in the same row indicate a significant difference among treatments.

3). According to Pluske et al. [23], feed intake affects back fat thickness. Since there was no evident difference in feed intake, there was no difference in back fat thickness loss among treatments. Unfortunately, BW of sows was not measured in this study, but we assumed that BW loss of sows was not different among treatments because the feed intake and the back fat thickness loss were not different among the treatment groups.

There was no difference in litter size, creep feed intake, and birth weight among treatments ($p > 0.05$; Table 3). Average weaning weight and average daily weight gain of piglets in T35 and T40 groups were greater than in the control group ($p < 0.01$; Table 3), but the T45 group did not differ from the control group ($p > 0.05$; Table 3).

According to Walser [24], suckling piglets respond to nursing calls of their own sow or to unfamiliar sows. Therefore, piglet suckling behavior may be induced by a nursing sound stimulus. King et al. [25] reported that the sow milk output at 35, 70, and 100 min after the last nursing period did not differ from output of after 50 min. Spinka et al. [15] also reported that sows were able to produce almost a full ration of milk at 35 min after the last milk release, and to release milk at intervals of 40 min or less for a relatively long period of time. Castren et al. [26] observed that sows stabilize after eight days postpartum, and nurse in about every 40 min. Based on these previous studies, it is believed that the nursing grunt stimulus might induce piglets in the T35 and T40 groups to suckle more frequently, resulting in greater daily weight gain, compared to the T45 and control groups. However, Bate et al. [27] reported that growth rate in suckling piglets increased when a nursing call stimulus was played every 47 or 57 min, but not in the interval of 37 min. It was not clear why the results of this study differed from those of Bate et al. [27]. Hence, we suggest that the nursing grunt stimulus may provide positive effect on the weight gain of piglets, but more studies are needed to find the exact effects of grunt stimulus.

No difference was detected among treatments in the percentages of sows returning to estrus within 5 days after weaning ($p > 0.05$; Fig. 1) and sows without crushed piglets ($p > 0.05$; Fig. 2). The weaning to estrus interval can be affected by the lactation length [9,8], parity [28], litter size [10], and ambient temperature [29]. In this experiment, all above mentioned factors were controlled in all groups, therefore it seems that the call stimulus during lactation had no effect on the sow weaning to estrus interval.

In suckling piglets, 5.2% died because of traumatic injury. Most of these were crushed by sows [6]. When piglets starve due to failure in suckling, they are highly likely to be crushed by their sows

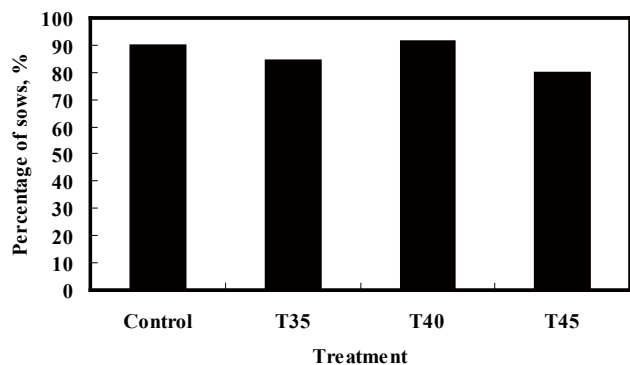


Fig. 1. Effect of a nursing sound stimulus on the percentage of sows returning to estrus within d 5 after weaning. T35, T40, and T45 = 35, 40, and 45 min grunt stimulus interval, respectively.

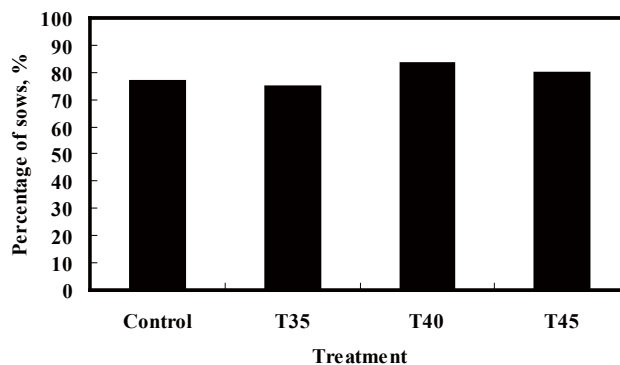


Fig. 2. Effect of a nursing sound stimulus on the percentage of sows without crushed piglets. T35, T40, and T45 = 35, 40, and 45 min grunt stimulus interval, respectively.

[5,30]. Sow milk production affects piglet growth [31], and that heavier piglets are less likely to be crushed by their sows [32]. Sow grunting is an important factor in milk release [33], because it synchronizes the piglet-suckling behavior [2,34,35]. Based on this information, it appears that crushing of suckling piglets by sows may be reduced in the nursing sound stimulus groups, through promotion of suckling behavior synchronization and increases successful suckling. However, there was no difference in the percentage of sows without crushed piglets among treatments.

In conclusion, the nursing sound stimulus did not affect sow performance, but it improved the performance of suckling piglets; the T40 group had the greatest average daily weight gain. These results suggest that the effective interval of the nursing sound stimulus should be near 35 or 40 min to improve the performance of suckling piglets.

REFERENCES

1. Mahan DC, Lepine AJ. Effect of pig weaning weight and associated nursery feeding programs on subsequent performance to 105 kilograms body weight. *J Anim Sci.* 1991;69:1370-8.
2. Kasanen S, Algers B. A note on the effects of additional sow gruntings on suckling behaviour in piglets. *Appl Anim Behav Sci.* 2002;75:93-101.
3. Jeon JH, Yeon SC, Chang HH. Selecting an effective sound for inducing sows and their piglets to nurse and suckle. *J Anim Sci Technol.* 2003;45:627-32.
4. Cronin GM, Leeson E, Cronin JG, Barnett JL. The effect of broadcasting sow suckling grunts in the lactation shed on piglet growth. *Asian-Australas J Anim Sci.* 2001;14:1019-23.
5. English PR, Morrison V. Causes and prevention of piglet mortality. *Pig News Inf.* 1984;5:369-76.
6. Svendsen J, Bengtsson ACH, Svendsen LS. Occurrence and causes of traumatic injuries in neonatal pigs. *Pig News Inf.* 1986;7:159-70.
7. Diehl JR, Albrecht JE. *Pork industry handbook.* West Lafayette, IN: Purdue University Cooperative Extension Service; 2001. Publication No. PIH-8.
8. Svajgr AJ, Hays VW, Cromwell GL, Dutt RH. Effect of lactation duration on reproductive performance of sows. *J Anim Sci.* 1974;38:100-5.
9. Xue JL, Dial GD, Marsh WE, Davies PR, Momont HW. Influence of lactation length on sow productivity. *Livest Prod Sci.* 1993;34:253-65.
10. Fahmy MH, Holtmann WB, Baker RD. Failure to recycle after weaning, and weaning to oestrus interval in crossbred sows. *Anim Sci.* 1979;29:193-202.
11. Fehr RL, Huhnke RL. *Pork industry handbook.* West Lafayette, IN: Purdue University Cooperative Extension Service; 2001. Publication No. PIH-92.
12. Reese DC, Hartsock TG, Morgan Morrow WE. *Pork industry handbook.* West Lafayette, IN: Purdue University Cooperative Extension Service. 2001. Publication No. PIH-18.
13. Tanaka T, Ochiai N, Tanida H, Yoshimoto T. The role of visual, auditory, and olfactory stimuli in teat seeking behavior of piglets. *Anim Sci Technol.* 1998;69:854-60.
14. Jensen P, Stangel G, Algers B. Nursing and suckling behaviour of semi-naturally kept pigs during the first 10 days postpartum. *Appl Anim Behav Sci.* 1991;31:195-209.
15. Spinka M, Illmann G, Algers B, Stetkova Z. The role of nursing frequency in milk production in domestic pigs. *J Anim Sci.* 1997;75:1223-8.
16. Bøe K. The process of weaning in pigs: when the sow decides. *Appl Anim Behav Sci.* 1991;30:47-59.
17. Hartman DA, Ludwick TM, Wilson RF. Certain aspects of lactation performance in sows. *J Anim Sci.* 1962;21:883-6.

18. Götz M. Changes in nursing and suckling behaviour of sows and their piglets in farrowing crates. *Appl Anim Behav Sci.* 1991;31:271-5.
19. Quiniou N, Noblet J. Influence of high ambient temperatures on performance of multiparous lactating sows. *J Anim Sci.* 1999;77:2124-34.
20. Renaudeau D, Quiniou N, Noblet J. Effects of exposure to high ambient temperature and dietary protein level on performance of multiparous lactating sows. *J Anim Sci.* 2001;79:1240-9.
21. Wechsler B, Hegglin D. Individual differences in the behaviour of sows at the nest-site and the crushing of piglets. *Appl Anim Behav Sci.* 1997;51:39-49.
22. Runyon RP, Haber A. *Fundamentals of behavioral statistics.* Boston, MA: Addison-Wesley; 1980.
23. Pluske JR, Williams IH, Zak LJ, Clowes EJ, Cegielski AC, Aherne FX. Feeding lactating primiparous sows to establish three divergent metabolic states:III. Milk production and pig growth. *J Anim Sci.* 1998;76:1165-71.
24. Walser EES. Recognition of the sow's voice by neonatal piglets. *Behaviour.* 1986;99:177-88.
25. King RH, Mullan BP, Dunshea FR, Dove H. The influence of piglet body weight on milk production of sows. *Livest Prod Sci.* 1997;47:169-74.
26. Castren H, Algiers B, Jensen P, Saloniemi H. Suckling behaviour and milk consumption in newborn piglets as a response to sow grunting. *Appl Anim Behav Sci.* 1989;24:227-38.
27. Bate LA, Van Lunen TA, Van Lunen K. Use of nursing sounds to influence performance of piglets. *Can J Anim Sci.* 1999;79:577.
28. Hughes PE. Effects of parity, season and boar contact on the reproductive performance of weaned sows. *Livest Prod Sci.* 1998;54:151-7.
29. Prunier A, de Braganca MM, Le Dividich J. Influence of high ambient temperature on performance of reproductive sows. *Livest Prod Sci.* 1997;52:123-33.
30. Fahmy MH, Bernard C. Causes of mortality in Yorkshire pigs from birth to 20 weeks of age. *Can J Anim Sci.* 1971;51:351-9.
31. Hartmann PE, McCauley I, Gooneratne AD, Whitely JL. Inadequacies of sow lactation: Survival of the fittest. In: Peaker M, Vernon RG, Knight CH, editors. *Physiological strategies in lactation.* London: Academic Press; 1984. p. 301-26.
32. Weary DM, Phillips PA, Pajor EA, Fraser D, Thompson BK. Crushing of piglets by sows: effects of litter features, pen features and sow behaviour. *Appl Anim Behav Sci.* 1998;61:103-11.
33. Algiers B, Jensen P. Communication during suckling in the domestic pig. Effects of continuous noise. *Appl Anim Behav Sci.* 1985;14:49-61.
34. Fraser D. A review of the behavioural mechanism of milk ejection of the domestic pig. *Appl Anim Ethol.* 1980;6:247-55.
35. Lewis NJ, Hurnik JF. An approach response of piglets to the sow's nursing vocalizations. *Can J Anim Sci.* 1986;66:537-9.