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Hourly Feeding Regime of Modern Genetics Lactating Sows: Enhancing Productive Performance, Welfare, and Piglet Growth in Smart Farm-Based Systems

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Abstract: Effective management of lactating sows significantly influences various aspects of swine production. This study compared the impact of an hourly feeding regime and a five-times-daily feeding regime on the productive performance, body condition, and welfare of lactating sows, as well as on the growth performance of their offspring. Twenty-eight lactating sows (Landrace × Yorkshire) were divided into two groups: Group 1 was fed five times a day, and Group 2 was fed according to an hourly regime. The data were analyzed using independent-samples *t*-tests and the Mann–Whitney U test using Statistical Analysis System (SAS, 2011, Version 9.3) software. An hourly feeding regime positively affected ($p < 0.05$) sows' feed intake and body condition, significantly reducing the days from the weaning-to-estrus interval. Group 1 exhibited significantly higher ($p < 0.05$) reductions in backfat thickness (BFT) and body condition score (BCS) during the weaning period compared to Group 2. Additionally, significant differences ($p < 0.05$) were observed in regard to sow body weight loss, feed intake, piglet livability and mortality rate at weaning, sow index, and calculated milk yield. Feeding sows according to an hourly regime positively impacted their productive performance compared to those fed five times daily. No significant differences ($p > 0.05$) were recorded in regard to the total number of piglets born, live births, mummified piglets, stillbirths, piglet mortality, litter size at weaning, and sow feed conversion ratio (FCR). However, the number of piglets weaned per sow per year (PSY) was numerically higher in Group 2 ($p > 0.05$). The piglets from Group 2 had significantly higher ($p < 0.05$) weaning weights and exhibited lower feed intake, greater weight gain, improved average daily gain, and greater litter size weight gain than those from Group 1. Statistically, sows from Group 2 exhibited a higher frequency of standing ($p < 0.05$), which potentially contributed to the reduction in shoulder skin lesions in sows ($p > 0.05$). In conclusion, an hourly feeding regime could optimize sow productive performance, body condition, milk yield, welfare, and piglet growth in swine production.

Keywords: backfat thickness; body condition score; feed intake; weaning-to-estrus interval; animal welfare; piglet

1. Introduction

Genetic selection for improved sow productivity has led to larger litter sizes, resulting in higher demands on sows to provide more nutrients during lactation [1,2]. Modern sows with more available resources during lactation, such as increased body tissue at parturition or increased feed intake, direct more energy towards milk production, supporting higher litter weight gain [3]. Lactating sows play a pivotal role in swine production by providing essential nourishment through their milk, which is crucial for supporting the growth and development of piglets during the critical pre-weaning period [4,5]. Effective management of lactating sows, including the regulation of feed intake, significantly influences milk production, sow body condition, and piglet growth performance [6–8]. In contrast, insufficient nutrient intake causes sows to mobilize body tissues to maintain milk production [9], often leading to catabolic metabolism, negatively impacting reproductive processes [10]. Studies have indicated that low feed intake and excessive backfat thickness loss during lactation can affect the reproductive performance of sows, resulting in a longer duration of the weaning-to-estrus interval and low milk yields [5,8,11]. The colostrum and milk yield of sows are vital for improving the survival rates of newborn piglets, especially in the pre-weaning stage [12].

The Landrace × Yorkshire crossbreed, a hybrid between the Danish Landrace and English Yorkshire (Large White), exhibits superior characteristics inherited from both parent breeds, making it highly valued in commercial pork production. This hybrid benefits from heterosis, enhancing traits such as reproductive performance, growth rate, and meat quality [13]. Aside from genetics, milk yield and sows' reproductive performance are also associated with feeding management [14]. Poulopoulu et al. [15] found that increasing feeding frequency from twice to three times daily during lactation increased sow feed intake, improved body condition score (BCS), and reduced shoulder lesions. Moreover, feeding sows three times daily lowered weaning-to-estrus intervals to a greater degree than feeding twice daily [7,15]. Additionally, Junior et al. [16] observed that feeding sows three times a day during lactation could reduce pre-weaning mortality rates by 1.4% when compared to feeding twice daily. Understanding the effects of feeding frequency on these parameters is crucial for optimizing swine husbandry practices and ensuring the health and productivity of both sows and piglets [17]. Feeding frequency, determining how often sows receive feed, is a key factor affecting nutrient intake, metabolic processes, and subsequent milk yield. While increasing feeding frequency may enhance nutrient availability and stimulate milk production, it also requires careful consideration of metabolic demands and nutrient partitioning within a sows' body [14].

In recent years, scientific research has focused on understanding the relationship between feeding frequency and determining optimal feeding strategies that meet the nutritional needs of lactating sows while supporting nursing piglets [7,14,15]. Lactating sows can be fed *ad libitum* or with a fixed amount of feed at set times (restricted) [18]. *Ad libitum* feeding has been shown to offer advantages for lactating sows, including increased feed intake [19–21] and enhanced welfare and productivity through increased time spent standing and feeding [18,22]. However, high postpartum feed intake has been linked to the development of periparturient dysgalactia syndrome (PDS) or mastitis, metritis, and agalactia (MMA) syndrome [23]. *Ad libitum* feeding in the latter half of lactation also leads to decreased feed intake, affecting follicle and oocyte quality and ovarian responsiveness to hormonal changes post-weaning [15,24]. Optimizing feeding strategies by increasing controlled feed intake at hourly intervals during lactation is hypothesized to be able to enhance the nutrition and productive performance of high-yielding-genotype sows more effectively than *ad libitum* feeding. Hence, this study aimed to broaden current knowledge by comparing the effects of conventional feeding, administered five times daily, with an hourly feeding regime in which controlled amounts of feed are dispensed and investigating their impacts on the productive performance, body condition, and welfare of lactating sows as well as the growth performance of their offspring in smart farm-based systems.

2. Materials and Methods

2.1. Experimental Animals and Housing

A total of 28 multiparous sows (Landrace × Yorkshire) were used in this study and raised at Sunchon National University's experimental swine facility from November 2023 to February 2024. The sows selected for the experiment had parity numbers ranging from 2 to 7, with an average of 2.33 for each group. The estrus synchronization and artificial insemination (AI) procedures were conducted in accordance with the methods outlined in previous studies [25]. The pregnant sows were raised in a gestation house and kept individually in gestation crates measuring 2.02 × 0.70 m, equipped with auto-loading feeding systems. They had *ad libitum* access to water through a drinker located in the feed trough of each farrowing crate. The pregnancy status of the sows selected for the experiment was determined by performing pregnancy diagnosis using an Easy Scan Gold pig ultrasound diagnostic device (Dongjin BLS Co., Ltd., Gwangju-si, Republic of Korea) at 35 days after artificial insemination [26].

Pregnant sows identified through ultrasound diagnosis were carefully managed and included in the experiment. On the 107th day of gestation, the sows were individually weighed and moved to the farrowing house based on their designated groups. Simultaneously, measurements of the sows' initial body weight, body condition score, and backfat thickness were obtained. The farrowing crate measured 2.02 × 0.70 m and was fitted hinged bottom bars to prevent the piglets from being crushed by the sows. The farrowing pen measured 2.60 × 2.90 m, including a brooding box with an infrared lamp (250 W) installed above to supply artificial heat for the piglets. The farrowing house was air-conditioned with an average housing temperature of 24.87 °C and humidity of 61%.

2.2. Feeding Management

The sows were fed a corn–soybean meal gestation diet with the following nutritional composition: 16% crude protein, 3200 kcal/kg of digestible energy, and 0.50% standardized ileal digestible lysine (SID Lys) [25,26]. In the lactation period, the dietary composition comprises 3400 kcal/kg of digestible energy, 18% crude protein, 0.80% SID Lysine, 5.50% crude fat, 10% crude ash, 9% crude fiber, 0.55% calcium, and 1.50% phosphorus. The same farm management practices and feeding amount (2.50 kg per day) were used for all sows during the gestation period. From the start of the gestation period to three days post-farrowing, all sows in Group 1 (n = 14) and Group 2 (n = 14) were fed five times daily based on the standard farm feeding amount and management practice at 8:00 a.m., 11:00 a.m., 2:00 p.m., 5:00 p.m., and 10:00 p.m. (Table 1). However, from the fourth day post-farrowing to the weaning period (28 days), the feeding regimes for sows in Group 2 were adjusted to hourly intervals. For the sows in Group 2, the auto-loading feeding system (Iontec, Namdong-gu, Incheon, South Korea) was programmed to release 800 g of feed per hour but would only dispense 200 g each time a sow touched the feeding sensor in the feeding trough. Prior to this study, a preliminary investigation was conducted wherein the feed intake of 14 sows was recorded over one month to determine their maximum feed intake per hour. This investigation revealed that the highest feed intake per hour was 800 g. Based on these findings, we set the feed dispensation rate at 800 g per hour for the current study. However, data from this preliminary investigation were not included in the current study's data set.

Table 1. Farm feeding management of lactating sows in Group 1.

Item	6-1 Days before Farrowing	1 Day after Farrowing	2–6 Days after Farrowing	7–13 Days after Farrowing	14–15 Days after Farrowing	16–28 Days after Farrowing
Feeding Amount (kg)	2.50	2.90	3.70	6.00	8.50	9.00

2.3. Productive Performance, Milk Yield, and Determination of Weaning-to-Estrus Interval

The birth weight and number of piglets born alive, mummified, and stillborn were recorded for each litter within 24 h of birth [26,27]. The mummified fetuses and stillbirths were not weighed, but they were included in the overall count of piglets born [26]. No obstetric assistance or oxytocin hormones were administered during farrowing. At 28 days of age, the piglets were weighed individually to measure their body weight gain and calculate the sows' milk yield based on the litters' weight gain. The total milk yield from Days 1–28 was determined by multiplying the litter size weight gain at weaning by a factor of 4.2 [11,26,28,29]. Subsequently, piglets were cross-fostered on day 3 to obtain an experimental litter size of 13–14 piglets per sow and ensure every litter had access to viable teats [11]. Piglets were cross-fostered within their groups, with the same sows' parity numbers, comparable body weights, and the average birth weight of the littermates being considered. This process was crucial as it could have influenced the subsequent growth and development of the piglets [30]. The piglets were provided with *ad libitum* access to water through a nipple drinker, and creep feed was provided on day 3. On the same day, piglets were injected with iron, tail docked, and castrated following established standard protocols.

The pre-weaning mortality rate was determined by dividing the total number of piglets in each group by the number of piglets that died after cross-fostering [26,31]. A digital infrared thermal imaging camera (FLIR E76) with an emissivity of 0.95 was used to detect estrus starting 3 days after weaning at 09:00 and 15:00 daily [11,26,32]. The body temperature readings were taken from the sows' vulvas at a distance of 1 m. Sows were identified as being in estrus when their average body temperature was 35 °C higher than the baseline [25]. A more detailed technique for estrus detection was described in previous studies [11,25,26,32].

2.4. Determination of Sow Backfat Thickness (mm) and Body Condition Score

A digital backfat-measuring device (Minitube Backfat meter (AG0307SP, Dongjin BLS Co., Ltd., Gyeonggi-do, Icheon-si, Republic of Korea) was used along with a sow backfat caliper. One researcher conducted measurements of body condition score (BCS) and backfat thickness (BFT) on standing sows after hair removal. The measurements were conducted at each sow's last rib on both sides, precisely at the P_2 point, positioned 65 mm away from the midline, in accordance with the manufacturer's instructions [11,26,32–34]. The mean values gathered from the digital backfat-measuring device were used for analysis [11]. Additionally, the procedure for measuring backfat thickness using a caliper involved gently positioning the instrument at the designated measurement point on the sows' backs, ensuring it made contact with the skin without exerting excessive force [11]. The backfat caliper arms were positioned on both sides of each sow's back, with the measurement point in the center, in accordance with the manufacturer's instructions. The resulting measurement of backfat thickness displayed on the caliper was recorded.

The body condition score (BCS) was determined using visual estimation and by assessing the ease of palpating the hipbone and backbone of the sows. This evaluation was conducted on a scale ranging from 1 to 5, with 1 indicating a visually emaciated condition in which the ribs, backbone, and 'H' and 'Pin' bones are obvious. In contrast, a BCS of 5 indicates that a sow is obese, a condition wherein the hipbone and backbone are not palpable [35,36]. During the weaning period, both backfat thickness (BFT) and BCS were measured at the same designated spot on both sides of the sows [11,37]. The evaluation of backfat thickness and BCS loss entailed determining the variance between the backfat thickness measured at 107 days of gestation and the measurements taken at the time of weaning [26].

2.5. Determination of Average Frequency of Standing and Shoulder Skin Lesions

DeepEyes™ cameras (M3SEN, Seoul, Republic of Korea) were installed 2.23 m above the ground in each farrowing crate. These cameras provided an aerial perspective of the farrowing area, allowing for automatic measurements, calculations, and continuous recording for 24 h. This camera system serves as an advanced tool for sow management, utilizing artificial intelligence (AI) technology to swiftly detect and alert farmers about sow labor, health status, changes in posture, and dystocia, providing immediate feedback to the farm manager or caretaker [11,26].

The DeepEyes™ M3SEN camera used automatically recorded the frequency with which the sows stood. Sows were considered standing when their bodies were elevated and supported by three or four legs. The data were collected over 24 h, starting from day 1 of post-farrowing and continuing until the weaning period. Skin lesion scoring was assessed utilizing a scale adapted from previous studies [38–40] (Table 2).

Table 2. Definition of skin lesion scores of sows fed using different feeding regimes.

Lesion Score	Definition
0	No lesion
1	<5 superficial lesions (skin unbroken)
2	5–10 superficial lesions or <5 deep lesions (skin broken and evidence of hemorrhage)
3	>10 superficial lesion or >5 deep lesion

2.6. Statistical Analysis

The data were first tested for normality of distribution and homogeneity of variance using the Shapiro–Wilk test and Levene's test, respectively. The independent-samples T-test was employed for the data with normal distribution and equal variance; otherwise, the Mann–Whitney U test was used via Statistical Analysis System (SAS, 2011, Version 9.3, SAS Institute, Cary, NC, USA) software. Chi-squared test was employed to test the sows with skin lesions. The correlation between housing environment, frequency of standing, and feed intake was analyzed using Sigmaplot software version 20. All analyses were performed with a 95% confidence level, and statistical significance was determined with $p < 0.05$.

3. Results

3.1. Backfat Thickness (BFT) and Body Condition Score (BCS)

The sows' backfat thickness and body condition score at 107 days of gestation showed no significant differences between the groups of experimental animals (Table 3). However, the sows in Group 1, subjected to a feeding regime of five times a day, exhibited a significantly higher ($p < 0.05$) reduction in BFT and BCS during the weaning period.

Table 3. Backfat thickness and body condition scores (BCSs) of sows subjected to different feeding regimes.

Parameters	Group 1 (n = 14)	Group 2 (n = 14)	SEM	*p*-Value
BFT (mm) and BCS at 107 gestation days				
Digital	17.07	17.04	0.19	0.910
Vernier Caliper	17.00	17.07	0.16	0.603
BCS	3.09	3.16	0.05	0.511
BFT (mm) and BCS at weaning, 28 days				
Digital	13.29	15.00	0.21	<0.001
Vernier Caliper	13.18	15.25	0.30	<0.001
BCS	2.57	3.00	0.07	0.002
BFT and BSC Difference (mm)				
Digital	3.79	2.04	0.25	<0.001
Vernier Caliper	3.86	1.82	0.30	<0.001
BCS	0.52	0.16	0.07	0.012

SEM = standard error of the mean; BFT = backfat thickness; BCS = body condition score.

3.2. Sows' Productive Performance, Milk Yield, and Weaning-to-Estrus Interval

Table 4 shows sow productive performance and calculated milk yields under different feeding regimes during lactation. Although some parameters did not exhibit significant variations, notable differences ($p < 0.05$) were observed in sow body weight loss, feed intake, piglet livability rate at weaning, piglet mortality rate, sow weaning-to-estrus interval, sow index, and calculated milk yield. The data indicate that feeding sows at an hourly rhythm positively impacted productive performance, a result that comes in contrast to the groups where feed was supplied only five times a day. The daily feeding curve indicates that both groups showed an increase during the 3rd and 4th weeks of the experimental period, with the sows in Group 2 exhibiting a higher feed intake than those in Group 1. Additionally, hourly feed intake peaked at 8:00 and 17:00 (Figure 1).

Table 4. Productive performance and calculated milk yields of sows subjected to different feeding regimes.

Parameters	Group 1 (n = 14)	Group 2 (n = 14)	SEM	p-Value
Initial weight [1]	224.45	224.36	2.51	0.285
Final weight [2]	210.21	215.92	4.36	0.482
Body weight loss (kg)	14.24	8.44	0.38	0.001
Total feed intake (kg) [3]	189.61	261.40	7.19	<0.001
Daily feed intake (kg) [4]	6.77	9.34	0.36	<0.001
Total number of piglets born [5]	14.00	13.57	0.38	0.578
Total live births (head)	13.07	13.29	0.36	0.772
Mummified piglets (head)	0.79	0.14	0.14	0.770
Stillbirths (head)	0.14	0.14	0.08	0.804
Mortality (Piglet; head)	1.29	0.50	0.92	0.560
Litter size weaned (head)	11.79	12.79	0.35	0.329
Livability, farrowing (%)	93.51	97.95	1.05	0.077
Livability, weaning (%)	90.28	96.29	1.26	0.012
Mortality rate (%)	9.72	3.71	1.26	0.012
WEI, day	6.36	5.43	0.14	0.001
Sow Index [6]	2.46	2.48	0.01	0.001
PSY [7]	29.01	31.65	0.88	0.194
FCR, Sow [8]	2.66	2.95	0.13	0.178
Calculated Milk Yield				
Milk Yield (kg) [9]	314.86	377.75	13.11	0.013
Milk Yield, kg/day	11.25	13.49	0.47	0.021

[1] Sows were individually weighed at 107 gestation days; [2] individually weighed at weaning (28 days); [3,4] feed intake starting from day 1 post-farrowing to weaning (28 days); [5] total number of born piglets, including mummified piglets and stillbirths; [6] determined by dividing the number of days in a year (365) by the sum of the gestation period, lactation period, and WEI; [7] number of piglets weaned per sow per year, calculated by multiplying the litter size weaned by the sow index; [8] calculated by dividing sow feed intake by the product of bodyweight gain and litter size weaned; [9] calculated as follows: litter size of the piglets × bodyweight gain multiplied by 4.2; SEM = standard error of the mean; WEI = weaning-to-estrus interval; FCR = feed conversion ratio.

The sows in group 1 showed excessive body weight loss in the weaning period, resulting in a longer weaning-to-estrus interval (WEI) in days ($p < 0.05$). No significant difference ($p > 0.05$) was observed in the PSY, but Group 2 had numerically higher values than Group 1. Statistically, no significant difference was observed in regard to the total number of piglets born, live births, mummified piglets, stillbirths, piglet mortality (head), litter size at weaning, and the sows' feed conversion ratio (FCR). However, the data indicated that there were numerically better results for Group 2 compared to Group 1.

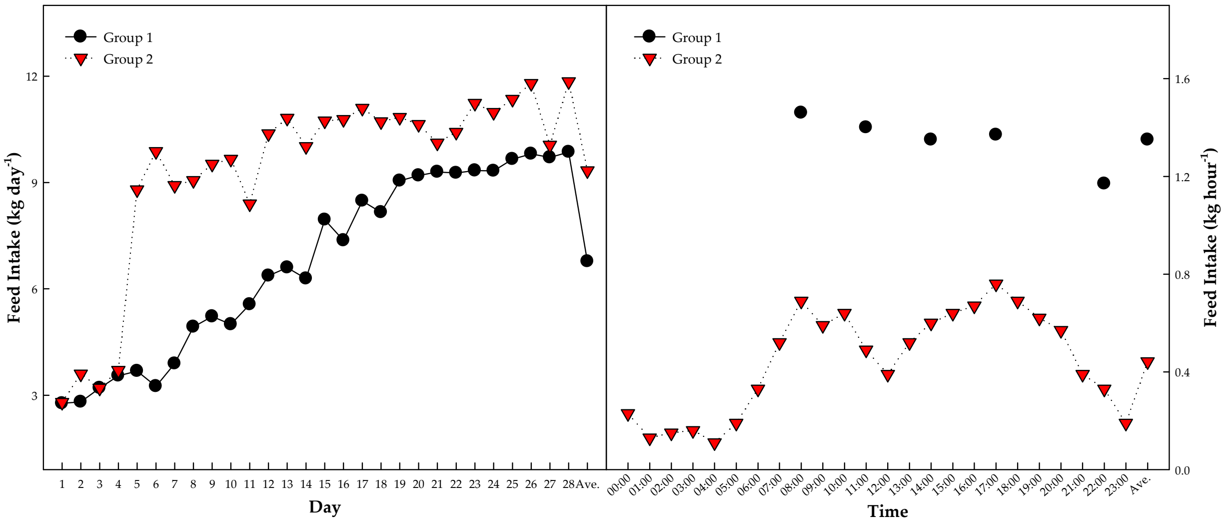

Figure 1. Average daily and hourly feeding curves for the five times and hourly feeding regimes applied to the sows during the lactation period.

3.3. Frequency of Standing and Skin Lesions

The sows in Group 2 presented a significantly higher frequency of standing compared to those in Group 1 (Table 5). No skin lesions were recorded at pre-farrowing; hence, it was not presented in the data. However, in the weaning period, the sows in Group 1 showed numerically higher scores ($p > 0.05$) for skin lesions than Group 2. Statistically, irrespective of feeding regimes, sows in both groups exhibited comparable percentages of skin lesions during the lactation period. However, Group 1 had a numerically higher occurrence of skin lesions ($p > 0.05$).

Table 5. Frequency of standing and skin lesions of sows subjected to different feeding regimes.

Parameters	Group 1 (n = 14)	Group 2 (n = 14)	SEM	p-Value
Frequency of Standing	14.76	19.18	0.79	0.001
Skin Lesions	0.35	0.14	0.08	0.204
Sows with Skin Lesions (%)	35.70	14.30	-	0.190

SEM = standard error of the mean.

3.4. Correlations between Ambient Temperature, Frequency of Standing, and Feed Intake

Positive correlations were noted among the daily ambient temperature and the frequency of standing, daily feed intake, hourly ambient temperature and feed intake, and the average daily frequency of standing and feed intake, with corresponding R^2 values of 0.115, 0.434, 0.350, and 0.167, respectively (Figure 2).

3.5. Piglets Growth Performance during the Lactation Period

Significant differences were observed between the two groups for most of the growth performance metrics for piglets (Table 6). Piglets birthed by sows in Group 2 showed notably higher values than those in Group 1, indicating improved performance. Specifically, piglets from sows in Group 2 had significantly greater ($p < 0.05$) weaning weights, lower feed intakes, greater body weight gain, improved average daily gain, and greater litter size weight gain compared to Group 1. However, no significant difference was found in regard to the birth weight and feed conversion ratio ($p > 0.05$) between the two groups. A lower feed intake in piglets could be associated with a higher milk yield from the corresponding dam. It should be noted that during the lactation period, the colostrum and sow milk are essential sources of nutrients for the piglets during their first life period. This implies that the feeding regimes implemented in Group 2 enhanced sow feed intake and positively influenced sow physiological condition, potentially contributing to increased milk production, the primary source of nutrients for piglets, leading to better overall outcomes than Group 1.

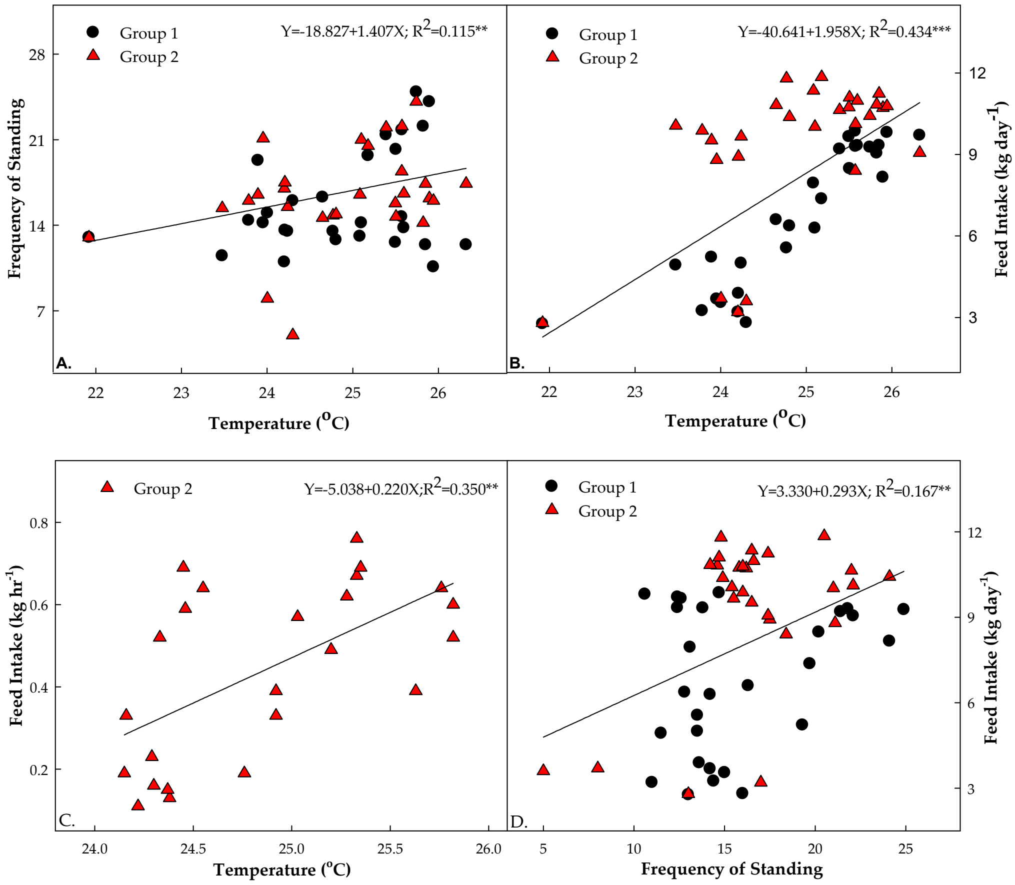

Figure 2. Correlations regarding the housing daily ambient temperature and frequency of standing (**A**); feed intake per day (**B**); hourly ambient temperature and feed intake of sows in Group 2 (**C**); and the average daily frequency of standing and feed intake (**D**); ** p-value < 0.01; *** p-value < 0.001.

Table 6. The average production performance of piglets during the lactation phase, 28 days.

Parameters	Group 1 (n = 14)	Group 2 (n = 14)	SEM	p-Value
Birth weight, kg.	1.33	1.40	0.04	0.306
Weaning weight, kg.	7.67	8.42	0.11	0.001
Feed Intake/head, kg.	0.45	0.44	0.04	0.003
Body weight gain, kg.	6.34	7.02	0.11	0.001
Average daily weight gain, kg.	0.23	0.25	0.01	0.001
Litter size weight gain, kg.	74.97	89.94	3.13	0.013

SEM = standard error of the mean.

4. Discussion

Assessing the body weight, backfat thickness (BFT), and body condition scores (BCSs) of sows at various stages of the production cycle is a common practice in the swine industry. This evaluation helps to adjust feeding levels to ensure that sows maintain optimal body condition [26]. Such maintenance, in turn, improves reproductive efficiency, litter performance, sow longevity, and promotes greater mammary gland development [12,26,41]. The recent findings contradict the observations of Schneider et al. [42], indicating no significant differences in the BFT of sows during the weaning period when fed two times a day compared to six times a day during the lactation period. Although lactating sows were fed at hourly intervals, they still exhibited decreases in backfat thickness and BCS, which confirms the results of previous studies reported by Cools et al. [21] and Neil et al. [43] showing that sows fed *ad libitum* still lose weight throughout lactation. The reduction in BFT and BCS in the present study was attributed to sow energy reserves, metabolic differences, nutrient utilization, litter size, and the increased energy demands of lactation, as supported by the findings of Mun et al. [11]. During lactation, a sow's energy levels are notably depleted as it produces milk to support large litters. Hence, it is vital to ensure that sows maintain proper body condition [5]. If the increased energy requirement cannot be met, sows will use their body fat stores for energy. While a certain amount of fat mobilization is acceptable, excessive fat mobilization or, even worse, the mobilization of protein can lead to fertility issues in the subsequent farrowing cycle [5,44,45].

Sows' initial and final weights did not significantly differ between different feeding regimes. However, body weight loss was significantly higher in sows fed five times a day, contributing to a greater number of unproductive days or longer weaning-to-estrus intervals than for sows fed hourly. Previous studies have supported the recent findings that excessive reductions in body weight and backfat thickness can result in longer weaning-to-estrus intervals and reported an increased incidence of anestrus, leading to reduced farrowing rates [11,46–48]. Therefore, it is crucial to maintain the ideal sow body weight and condition during gestation and lactation to maximize productivity and ensure efficient feed utilization [26,49]. Sows fed at hourly intervals exhibited significantly higher total and daily feed intake. This increase in feed intake had a positive impact, leading to higher livability rates at weaning, lower mortality rates of piglets, and fewer days in the weaning-to-estrus interval. These factors collectively contributed to significantly improving the sow index and calculated milk yield and allowing numerically higher piglet weaned per sow per year (PSY) values. According to recent factorial calculations by Theil [12], modern high-yielding sows meet their energy requirements by consuming approximately 9 kg of feed per day during peak lactation, which also corroborates the findings of the current study.

The preceding discussion is supported by the research by Gorr et al. [18], who compared controlled or non-*ad libitum* and *ad libitum* feeding for lactating sows. They reported that sows in non-*ad libitum* systems consumed feed more rapidly due to receiving larger quantities over shorter intervals, unlike in sow-controlled *ad libitum* systems where only small portions were dispensed at a time. This explains the current findings that a slower feeding rate allows for extended digestion periods, potentially improving nutrient breakdown, utilization, and absorption. Furthermore, as feed would be dispensed more frequently, a sow might have perceived it as being fresher and thus more attractive over a longer period, extending feeding time [18]. This can ultimately extend the time spent on feeding, a significant aspect of a sow's natural behavior, and can be considered a positive indicator of welfare [18,50]. Hence, feeding lactating sows hourly promotes optimal digestion, absorption, and nutrient utilization, improving production and sow health.

The total number of piglets born, including with regard to live births, mummified piglets, stillbirths, birth weight, and litter size weaned, did not significantly differ between feeding regimes. This lack of difference can be attributed to the fact that the experimental feeding regimes commenced four days post-farrowing, indicating that any potential effects on the sows' reproductive performance would only have been observed if the treatments had begun during the gestation period [26,27,51–53]. Adequate nutrition is crucial during gestation to ensure optimal fetal development, prepare for successful lactation, and improve birth weight and piglet size uniformity at birth [54]. The significant increase in the growth performance of piglets from lactating sows in Group 2 could be associated with the sows' yields of milk, which is the primary source of nutrients for piglets. The positive effect on the growth of piglets could be related to the sows' nutritional requirements, energy reserves, protein synthesis, and physiological changes during the lactation period [26].

A potential explanation for the numerically higher occurrence of skin lesions and the percentage of skin lesions in Group 1 is their significantly greater body weight, body condition score (BCS), and backfat thickness reductions. Furthermore, the standing frequency of sows in both groups appears statistically comparable. Zurbigg [55] also found similar results, noting that skin lesions are linked to weight loss and decreased BCS among sows during lactation, especially those with high milk production or an inadequate energy intake. The recent findings also corroborate the report made by Poulopaoulou et al. [15] that feeding animals twice compared to three times daily leads to increased standing, more vigorous behavior, and lower body condition scores (BCSs), increasing the severity of shoulder lesions.

The significantly higher frequency of standing in Group 2 positively affected the sows' welfare, resulting in a lower occurrence of skin lesions and a lower percentage of sows with skin lesions. Skin lesions in lactating sows commonly develop during the first two weeks of farrowing [56,57]. These lesions occur when sows spend more time lying down and are caused by a lack of oxygen reaching the tissue in the shoulder area due to pressure from the floor; thus, the tissue loses its blood supply and dies, similar to pressure ulcers in humans [56,58]. The positive correlation between temperature, the frequency of standing, and feed intake could be explained by the fact that the sows were raised in a controlled environment and subjected to different feeding regimes. The hourly feeding regime in the current study improved sow productive performance, welfare, physiological conditions, and piglet growth performance.

5. Conclusions

In conclusion, maintaining optimal body weight, backfat thickness (BFT), and body condition score (BCS) among lactating sows is crucial for maximizing productivity and ensuring efficient feed utilization in the swine industry. Initial and final weights did not significantly differ between feeding regimes, but the sows fed five times daily exhibited excessive bodyweight loss, which led to longer weaning-to-estrus intervals and lower milk yields. Feeding sows according to an hourly rhythm led to higher feed intakes, contributing to improved productive performance, higher livability rates of piglets at weaning, and shorter intervals from weaning to estrus. Moreover, feeding lactating sows at hourly intervals significantly increased the frequency of standing, positively reducing skin lesion scores and the percentage of sows with skin lesions. Piglet growth performance for the sows in Group 2 also showed a significant improvement compared to that in Group 1. A sow's feed intake is also associated with the frequency of standing. This study highlights the importance of nutrition management during lactation for optimizing sow feed intake patterns, productive performance, physiological conditions, milk yield, welfare, and piglet growth.

In the future, we recommend conducting similar studies during the summer, comparing the feed intake patterns of sows raised in air-conditioned and non-air-conditioned housing environments at hourly intervals. This will help determine how housing temperature influences feed intake and identify the optimal feeding times for sows in hot weather, particularly in backyard swine farming. Additionally, we recommend investigating effects of feed intake and sow productivity by maintaining the same feeding amount for both groups while varying the feeding frequency.

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