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Effects of days of raising TLRI Black Pig No. 1 lactating sows in farrowing crate on the welfare of sows and survival rate of piglets (1)

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Abstract

Conventional farrowing crate is a controversial issue from the viewpoint of animal production and welfare in swine industry. The purpose of this study was to evaluate the effect of crating length on the welfare of sows and survival rate of piglets. Twenty four multi-parous TLRI Black Pig No. 1 (TBP) sows were allocated to four treatments through a completely random design, where sows and piglets stayed in conventional farrowing crate throughout the experiment as the control group (C). Sows and their piglets were moved to concrete floor nursing pen on day 4, 7 or 10 until weaning on day 28 postpartum as treatment F, S and T, respectively. On day 14 postpartum, the respiratory rate, body temperature and salivary cortisol concentration were measured and while behaviors of sows were filmed for 24 hours. The results showed that there was no difference on the body weight, backfat thickness loss, daily feed intake, and the physiological parameters, in terms of respiratory rate and rectal temperature of sows amongst treatments. Sows raised in nursing pens tended to have higher salivary cortisol concentration ($P = 0.06$). With regards to survival, from birth to day 7 of age, the survival rate of group F was lower ($P < 0.05$) than groups C, S and T. After day 7 of age, the survival rate was not different amongst treatments. Behavioral data indicated that sows raised in farrowing crate tended to have higher proportion of laterally lying ($P < 0.10$), and higher proportion of lying and siting posture and less standing posture than the sows raised in nursing pen ($P < 0.05$). In summary, farrowing crate could protect neonate, however, after the 7th day postpartum, sows and piglets could be moved and raised in enlarged nursing pen to improve welfare of sows without detriment of piglets.

Key words: Animal welfare, Survival rate, TLRI Black Pig No. 1, Sows..

Introduction

The conventional farrowing crate is developed in the 1960s (Edwards and Fraser, 1997), which is a dilemma of swine industry. The space of farrowing crate is just narrow for sows to stand up for feeding, drinking, urination, and defecation, but not allowing the sow to turn around. The original function of farrowing crate is to limit the activity in terms of posture changing of sows during parturition and nursing period later on, in which protect the neonatal piglets from crush by sows when they are changing the posture. In terms of survival of suckling piglets, record has shown the farrowing crate achieved tremendous success (Baxter *et al.*, 2011) to decrease the high levels of piglet mortality.

Despite of the protective function, however, the use of farrowing crates evokes concern by animal welfare groups due to severely limit the normal behaviour expression of sows (Jensen, 1988), and the implication that confinement crate leads to chronic stress of sows and hence reduces the welfare (Jarvis *et al.*, 2006). Enlarged nursing pen during lactation period may improve the sow welfare. However, survival of piglet may be put at risk as the absence of crate confinement allows more sow

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postural changes which may increase the risk of crushing. A number of researches have tried to address this issue by alternative loose-house systems. Results from these studies are however contradictory. In studies by Moustsen *et al.* (2013), Hales *et al.* (2014), Condous *et al.* (2016), and Buoio and Costa (2020), the preweaning mortality was reduced when the sow was confined at farrowing compared to being loose-housed. On the other hand, findings from Weber *et al.* (2007), Pedersen *et al.* (2011) and Goumon *et al.* (2018) showed no differences in preweaning piglet mortality between crated or loose housed sows. Such different results imply the difficulty to abolish conventional farrowing crate completely and the farrowing crate still dominate the main equipment in farrowing house of swine industry (Baxter *et al.*, 2011; Lo and Dai, 2012).

Piglet mortality is the outcome of a set of complex interactions amongst the sow, the piglet and the environment. Research indicated that newborn piglets have the highest mortality within three days after birth, and gradually decrease after seven days postpartum (Dyck and Swierstra, 1987; Marchant *et al.*, 2000; Baxter *et al.*, 2011), which implies that different strategy approaches might be applied to manage lactating sows. As farrowing crates are still used in most of domestic farms for lactation sows (Lo and Dai, 2012), yet there is very little research addressing the issue in Taiwan. Therefore, the purpose of this study was to evaluate the effect of farrowing crate and nursing pen during lactation period on welfare in terms of physiology, reproductive performance and behaviour of sows and survival of piglets.

Materials and Methods

Animals used in this study and the procedures were according to the Guide for Care and Use of Agricultural Animal of Livestock Research Institute, Council of Agriculture (Affidavit of Approval of Animal Use Protocol no. 99022).

I. Animals and management

Twenty four multiparous pregnant TBP (Taiwan Livestock Research Institute Black Pig No. 1) sows, in which average parity was 3.7 (range: 2 - 6) were selected and raised in conventional gestation stall. At approximately one week before the expected parturition day (calculated on the basis of 114 days of pregnancy), each sow was moved to farrowing house and raised in a 210 × 210 cm wire-meshed farrowing bed containing a 210 × 60 cm conventional farrowing crate in the center. Another 210 × 210 cm nursing pen was designed for experiment. There was a 210 × 60 cm metal slat area at the rear of the concrete floor nursing pen for defecation and urination. The space of the nursing pen allowed the sows to turn around. At the side part of both farrowing bed and nursing pen, there was a 102 × 50 cm creep area attached with a heat lamp above for the suckling piglets (Fig. 1).

The experiment was designed as completely random design and each sow was allocated to one of the following four treatment groups. After parturition, the sows and their piglets kept in the farrowing pen throughout the experiment was crate group (Crate; C). The sows and their suckling piglets transferred to nursing pen together on the 4 th (F group), 7th (S group) or 10th (T group) day postpartum and stayed in the nursing pen until piglets were weaned on the 28th day of age, respectively.

All newborn piglets were weighed individually and ear-notched within 24 hours of birth (average birth weight 1.43 ± 0.20 kg total piglets of 24 sows). Sows were offered a commercial diet containing CP 15% and DE 3,250 kcal/kg twice daily (09.00 h and 15.00 h) throughout the experiment. Pelleted creep feed containing CP 18.2% and DE 3,460 kcal/kg was supplied to piglets on the 7th day after birth until weaning. Water was supplied to the animals ad libitum throughout the experiment. The farrowing crate and nursing pen were cleaned in the morning. Supplementary dim lighting with 20 lux was supplied at night for video recording.

II. Measurements

The feed intake of sows during the lactation period was recorded. The body weight and backfat thickness of sows were measured within 24 hours after parturition and on the weaning day to calculate the changes during the lactation period. Backfat thickness was taken at the first rib, last rib and last lumbar vertebrae 2 cm away the dorsal line by A-mode ultrasonic instrument (The PREG-ALERT PRO®, USA). On day 14 after birth at about 13.00 h, cotton swabs attached at the end of a wooden rod allowing the sows to chew until the cotton swabs were thoroughly moistened. Samples were taken on calm and lying sows, not during nursing bouts. Saliva was extracted from the swabs by centrifugation (HITACHI CR22G, Japan) for 20 min at 1,870 × *g* at room temperature and then stored at −20 °C until assay. Salivary cortisol was

analysed by ABBOTT ARCHITECT Cortisol 8D15-25 kit (ABBOTT RCHITECT Cortisol®, USA) with a delayed one-step immunoassay assess. At the same time, the respiration frequency, rectal temperature and body surface temperature at the ears near the neck were measured by manual counter, electronic thermometer (SHANG NONG, China) and infrared thermal imager (TECPEL TIG-320, Taiwan), respectively. After the measurement was completed, the behaviour of the sows and the number of nursing were monitored by using a wide-angle lens (SONY DCR-PC350) on a ceiling mounted camera on a 24-hour mode recording (DECTEC DR-4043).

The 24 hours video data was analysed by video playback by a 1-min interval scanning method (i.e. 1440 scans in 24 h). The postures of sows were defined as below:

(i) Stand: Sow was upright with legs extended and all four feet on the ground.
(ii) Sit: Rear end on the floor with two front feet on the ground and front legs extended.
(iii) Kneel: Front legs bent with two back feet on the ground and back legs extended. This is a transitory posture during lying down or when the sow was trying to reach something under the trough or bars.
(iv) Lie ventrally: Lying on udder with neither shoulder touching the ground.
(v) Lie laterally: Lying with udder exposed and one shoulder completely in contact with the ground. Spine line is either left or right of centre.

Body weight of each piglet born alive was weighed within 24 hours after birth and on the weaning day to calculate the weight gain. The number of piglets born alive, on the 4th, 7th, 10th, 14th and the weaning day were recorded to calculate the survival rate and cause of each death case in terms of malnutrition, weakness, illness and unknown was judged and recorded by the same worker during the nursing period.

III. Statistical analysis

All data were analysed using the PROC GLM procedure of SAS (SAS, 2008) in a completely randomized design. The model was $Y_{ij} = \mu + \tau_i + \varepsilon_{ji}$ where Y_{ij} is the j^{th} observation of the i^{th} treatment, μ is the observation mean, τ_i is the treatment effect of the i^{th} treatment, and ε_{ji} is the random error. Body weight and backfat thickness of sows at parturition was used as a covariate to analyse body weight of weaning and the loss of body weight during lactation, and to analyse backfat thickness at weaning and the loss of backfat thickness during lactation. The number born alive was used as a covariate to analyse the performance of piglets. The significant differences amongst treatments were detected by Tukey's Multiple Range Test. Variability in the data was expressed as standard error of the mean (SEM) and probability level of $P < 0.05$ was considered to be statistically significant. Based on the fact that sows in treatments F, S and T were raised in nursing pen from the 10th day postpartum to weaning. The physiological parameter, posture pattern and nursing number measured on day 14 postpartum were not significantly different amongst F, S and T treatments. Therefore these data were pooled as treatment nursing pen (F + S + T) for further statistical analysis.

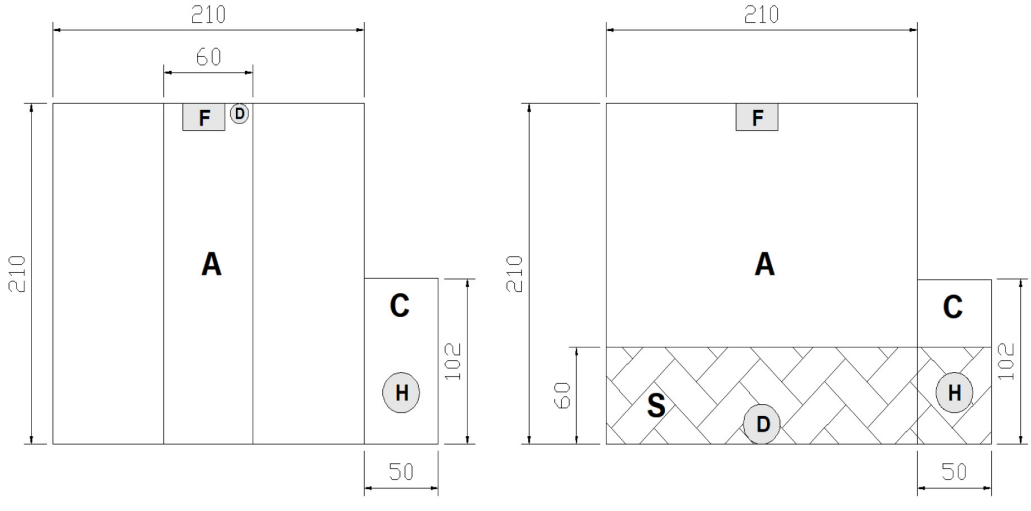

Fig. 1. The chat of typical conventional farrowing crate (left) for control sows and concrete floor nursing pen (right) for treatment sows. A = sow area; C = creep area for piglets; D = drinker; F = feed trough, H = heating lamp, S = slat area. All measurements are in centimeters. Area detail of the crate and pen was descripted in Materials and Methods.

Results and Discussions

I. Body weight, backfat thickness, feed intake of sows and performance of piglets

There were no difference of body weight, backfat thickness and feed intake of sows amongst treatments (Table 1). In this study, the body weight of TBP No. 1 sows at parturition ranged from 250 to 256.6 kg. After four weeks of lactation, the weaning weight ranged from 227.5 to 236.1 kg and the loss of body weight ranged from 19.7 to 22.2 kg. The average backfat thickness of TBP No. 1 sows at parturition was 28.1 mm. After four weeks of lactation, the average backfat thickness was 25.2 mm and the average loss of backfat thickness was 2.9 mm. The daily feed intake ranged from 2.58 to 3.06 kg.

Table 1. Effect of nursing crate and pen on body weight, backfat thickness, feed intake of TBP No. 1 sows and survival rate of piglets

Items	Treatments[§]				
	C	F	S	T	SEM
No. of sows	6	6	6	6	
Body weight at parturition, kg	251.1	255.6	250.0	253.4	4.7
Body weight at weaning, kg	229.8	236.1	227.5	232.7	4.7
Body weight loss during lactation, kg	21.4	19.7	22.2	20.7	1.8
Backfat thickness at parturition, mm	27.7	27.7	27.2	29.6	0.7
Backfat thickness at weaning, mm	25.0	25.3	24.3	26.0	0.7
Backfat thickness loss during lactation, mm	2.6	2.5	2.9	3.6	0.3
Sow feed intake, kg /d	3.01	2.58	2.60	3.06	0.39
No. of piglet born alive	8.3	9.7	9.5	8.5	0.3
Body weight at birth, kg/piglet	1.52	1.43	1.34	1.45	1.47
Body weight at weaning, kg/piglet	5.76	5.61	5.10	5.65	0.98
Body weight gain during nursing period, kg/piglet	4.24	4.18	3.77	4.19	0.20
Survival rate from birth to day 4, %	92.5	95.2	93.9	97.9	1.4
Survival rate from birth to day 7, %	90.6^{a}	82.7^{b}	92.5^{a}	94.3^{a}	1.3
Survival rate from birth to day 10, %	90.6^{ab}	82.7^{b}	90.1^{ab}	94.3^{a}	1.6
Survival rate from day 4 to weaning, %	91.3^{a}	79.1^{b}	86.6^{ab}	90.7^{a}	1.6
Survival rate from day 7 to weaning, %	93.2	91.3	88.0	93.9	1.7
Survival rate from day 10 to weaning, %	93.2	91.3	90.8	93.9	1.7
Survival rate from birth to weaning, %	84.5^{a}	75.3^{b}	81.4^{a}	88.6^{a}	1.9
No. of piglet at weaning	7.0	7.2	7.8	7.5	0.3

[§] C: farrowing crate group; F, S, T: After parturition, the sows and their suckling piglets were transferred to a concrete floor nursing pen on the 4th, 7th or 10th day, respectively until piglets were weaned on the 28th day of age.

[a, b] Means in the same row with the different superscript differ significantly ($P < 0.05$).

The effect of nursing crate and pen on growth performance and survival rate of piglets during lactation period was shown in Table 1. The number of piglet born alive, body weight at birth and at weaning, and body weight gain of piglet during nursing period were not different amongst treatments. The number of piglet born alive ranged from 8.3 to 9.7 heads. The average birth weight and weaning weight were 1.44 and 5.53 kg, respectively. The average body weight gain during nursing period was 4.10 kg.

For the survival, within 4 days after birth, the average survival rate was over 92% and were not significantly different amongst treatments. From birth to day 7 of age, the survival rate of group F (82.7%) was lower than groups C, S and T with significant consistency lower ($P < 0.05$), but was not significantly different compared with groups C and S

from birth to day 10. Furthermore the survival rate from day 4 to weaning of group F was significantly lower ($P < 0.05$) than groups C and T, but was not significantly different compared with group S. After day 7 of age, no matter from day 7 or 10 to weaning, the survival rate was not significantly different amongst treatments. Although the survival rate from birth to weaning of group F was lower ($P < 0.05$) than groups C, S and T, overall the number of weaning piglet was not significantly different amongst treatments and the average number of weaning piglet was 7.4 heads.

During the four weeks of lactation period, causes of death of piglets revealed that the main cause included malnutrition, weakness, illness and unknown, which accounted for 79.5% (31/39) while crush happened at about 20.5% (8/39) (Fig. 2).

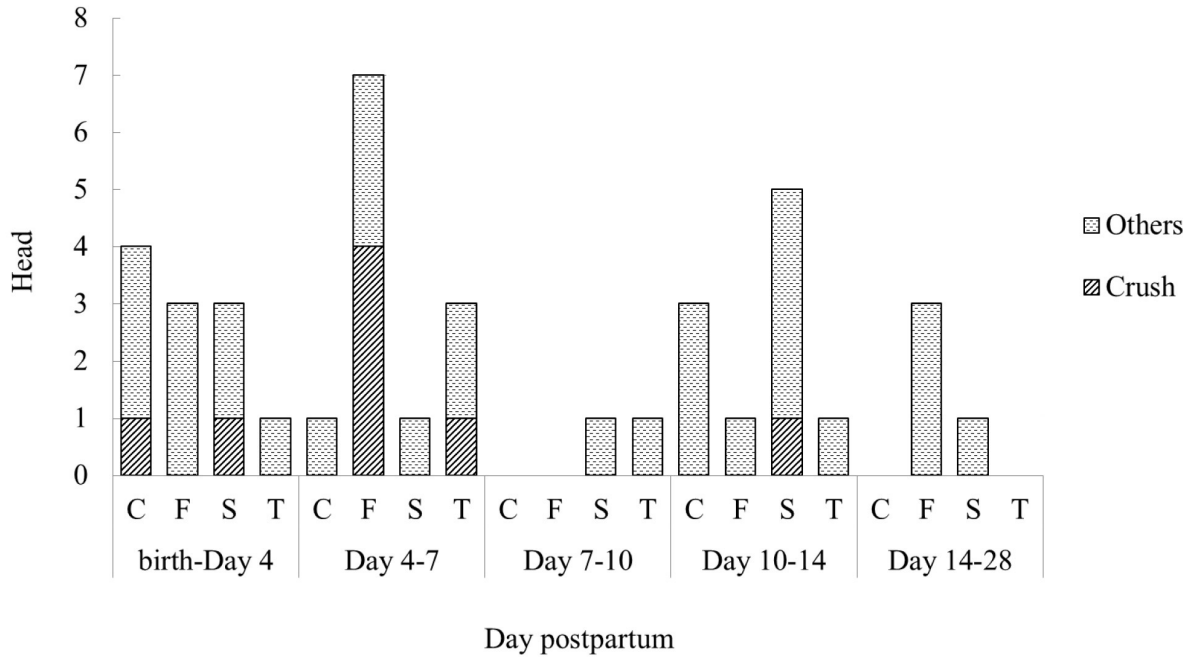

Fig. 2. The distribution of death case and the cause of death of suckling piglets in different sessions of age.
C: farrowing crate group; F, S, T: After parturition, the sows and their suckling piglets were transferred to a concrete floor nursing pen on the 4th, 7th or 10th day, respectively until piglets were weaned on the 28th day of age. Causes of death included crush and others in terms of malnutrition, weakness, illness and unknown. Each value was expressed as the sum of six experimental sows.

In general, the nutrient intake from feed of sows is less than the nutrient output in milk. In order to meet the milk requirement for suckling piglet, lactating sow would break down body tissue hence lead to the loss of body weight and backfat thickness during lactation. The extent of loss depends on feed intake and the number of suckling piglets. Results indicated that farrowing crate and nursing pen did not affect feed intake of sows, piglet born alive and growth performance of piglets, hence the change of body weight and backfat thickness was not significantly different amongst treatments. The feed intake in present study is lower than the study by Hsu *et al.* (2005) which might be due to the different breed of sow since the breed used in the study of Hsu *et al.* (2005) was LY sows. By contrast, the feed intake in present study is similar to the result by Liao *et al.* (2008) in which the breed is TBP No. 1 sows as well.

The mortality of suckling piglets is the outcome of a set of complex interactions amongst the sow, the piglet and the environment. It is well known that the mortality of suckling piglets and the cause of death varied amongst farms (Marchant *et al.*, 2000). In general, within three days after birth is the critical period that the highest mortality of neonatal piglets occurs, and the mortality gradually decreases after seven days postpartum (Dyck and Swierstra, 1987; Marchant *et al.*, 2000; Baxter *et al.*, 2011).

Although crushing by the sow is the main ultimate cause of piglet death in particularly within the neonatal period postpartum, it is often consequence of perinatal hypothermia and starvation (Dyck and Swierstra, 1987; Marchant *et al.*, 2000). Since the 1970s, many researchers suggested neonatal survival of piglet could be improved via the nutrient strategy in terms of supplementation of dietary nutrients such as fat to late pregnancy or lactation diet (Seerley *et al.*,

1974). However, Pettigrew, Jr. (1981) demonstrated the result of survival improvement by such nutritional manipulation varied amongst researches.

Another approach to improve the neonatal survival is the application of farrowing crate which was developed in the 1960s. The crate is a structure that contains a sow which prevents the sow from turning around. The crate forces the sow faces forward, towards a feeder and watering device. The manure will be deposited in a smaller location at her rear end which maintains a fairly hygienic environment. This device results in a tremendous improvement of neonatal survival through the protection from crush by sows when they are changing the posture (Glencorse *et al.*, 2018)

In present study before the 4th day postpartum, all animals were raised in farrowing bed with farrowing crate. The crate did protect the neonatal piglets from crush though it still happened occasionally. For the piglets in treatment F, the piglets were transferred and raised in nursing pen on the 4th day postpartum. There is lack of the protection of crate and the space of nursing pen allowed sows to turn around, thus it increased the risk of crushing. In present study, the number of crush increased from day 4 to 7 resulted in lower survival from birth to either day 7 or to day 10 and from day 4 to weaning in group F compared with group C, that indicated the vitality of piglets under the age of 7 day might not be good enough to escape the risk of crush. From another point of view that the survival rate from day 7 to weaning was not significantly different amongst treatments suggested that over the age of 7 days, animals could be raised in an enlarged pen with less detrimental effect in term of crush and the welfare in terms of space allowance for sows could be improved. Goumon *et al.* (2018) found similar result that temporary crating limited to the first 3 days postpartum would not affect the weight gain and survival of piglets compared with permanently crated group. However, Edwards and Fraser (1997) found that enlarged pen representing an improvement of welfare for sows, showed a higher crushing rate in comparison with the conventional crate. Even from day 15 to the weaning, enlarged pen furtherly lowered piglet survival rate (Buoio and Costa, 2020). These different results highlight the difficulty of alternative farrowing crate between the welfare and economic losses related to production. In addition, the application of nursing pen required more labour to maintain hygiene compared with the farrowing crate. A number of deaths caused by un-crushed were noticed in enlarged nursing pen from the 10th day postpartum to weaning. These deaths were mainly consequence of starvation from malnutrition, weakness, illness and unknown causes implied the application of enlarged nursing pen required higher skill to maintain the well-being of piglets.

II. Physiological parameters of sows on day 14 postpartum

The effect of farrowing crate and nursing pen on physiological parameters and nursing number of TBP No. 1 sows was shown in Table 2. There were no differences of respiratory frequency, body surface temperature, rectal temperature on day 14 postpartum and nursing number on day 14 to 15 postpartum between treatments. The concentration of cortisol in saliva of sows raised in nursing pen tended to be higher than sows raised in farrowing crate (1.0 *vs.* 0.3 ug/dL; $P < 0.10$). On the 14th day postpartum at 1:30 pm, sows breathed an average of 50.2 times per minute. The average of body surface temperature and rectal temperature were 35.6 and 38.9°C, respectively. For 24 hour observation of nursing on day 14 to 15, the nursing number was 39.0 bouts per day.

Table 2. Effect of farrowing crate and nursing pen on physiological parameters and nursing number of TBP No. 1 sows

	Treatments[§]		
Items	C	F + S + T	SEM
No. of sows	6	18	
Respiratory frequency, no./min	49.3	51.1	5.1
Body surface temperature, ℃	34.9	36.2	0.4
Rectal temperature, ℃	38.7	39.1	0.2
Salivary cortisol concentration. ug/dL	0.30[b]	1.00[a]	0.16
Nursing number in 24 hours, bout	39.5	38.4	0.4

[§] C: farrowing crate group; F + S + T: sows and the piglets were raised in nursing pen.
Parameters were collected on day 14 postpartum at about 13.00 h. Nursing number was measured form day 14 to 15 postpartum.
[a, b] Means in the same row with the different superscript tended to be differed ($P = 0.06$).

Physiological state of animal is a response to environmental stimuli. Pigs are homeothermic animals with the ability to regulate body temperature and rectal temperature to maintain the physiological function (Mount, 1974). The respiration frequency and body temperature of pigs are mainly affected by the effects of the surrounding environment and the efficiency of heat dissipation. Pond and Maner (1984) found under 30℃ environmental temperature, the respiration frequency for growing-finishing pigs was 30.6, then increased to 78.8 times per minute when the environmental temperature rose to 32.2℃ and the rectal temperature would increase to 40.0°C if the environmental temperature continue rose to 37.8°C. Wang *et al.* (2008) also found the respiratory frequency, body temperature and rectal temperature increased along with the increase of ambient temperature. Animals of present study were raised in open-house under the same climate condition where the environment condition and the indoors sows were affected by the climate condition outdoors. The respiratory frequency, body surface temperature and rectal temperature were not significantly different between farrowing crate and nursing pen groups implied that the effect from environmental climate might be greater than the effect from treatments.

Animals secrete cortisol when they are facing pressure, which as an indicator to assess the welfare of sows. Research suggested permanent confinement of sows leads to long term and chronic stress with a higher cortisol response (Cronin *et al.*, 1991; Jarvis *et al.*, 2006; Yin *et al.*, 2016). In present study though the space of nursing pen allowed sows to turn around, it failed to decrease the cortisol level, even tended to be higher than farrowing crate group. The reason for the difference between present result and the studies by Cronin *et al.* (1991), Jarvis *et al.* (2006) and Yin *et al.* (2016) might be due to the lack of long term effect of present study since the sampling day in present day was on the 14 day postpartum. Goumon *et al.* (2018) also found removal of confinement crate on the 4th day postpartum had short-term positive effects in terms of less stress levels (as measured by Ig A), but no effect of housing were found on cortisol concentrations for long term effect on day 25 postpartum.

Milk yield peaks at around two weeks postpartum, depending on the litter size and litter weight, and the feed intake of sows (Pluske *et al.*, 1995). Neither farrowing crate nor nursing pen affected the nursing bout on day 14 to 15 postpartum in present study. The average of nursing number was 39.0 bouts per day which is similar to the result found by Nien *et al.* (2013), in which the Landrace sows were also raised in conventional farrowing crate at open-house and had 37 nursing bouts on day 14 postpartum. In addition, the piglets' performance from day 7 postpartum to weaning and the feed intake of sows were not significantly different amongst treatments that lead to no significant difference of nursing bout between treatments.

III. Postures of sows on day 14 to 15

The sows raised in farrowing crate tended to have higher proportion of laterally lying posture (LL) ($P < 0.10$), higher proportion of lying and siting posture (SI) and less standing posture (ST) ($P < 0.05$) than the sows raised in nursing pen. The proportion of ventrally lying (LV) and kneeling posture (KN) between treatments were not significantly different (Fig. 3).

Both groups of sows tended to be very passive spending most of their time lying laterally and ventrally during 24 hour observation. Sows were raised in farrowing crate and in nursing pen spent 87.5 and 81.6%, respectively of the observation time lying laterally. Combining with lying laterally and ventrally, overall the proportion of total observed lying posture for the two groups was over 90%.

Sows raised in nursing pen were more active that spent 8.4% of the observation time standing while sows raised in farrowing crate spent 3.3% of the time. On the contrary, sows raised in farrowing crate spent 1.8% of the observation time siting and sows was raised in nursing pen, which spent 0.8% of the time. Kneeling is a transitory posture when the sows were lying down or trying to reach something under the trough or bars which contributed a less proportion of time (0.6%) in the 24 hour observation.

As expected, the nursing pen that increased the space allowance, made the sows spend more time standing and be more active than farrowing crated sows over the 24 hour observation. Goumon *et al.* (2018) also found sows raised in enlarged pen after temporary crating to the first 3 days postpartum increased the activity than the crated sows. However, the finding of present study contrasts those of Lambertz *et al.* (2015) and Chidgey *et al.* (2016) who found no differences in the amount of time spent active between temporary confined sow (e.g., until day 5 or 7 and 14, respectively) and

permanently crated sows.

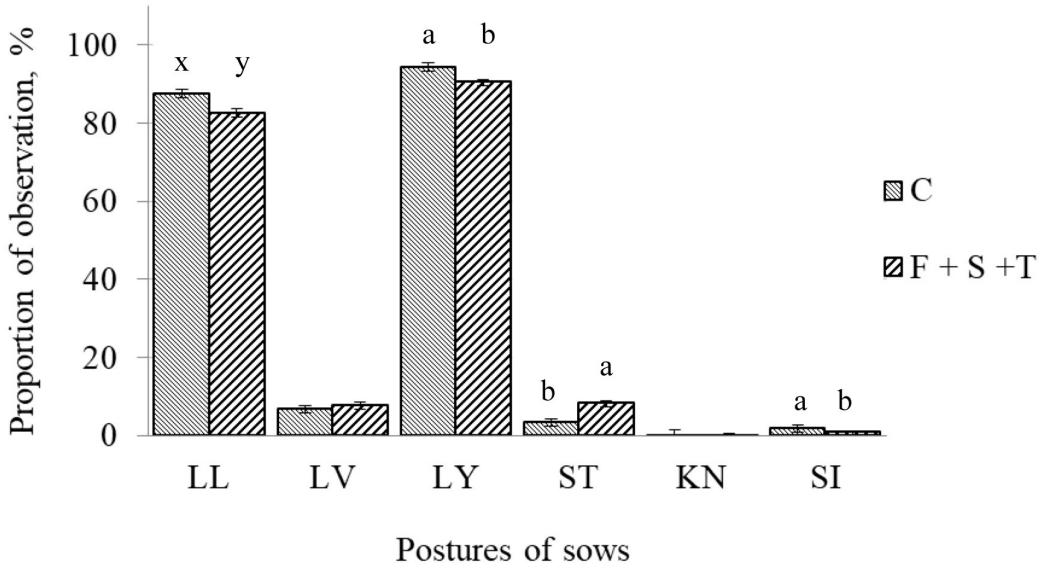

Fig. 3. The proportion of posture of sows on day 14 to 15 postpartum.
C: farrowing crate group; F + S + T: sows and the piglets were raised in nursing pen.
LL: lie laterally; LV: lie ventrally; LY: combine with lie laterally and lie ventrally; ST: stand; KN: kneel; SI: sit. Detail of behavuoural ethogram was described in Materials and Methods.
x, y : $P < 0.10$; a, b : $P < 0.05$.

The behavioural parameters were sampled on day 14 postpartum that was at the peak of milk production. Sows performed lying posture for nursing and rest resulted in high proportion of laterally lying, in particularly for the sows raised in farrowing crate. The crate limited the mobility of sows that might also increase the difficulty to stand up. Furthermore, standing is a posture when sows were eating, drinking, defecation, urination, and walking or exploring the surrounding environment. Domestic sows would move up to miles away and spend a lot of time exploring, rooting, and foraging when they are raised in the wild (Stolba and Wood-Gush, 1989). Sows in present study were fed ad libitum, it is not necessary to spend lot of time foraging. Siting also is a transitory posture when the sows were lying down or trying to stand. Sows raised in farrowing crate performed higher siting posture might be due to the limit of locomotion from the crate.

From the view of animal welfare, nursing pen supplied a better environment in terms of enlarged space for sow performing higher activity and more flexible behaviours.

Conclusions

From the view of animal welfare, sows raised in enlarged nursing pen had better well-being. However, the management application of nursing pen should be considered carefully to avoid the detrimental effect of piglets in terms of survival. The study showed sows were temporary crated for at least 7 days after parturition then raised in an enlarged nursing pen might be taken into account of welfare and production at the same time. Such manipulation could be regarded as a compromise solution between conventional farrowing crates and nursing pens to better accommodate the welfare of both sow and piglets during nursing period.

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References

Baxter, E. M., A. B. Lawrence, and S. A. Edwards. 2011. Alternative farrowing accommodation: welfare and economic aspects of existing farrowing and lactation systems for pigs. Animal 6: 96-117.

Buoio, E. and A. Costa. 2020. Space allowance and piglets survival rate in the farrowing crate. Large Anim. Rev. 26: 239-247.

Chidgey, K. L., P. C. H. Morel, K. J. Stafford, and I. W. Barugh. 2016. Observations of sows and piglets housed in farrowing pens with temporary crating or farrowing crates on a commercial farm. Appl. Anim. Behav. Sci. 176: 12-18.

Condous, P. C., K. J. Plush, A. J. Tilbrook, and W. H. E. J. van Wettere. 2016. Reducing sow confinement during farrowing and in early lactation increases piglet mortality. J. Anim. Sci. 94: 3022-3029.

Cronin, G. M., J. L. Barnett, F. M. Hodge, J. A. Smith, and T. H. McCallum. 1991. The welfare of pigs in two farrowing/lactation environments: cortisol responses of sows. Appl. Anim. Behav. Sci. 32: 117-127.

Dyck, G. W. and E. E. Swierstra. 1987. Causes of piglet death from birth to weaning. Can. J. Anim. Sci. 67: 543-547.

Edwards, S. A. and D. Fraser. 1997. Housing systems for farrowing and lactation. Pig J. 39: 77-89.

Glencorse, D., K. Plush, S. Hazel, D. D'Souza, and M. Hebert. 2018. A systematic review and meta-analysis on the influence of farrowing pens on piglet traits. Report prepared for the Co-operative Research Centre for High Integrity Australian Pork. http://porkcrc.com.au/wp-content/uploads/2019/01/1A-117-Project-Final-Research-Report-1A-117-Version-2-clean.pdf.

Goumon, S., I. Leszkowová, M. Šimečková, and G. Illmann. 2018. Sow stress levels and behavior and piglet performances in farrowing crates and farrowing pens with temporary crating J. Anim. Sci. 96: 4571-4578.

Hales, J., V. A. Moustsen, M. B. F. Nielsen, and C. F. Hansen. 2014. Higher preweaning mortality in free farrowing pens compared with farrowing crates in three commercial pig farms. Animal 8: 113-120.

Hsu, C. B., J. T. Lee, H. J. Huang, S. C. Chang, F. C. Liu, and A. L. Hsu. 2005. Effects of dietary valine supplementation on the performance of lactating sows and piglets. J. Taiwan Livestock Res. 38: 47-56. (in Chinese).

Jarvis, S., R. B. D'Eath, S. K. Robson, and A. B. Lawrence. 2006. The effect of confinement during lactation on the hypothalamic-pituitary-adrenal axis and behavior of primiparous sows. Physiol. Behav. 87: 345-352.

Jensen, P. 1988. Maternal behaviour and mother-young interactions during lactation in free-ranging domestic pigs. Appl. Anim. Behav. Sci. 20: 297-308.

Lambertz, C., M. Petig, A. Elkmann, and M. Gauly. 2015. Confinement of sows for different periods during lactation: effects on behaviour and lesions of sows and performance of piglets. Animal 9: 1373-1378.

Liao, C. W., C. F. Liu, S. F. Wu, and T. M. Su. 2008. Effects of L-carnitine fed during gestation and lactation on reproductive and litter performance of TLRI Black Pig No. 1 sows. J. Taiwan Livestock Res. 41: 139-144. (in Chinese).

Lo, L. L. and M. E. Dai. 2012. Survey of management practice on animal welfare of breeding pigs in Taiwan. Hwa Kang J. Agric. 29: 67-88. (in Chinese).

Marchant, J. N., A. R. Rudd, M. T. Mendl, D. M. Broom, M. J. Meredith, S. Corning, and P. H. Simmins. 2000. Timing and causes of piglet mortality in alternative and conventional farrowing systems. Vet. Rec. 147: 209-214.

Mount, L. E. 1974. The concept of thermal neutrality. In: Heat loss from animals and man. eds. Monteith, J. L. and Mount, L. E. Butterworths, pp. 425-439. London, UK.

Moustsen, V. A., J. Hales, H. P. Lahrmann, P. M. Weber, and C. F. Hansen. 2013. Confinement of lactating sows in crates for 4 days after farrowing reduces piglet mortality. Animal 7: 648-654.

Nien, P. C., C. M. Wang, Y. C. Chang, C. L. Hu, H. F. Lee, and Y. S. Jea. 2013. The effect of different jouses on the reproductive performance of sows. J. Taiwan Livestock Res. 46: 81-86. (in Chinese).

Pedersen, L. J., P. Berg, G. Jørgensen, and I. L. Andersen. 2011. Neonatal piglet traits of importance for survival in crates and indoor pens. J. Anim. Sci. 89: 1207-1218.

Pettigrew, Jr., J. E. 1981. Supplemental dietary fat for peripartal sows: a review. J. Anim. Sci. 53: 107-117.

Pluske, J. R., I. H. William, and F. X. Aherne. 1995. Nutrition of the neonatal pig. In The neonatal pig: development and survival. ed. M. A. Varley. pp. 187-235. CAB International, Oxon, U.K.

Pond, W. G. and J. H. Maner. 1984. Swine production and nutrition. AVI Publishing Co., Inc. US.

SAS. 2008. SAS/STAT® User's guide: Ver. 6.2. SAS Institute Inc., Cary, NC. USA.

Seerley, R. W., T. A. Pace, C. W. Foley, and R. D. Scarth. 1974. Effect of energy intake prior to parturition on milk lipids and survival rate, thermostability, and carcass composition of piglets. J. Anim. Sci. 38: 64-70.

Stolba, A. and D. G. M. Wood-Gush.1989. The behaviour of pigs in a semi-natural environment. Anim. Prod. 48: 419-425.

Wang, S. K., S. H. Chiang, A. L. Hsu, and H. F. Lee. 2008. Effects of ambient temperature and dietary lysine:energy ratio on physiological characteristics and nitrogen retention of growing-finishing pigs. J. Taiwan Livestock Res. 42: 73-85. (in Chinese).

Weber, R. N. M., Keil, M. Fehr, and R. Horat. 2007. Piglet mortality on farms using farrowing systems with or without crates. Anim. Welfare 16: 277-279.

Yin, G., H. Liu, X. Li, D. Quan, and J. Bao. 2016. Effect of farrwoing environment on behaviour and physiology of primiparous sows with 35-day lactation. Intern. J. Appl. Res. Vet. Med. 14: 159-169.

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畜試黑豬一號泌乳母豬飼養於分娩架之日數對其福祉及仔豬存活率之影響 (1)

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摘　要

從生產及動物福祉的觀點而言，使用母豬傳統式分娩架具正反爭議。本研究旨在探討泌乳母豬飼養於分娩架中的日數長短對母豬動物福祉及其仔豬存活率的影響。試驗採完全逢機設計，選取經產畜試黑豬一號懷孕母豬 24 頭，分至四處理組，母豬分娩後，母豬與同窩仔豬飼養於分娩架內者為對照組 (C 組)，處理組於分娩後第 4 日 (F 組)、第 7 日 (S 組) 或第 10 日 (T 組)，將母豬與同窩仔豬移至水泥地面之哺乳欄至分娩後第 28 日離乳止。分娩後第 14 日量測母豬呼吸頻率、直腸溫度與耳根處之體表溫度，同時採集母豬唾液分析皮質醇濃度；並以錄影－放影方式記錄 24 小時內母豬之行為態樣。結果顯示，各組母豬哺乳期每日採食量、體重及背脂變化以及呼吸頻率與體溫差異皆不顯著，哺乳欄母豬唾液中有較高皮質醇濃度之趨勢 (P = 0.06)。存活率方面，出生至 7 日齡間，F 組仔豬存活率低於 C、S 及 T 組 (P < 0.05)，從 7 日齡之後，各組間存活率差異不顯著。和飼養於分娩架之母豬相比，飼養於分娩架組有較高的側躺姿勢比例之趨勢 (P < 0.10)，及有較高的躺臥與坐姿比例以及較低的站立姿勢比例 (P < 0.05)。綜合上述結果，分娩後初期分娩架可保護新生仔豬，但是於分娩後第 7 日，將母豬與仔豬飼養於較大空間的哺乳欄可以提升母豬福祉，並且不影響仔豬存活率。

關鍵詞：動物福祉、存活率、畜試黑豬一號、母豬。

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