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# Season effects on the suckling behavior of piglets

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**Abstract:** The suckling behavior of piglets was evaluated in summer and winter, using 21 sows of the same genetic line. Data were collected in July (winter) and in January (summer). The experimental design was a randomized complete block (age of piglets) in a 2x2 factorial scheme, with season of the year (winter and summer) and shift (day, from 06 h to 1h:59min and night from 18h to 05h:59min) as factors. The behavioral variables analyzed were number, interval, and frequency of suckling. The behaviors were monitored on day 7 and 15 of lactation, for 24 hours. In winter, the farrowing room had a mean temperature of 20.32 ±2.17°C and a relative humidity (RH) of 58.63 ±2.99%. In the summer, the mean temperature was 26.65 ±4.02°C, with an RH of 62.22 ±12.06%. During winter, the piglets presented longer sucklings during the night, dedicating 1.84 minutes more to suckling compared to the daytime. Nighttime sucklings were 3.13 minutes longer in winter than in summer. However, in summer, piglets suckled more often during the night, with greater interval between feeds during the day. Based on our results, the season influences the suckling behavior of piglets, with shorter feedings and greater frequencies in summer.

**Key words:** Litter, number of suckles, suckling interval, suckling length, lactation, swine.

## INTRODUCTION

One of the major factors potentially affecting milk production of sows or piglet access to the milk is the thermal environment of the housing facility. In farrowing rooms, there are two animal categories with different thermal requirements, sows and piglets, varying respectively from 16 to 22°C and 30 to 32°C (De Bragança et al. 1998). During lactation, females are more susceptible to heat, as lactogenesis is highly thermogenic (Williams et al. 2013). This fact can affect both gilts (Graves et al. 2018) and sows (Ribeiro et al. 2018).

Heat can also compromise the behavior of females (Malmkvist et al. 2012), which may affect the behavior and performance of piglets. Within the expected behavior of the piglets, the feeding behavior is directly related to the consumption of milk and, consequently, to the survival rate and the performance of the litter until weaning. This behavior has been evaluated based on the number, interval, and duration of feedings (Moreira et al. 2018) and represents an interesting indicator of the comfort and well-being of piglets during lactation.

Studies that evaluated the behavior of piglets stress the importance of management effects, considering the type and housing system (Singh et al. 2017, Goumon et al. 2018), fiber supplementation on pre-weaning diets (Clouard et al. 2018), the social environment and interaction of litters (Hong et al. 2017), and artificial vocalization (Khonmee et al. 2018, Moreira et al. 2018). However, the effects of the thermal environment on the suckling behavior of piglets have hardly been explored, although such a characterization of the feeding behavior could serve as the basis for the idealization of strategies (environmental change, sow diet alterations, and animals handling) to ensure an adequate consumption of milk by the piglets, maximizing their survival and performance. In this context, the objective of this study was to evaluate the suckling behavior of piglets in different thermal environments.

## MATERIALS AND METHODS

The study was approved by the bioethics committee of the Federal University of Lavras, Brazil, registered under number 070/14.

### Facilities

The experiment was conducted at a commercial farm in Oliveira, Minas Gerais, Brazil (latitude 20°50’50.7444’’S, longitude 44°48’51.7428’’W, 973 m above sea level). According to the classification of Köppen, the climate of the region is defined as Cwa (monsoon-influenced humid subtropical climate with dry winters and hot summers).

The transfer of the sows from the gestation barn to the farrowing barn occurred at 108 days of gestation. The farrowing barns used were on average 90 m long, 10 m wide, 5 m high at the highest point (ridge), and 3.5 m on the ceiling height, divided into two rooms, each with an average length of 45 m.

The barns were equipped with curtains throughout their length to control natural ventilation and adjust the internal temperature. In each room of the farrowing barn, there were 40 farrowing crates and pens equipped with a nipple drinker for the sow and another one for the piglets as well as a concrete feeder; the floor was a two-third slatted and creep-area, with the use of lamps as a heat source for piglets.

### Animals, diets, and experimental design

The experiment was conducted using a total of 21 sows of the same genetic line (DB-90) from second to fourth parity; 13 of them during the winter and eight during the summer. At the beginning of the trial 30 sows were selected being 15 for each season, however, external interferences occurred, for example: some sows had health issues or piglets were transferred, what could interfere on the results and in this way were disregard of the evaluation.

For the characterization of the seasons of the year, the data were collected in the months of July (winter in Brazil) and January (summer in Brazil)

The sows were selected considering the reproductive history of 12 to 13 piglets born per delivery and the similar management records of the same boars used for insemination.

The experimental design was a randomized complete block (age of piglets) in a 2 x 2 factorial scheme, with season (winter and summer) and shift (daytime, from 06 h to 17 h: 59 min and night from 18 h to 05 h: 59 min) being considered the factors and each litter being one experimental unit (Figure 1). Only the sows received feed during the trial, according to the formula adopted by the farm, based on corn and soybean meal (Table I), while the piglets had access only to milk. The feed provision for the sows followed the management adopted by the farm, with food being provided *ad libitum*. The animals had free access to water throughout the experimental period.

The litters were equalized after farrowing, with 12 or 13 piglets per sow, depending on the availability; all the piglets were assisted to guarantee that they ingested colostrum. During

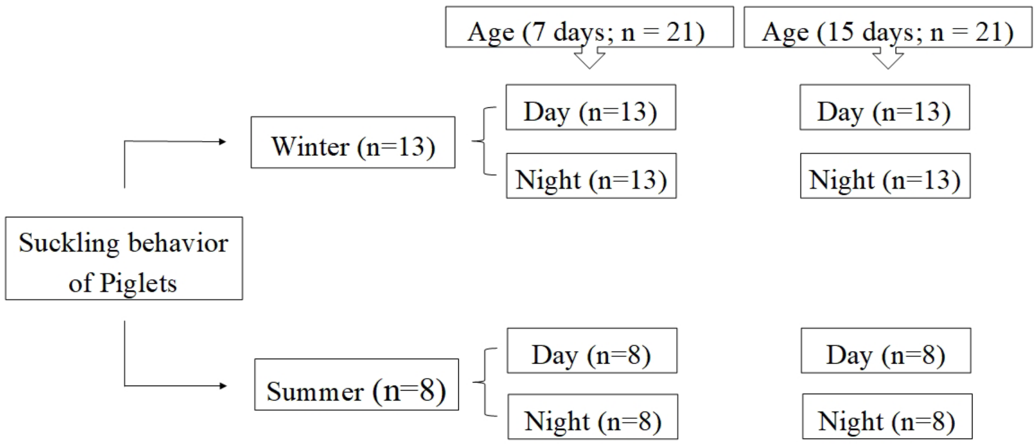


**Figure 1.** Schematic representation of number of litters observed according to age and shift.

farrowing, the mammary gland was pressed and massaged and the presence of colostrum in the teat was stimulated, aiming to orient the colostrum intake to the piglet, to suckle an adequate amount of colostrum in the first hours of life, and let them suck directly on the teats. To maintain an environment within the thermal comfort zone (32°C) of the piglets, in the first week after birth, a lamp was used on the creep for each farrowing crate.

## Behavioral parameters

The behavioral variables analyzed were as follows: number, interval, and frequency of sucklings. The onset of suckling was characterized and consequently accounted when at least half of the litter was suckling, and finalization was obtained when at least half of the litter was not at the teats anymore.

The behaviors were monitored on two distinct days, day 7 and 15 of lactation, over a period of 24 h, to characterize the nictemeral profile. The first days of lactation was not measured because piglets chose a preferential teat in the first 18 h of life, and there were disputes over the breast (Hartsock & Graves 1976, Jeppesen 1982, Rosillon-Warnier & Paquay 1984), which could affect the natural suckling behavior. The assessments were performed using images obtained through four video cameras placed at the upper part of the pen and directly connected to a device equipped with a DVD recorder and LCD monitor (Neocam, model H.264DVR, São Paulo, Brazil).

After the images were recorded, they were stored in the memory of the monitoring device and later used for the assessments. To evaluate the frequency of the behavioral activities, the images were visualized using the video software CyberLink. The film footage was analyzed uninterrupted during the 24h record. The identity of each litter and its activities were recorded. The behavior of the litter was analyzed together, and each liter was considered an experimental unit. For all behavior evaluations during each season the same litter was used.

## Environmental monitoring

To characterize the internal environment of the farrowing rooms, one temperature and relative humidity sensor was used per room, attached to a datalogger (Instrutherm, HT-500, São Paulo, Brazil), and installed at a height of 1 m from the sows. Data were collected every 10 min throughout the experimental period.

## Statistical analyses

Statistical analyses were performed using the SAS statistical package (9.4). All data were

**Table I. Formula and centesimal composition of the lactation feed of the sows.**

| Ingredients | Lactation feed (%) |
|---|---|
| Corn | 52.03 |
| Soybean meal | 29.20 |
| Meat meal | 3.00 |
| Salt | 0.50 |
| Dicalcium phosphate 18% | 1.50 |
| Soybean oil | 5.00 |
| Sodium bicarbonate | 0.13 |
| Kaolim | 0.15 |
| Chloride choline 60% | 0.40 |
| Vitamin premix [1] | 0.04 |
| Mineral premix [2] | 0.39 |
| L-lisyne | 0.30 |
| L- threonine 98% | 0.07 |
| DL-methionine 99 | 0.05 |
| L-valine | 0.19 |
| Sugar | 5.00 |
| Molasses | 0.30 |
| Sugarcane yeast | 1.25 |
| Citric acid | 0.13 |
| Nutritional supplement [3] | 0.38 |
| Total | 100.00 |

[1] **The mineral premix provided the following quantities of minerals per kilogram of complete diet: 45 mg $kg^{-1}$ copper; 275 mg $kg^{-1}$ iron; 8.5 mg $kg^{-1}$ phosphorus; 85 mg $kg^{-1}$ fluorine; 1.75 mg $kg^{-1}$ iodine; 125 mg $kg^{-1}$ manganese; 0.75 mg $kg^{-1}$ selenium; 4.9 mg $kg^{-1}$ sodium; 275 mg $kg^{-1}$ zinc; 0.5 mg $kg^{-1}$ chrome; 100 mg $kg^{-1}$ zinc bacitracin.**

[2] **The vitamin premix provided the following quantities of vitamins per kilogram of complete diet: 9000 IU $kg^{-1}$ retinol; 1500 IU $kg^{-1}$ cholecalciferol; 60 mg $kg^{-1}$ dl-α-tocopherylacetate; 3 mg $kg^{-1}$ vitamin K; 25 mg $kg^{-1}$ vitamin B12; 40 mg $kg^{-1}$ niacin; 20 mg $kg^{-1}$ pantothenic acid; 2.6 mg $kg^{-1}$ folic acid; 0.27 mg $kg^{-1}$ biotin; 336 mg $kg^{-1}$ choline; 4 mg $kg^{-1}$ pyridoxine; 6 mg $kg^{-1}$ riboflavin; 1.3 mg $kg^{-1}$ thiamine.**

[3] **Nutritional supplement: inactivating mycotoxins and antioxidant.**

submitted to normality analysis using the Shapiro-Wilk test at the 5% probability level. The dependent variables that did not present normal distribution were normalized through PROC RANK of the SAS statistical package (9.4). The normal distribution data were compared by the Tukey test, except for the age effect of the piglets, which was compared by the F test. In cases where the parameters had more than one factor (season, age of piglets, and shift), the interactions were evaluated; if not significant, they were disregarded in the analyses:

$$Y_{ijk} = \mu + £_{k-} + Ǥ_{i} + \beta_{j} + \delta_{l} + (Ǥ \times \beta)_{ij} + \varepsilon_{ijkl}$$

where:

$Y_{ijk}$ = observations of the effects of the parameters *i*, replicate *j*, and trial *k*;

$\mu$ = overall average;

$£_{k}$ = random effect of the sow;

$Ǥ_{i}$ = fixed effect of the season;

$\beta_{j}$ = fixed effect of the shift;

$\delta_l$ = fixed effect of the lactation week;

$(G \times \beta)_{ij}$ = interaction between season and shift;

$\varepsilon_{ijkl}$ = random error associated with each observation, considered independent, identically distributed, normal with mean 0 and variance σ.

## RESULTS

### Environmental monitoring

During winter, sows were maintained at an average temperature of 20.32 ± 2.17°C and a relative humidity (RH) of 58.63 ± 2.99%. In the summer period, the average temperature was 26.65 ± 4.02°C and RH was 62.22 ± 12.06% (Figures 2 and 3).

### Behavioral parameters

There were interactions ($P < 0.05$) of the season with the shift for duration, interval, and number of sucklings. In the winter, the piglets presented longer suckling period ($P < 0.05$) during the night, dedicating 1.84 minutes more to the accomplishment of this behavior. For the different seasons, the night suckling was also longer ($P < 0.05$) in the winter, in which piglets dedicated 3.13 minutes more (Table II).

Considering the shifts, the behavioral repertoire regarding the interval and number of sucklings was homogeneous ($P > 0.05$) in winter. However, in the summer, the piglets suckled more ($P < 0.05$) frequently during the night, with a greater ($P < 0.05$) suckling interval during the daytime (Table II).

Sabino et al. (2011) evaluated the behavior of piglets in the farrowing unit and observed that they spent 33.77% of their time suckling. One of the explanations for this divergence with the present study (14.38%) might be related to the methodology; the authors considered the beginning of the suckling when the first piglet started, while in our study, we considered the suckling when half of the litter had the mouth on the teat and the end of the feed when half of the litter had left the teats.

The age of the piglets did not ($P > 0.05$) influence the duration of suckling, regardless of the season. However, in comparison to 7-day-old piglets, those at an age of 15 days presented two fewer daily sucklings ($P < 0.05$), with larger ($P < 0.05$) suckling intervals (Table III).

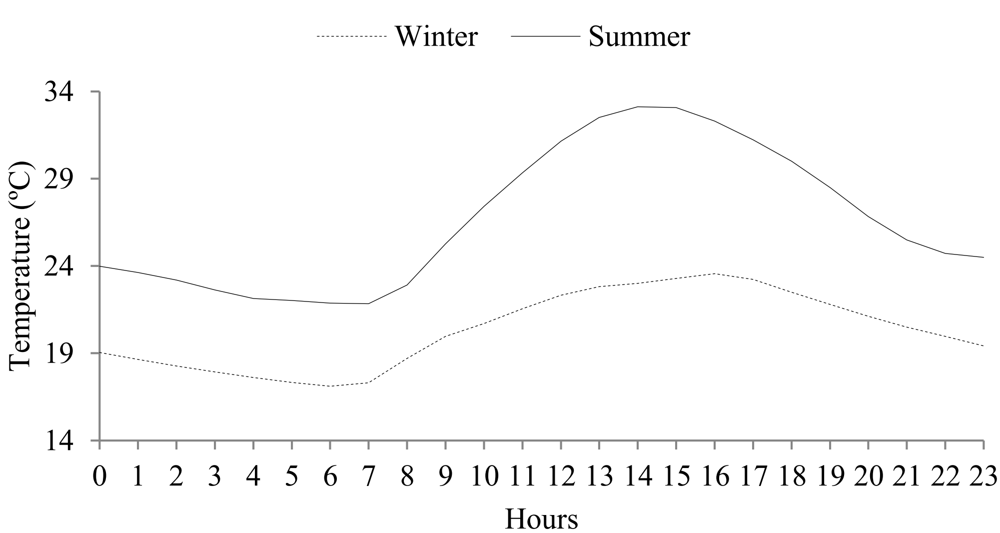


**Figure 2. Temperature (°C) regarding the time.**

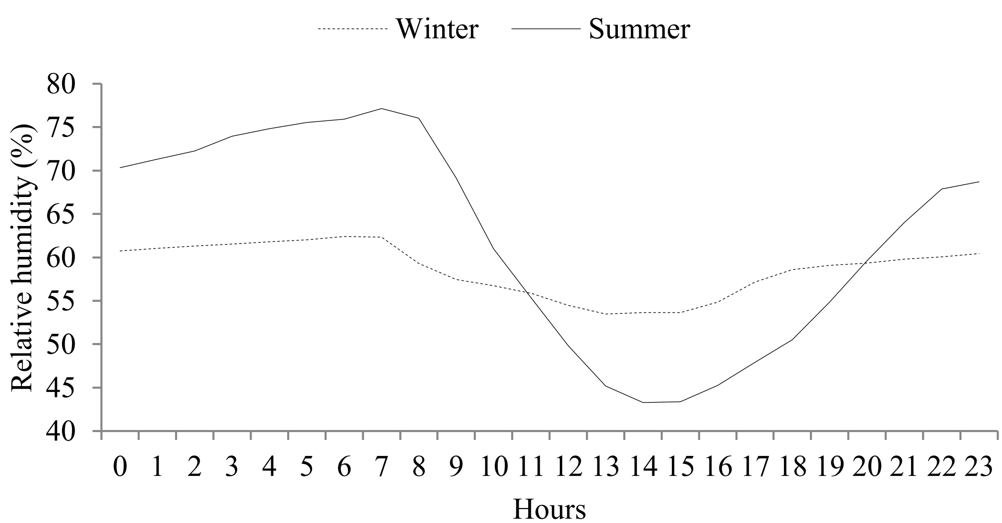


**Figure 3.** Relative humidity (%) regarding the time.

**Table II.** Behavior of suckling piglets according to the season and shift of the day.

| Season | Winter | | Summer | | CV | P value | | |
|---|---|---|---|---|---|---|---|---|
| Shift | Daytime | Night | Daytime | Night | (%) | Season | Shift | Interaction |
| Sows (n) | 13 | | 8 | | | | | |
| Piglets/sow (n) | 13.15 | | 13.12 | | | | | |
| Observations (n) | 220 | 221 | 128 | 152 | | | | |
| Duration (min) | 6.58[b] | 8.42[a] | 5.54[bc] | 5.29[c] | 47.43 | <0.001 | <0.001 | <0.001 |
| Interval (min) | 32.2[ab] | 32.2[ab] | 33.4[a] | 30.1[b] | 42.1 | 0.966 | 0.037 | 0.002 |
| Suckles (n) | 17.1[b] | 17.5[ab] | 16.1[b] | 19.1[a] | 15.72 | 0.801 | 0.001 | 0.009 |

**Means with superscript lowercase letters differ from each other in the row, by Tukey test (5%).**

**Table III.** Behavior of suckling piglets according to age in days.

| Parameters | Age (days) | | CV (%) | P value |
|---|---|---|---|---|
| | 7 | 15 | | |
| Sows (n) | 21 | 21 | | |
| Piglets/sow (n) | 13.12 | 13.15 | | |
| Duration (min) | 6.10 | 6.07 | 47.43 | 0.184 |
| Interval (min) | 30.0B | 34.9A | 42.10 | <0.001 |
| Suckle (n) | 35.07A | 33.00B | 9.30 | 0.021 |

**Averages with uppercase letters differ from each other in the row, by the F test (5%).**

## DISCUSSION

Due to climatic variations in tropical countries such as Brazil, the study of the influence of climatic conditions on animal production is extremely important. Within swine production, lactating sows are more susceptible to climatic variations, mainly when exposed to high temperatures. In the present study, sows were under heat stress during the summer period and the daily relative humidity levels were within recommendations (40 to 70%) suggested by Bortolozzo et al. (2011). Temperatures above the thermal comfort zone (16 to 22°C) for lactating sows (De Bragança et al. 1998) may compromise the performance of the sow and her litter (Liu et al. 2019). Ribeiro et al. (2018), in a meta-analytical study, found that for every 1°C increase in ambient temperature, the feed intake of the sows was reduced by 148 g/day, and the daily milk production was reduced by 227 g. According to Martins et al. (2008), lactating sows maintained in a warm environment are more reactive to the hotter periods of the day and reduce the frequency of a lateral decubitus posture and the number of breastfeeds.

According to the objective of the present the study, which was to evaluate the behavior of lactating piglets during winter and summer, the main results observed were variations in duration and number of sucklings, mainly comparing the coldest period of winter (night) with the hottest period of the summer (day). Thus, there is a longer duration of sucklings during the cooler periods, associated with a shorter interval. The opposite was true for warmer periods in the current study. This influence of ambient temperature on piglet suckling bouts is supported by other published work (Renaudeau et al. 2003, Le Blanc & Mount 1968, Trayhurn et al. 1989, Spinka et al. 2000).

The longer duration of feedings in the winter during the night can be associated with the natural behavior of the sows. During the night, the farrowing room is much quieter, and dark, so sows may prefer to nurse their piglets more during these hours, independent of temperature. However, it is known that heat stress in lactating sows causes changes in ingestive behavior, characterized by a reduction in feed consumption during the hotter periods and an increase in the food intake at night or in the cooler hours (Black et al. 1993, Gourdine et al. 2006). This change in sow feeding time could affect the feeding behavior of piglets. According to Spinka et al. (2000), during the nocturnal period in thermoneutral environments, the feeding behavior is determined by the sow. Thus, sows were more comfortable to suckle the piglets during the cool hours of the night. These results are supported with the intervals between sucklings, which were shorter and consequently in greater numbers at night in the summer to ensure milk consumption. Most likely, this is because the piglets receive less milk during the day due to the heat, and the sows rest in a reclining posture during most of the night, as reported by Bùe (1991, 1994), thus facilitating access to the teats. In this regard, Renaudeau & Noblet (2001) observed a greater suckling interval (37 minutes) for sows under heat stress (29°C) and Martins et al. (2008) reported fewer sucklings during the daytime period (6 am to 5:59 pm). Taken together, these results support the link between the feeding behavior of piglets and the season of the year or shift (day vs night) described in this study.

The greater duration of suckling during the winter is probably due to the superior milk production and the greater need of heat production by the piglets due to the lower ambient temperature (Le Blanc & Mount 1968, Trayhurn et al. 1989). While the suckling interval can range from 30 to 70 minutes (Spinka et al. 1997) the frequency of suckling tends to decrease with the advancement of lactation (Barros et al. 2008). These findings corroborate with the results observed in the present study, where on day 7 of lactation, the interval was 30 min, whereas, at day 15 of lactation, the interval was 34.9 min. In the same way, the number of feedings also reduces, which can also be associated with the greater capacity for milk intake by the piglets within a shorter time frame (Cronin et al. 1996, Valros et al. 2002).

Milk demand determines the milk production process (King 2000), where larger piglets can massage the teats of the sows more vigorously, resulting in increased blood flow to the mammary glands (Fraser 1984) and, consequently, greater milk production. If piglets suck more often, with shorter intervals between sucklings, they will obtain more milk, increasing the milk production of the sows (Birkenfeld et al. 2006). As the feeding frequency plays an important role in the regulation of mammary gland development and milk production in sows (Auldist et al. 2000), knowing the behavioral profile of suckling piglets in the different seasons of the year becomes an additional tool for decision-making in pig farms. Improvement of the thermal control is a key point of better well-being of sows and piglets, additionally, nutritional additives can be provided for sows with the aim to minimize heat stress and the use of creep feed for piglets earlier could improve their performance.

## CONCLUSIONS

The season of the year largely influences the behavior of suckling piglets. Compared to winter, the suckling duration was shorter in summer, and the piglets suckled more often during the night.

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Rennan Herculano Rufino Moreira contributed to the conception, data acquisition and interpretation, design, discussion, design of figures, and critically revised the manuscript, Rodrigo Fortunato de Oliveira and Jorge Yair Pérez Palencia data acquisition and interpretation, discussion and critically revised the manuscript, Leonardo da Silva Fonseca and Cesar Augusto Pospissil contributed to interpretation, discussion and critically revised the manuscript, Márvio Lobão Teixeira de Abreu and Rony Antônio Ferreira contributed to design and critically revised the manuscript. All authors gave their final approval and agree with all aspects of the work.

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