Jurnal Veteriner pISSN: 1411-8327; eISSN: 2477-5665
Terakreditasi Nasional, Dirjen Penguatan Riset dan Pengembangan,
Kemenristek Dikti RI S.K. No. 36a/E/KPT/2016

September 2025 Vol. 26 No.3: 387-397
DOI: 10.19087/jveteriner.2025.26.3.387
online pada http://ejournal4.unud.ac.id/index.php/juvet

Mucus Drying Shortly After Birth Using Clay Adsorbent Effectively Maintained Temperature, Performance, Behaviour, and Reduced Mortality In Pre-Weaning Piglets

(PENGERINGAN LENDIR SEGERA SETELAH LAHIR MENGGUNAKAN ADSORBEN EFEKTIF MEMPERTAHANKAN SUHU, PERFORMA, TINGKAH LAKU, DAN MENURUNKAN MORTALITAS ANAK BABI PRA-SAPIH)

Besse Tenri Nurul Hikmah[1], Tri Satya Mastuti Widi[2]*, Ika Sumantri[3], Sigit Bintara[4], Tristianto Nugroho[2], Hamdani Maulana[2], Erika Kusuma Wardani[5]

[1]Postgraduate Program, Faculty of Animal Science,
Universitas Gadjah Mada, Yogyakarta, 55281, Indonesia
[2]Department of Animal Production, Faculty of Animal Science,
Universitas Gadjah Mada, Yogyakarta
[3]Department of Animal Science, Faculty of Agriculture,
Universitas Lambung Mangkurat, Banjarbaru, 70714
[4]Departement Animal Breeding and Reproduction,
Faculty of Animal Science,
Universitas Gadjah Mada, Yogyakarta,
Jl. Fauna No.3, Karang Gayam, Caturtunggal,
Kec. Depok, Kabupaten Sleman,
Daerah Istimewa Yogyakarta 55281, Indonesia
[5]PT Clariant Adsorbents Indonesia, Bogor, 16820, Indonesia
*Email: widi.tsm@ugm.ac.id

ABSTRACT

This study was aimed to determine the effect of mucus drying methods on newborn piglets on their postnatal behavior and preweaning performance. The research was conducted from February to May 2024 at a smallholder pig farm in Godean District, Sleman Regency, Yogyakarta. Treatments were applied to 66 newborn Landrace crossbred piglets and consisted of no drying assistance (P1), drying assistance using cloth (P2), and drying assistance using a clay as adsorbent (P3). The variables observed included body temperature, drying time, suckling time, postnatal behavior, and pre-weaning performance. Behavior was recorded and analyzed using Closed-Circuit Television (CCTV) video footage. The data were analyzed using Analysis of variance and Analysis of covariance with the R programming language. The P3 treatment significantly ($p<0.05$) influenced body temperature at the 120th minutes and 24 hours after birth, body weight at two weeks, average daily gain (ADG) at 0–2 weeks (138.75 g/day), body length at 2 and 4 weeks, and chest circumference at 2 and 6 weeks. The P3 group also exhibited the lowest mortality rate (13.33 vs. 21.74%). Furthermore, P3 affected behavior 24 hours after birth, particularly walking, standing, searching for the mother's nipple, and lying down with other piglets. Overall, the use of clay adsorbent effectively maintained piglet body temperature during the first 120 minutes after birth and primarily influenced piglet performance during the early postnatal period, with no significant effects observed in the later stages. Additionally, the use of clay adsorbent reduced mortality rates and enhanced piglet activity levels, demonstrating its effectiveness in supporting early postnatal adaptation.

Keywords: Behaviour; Mucus Drying; Performance; piglets; adsorbent

ABSTRAK

Penelitian ini bertujuan untuk mengetahui pengaruh pengeringan lendir anak babi yang baru lahir terhadap tingkah laku postnatal dan performa prasapih. Penelitian dimulai pada bulan Februari sampai Mei 2024 di peternakan babi masyarakat yang berlokasi di Kecamatan Godean, Kabupaten Sleman, Daerah Istimewa Yogyakarta. Penelitian dilakukan dengan memberikan perlakuan berupa bantuan pengeringan pada 66 ekor anak babi peranakan *landrace* (*Landrace cross*) yang baru lahir. Perlakuan (pengeringan lendir) yang diberikan meliputi tanpa bantuan pengeringan (P1), dengan bantuan menggunakan kain (P2), dengan menggunakan adsorben berbahan *clay* (P3). Variabel yang diamati terdiri atas suhu tubuh, waktu pengeringan dan waktu menyusu, tingkah laku postnatal dan performa prasapih. Tingkah laku diamati menggunakan hasil rekaman *video Closed-circuit television* (CCTV). Data dianalisis dengan analisis varians dan analisis kovarians menggunakan bantuan *R programming language*. Perlakuan P3 memberikan pengaruh terhadap suhu menit ke-120 dan 24 jam setelah lahir, bobot badan dua minggu, *Average Daily Gain* (ADG) 0-2 minggu (138,75 g/hari), panjang badan umur dua dan empat minggu, lingkar dada anak babi umur dua minggu, dan lingkar dada umur enam minggu. Kelompok P3 juga memiliki tingkat mortalitas terendah (13,33 vs 21,74%). Selain itu, P3 juga berpengaruh terhadap tingkah laku 24 jam setelah lahir, utamanya pada tingkah laku berjalan, berdiri, mencari puting induk, dan berbaring bersama anak babi lain. Secara keseluruhan, penggunaan adsorben mampu mempertahankan suhu tubuh anak babi hingga 120 menit pertama setelah kelahiran, dan hanya memengaruhi performa anak babi pada masa awal setelah kelahiran tetapi tidak pada masa selanjutnya. Selain itu, penggunaan adsorben juga menurunkan tingkat mortalitas dan meningkatkan tingkat aktivitas anak babi, menandakan metode ini lebih efektif mendukung adaptasi awal.

Kata-kata kunci: tingkah laku; pengeringan lendir; performa; anak babi; adsorben

INTRODUCTION

Newborn piglets are covered in mucous membranes at birth, including around the mouth and nose, which can interfere with breathing (Gunawan *et al.,* 2022). They also have low immunity, making them vulnerable to infections. Piglets begin to develop immunity after receiving colostrum from the sows, which contains proteins rich in immunoglobulins.

Newborn piglets possess an underdeveloped thermoregulatory system, rendering them incapable of effectively responding to thermal stress, whether from excessive heat or cold. As noted by Mirkov *et al.* (2021), the thermoregulatory capacity of neonatal piglets is immature, and even minor temperature fluctuations may have detrimental effects. Additionally, the absence of brown adipose tissue in piglets further impairs their ability to maintain body temperature postnatally (Hou *et al.*, 2017).

The presence of mucus on the surface of the piglets' bodies exacerbates heat loss, as body heat is utilized to evaporate the moisture contained in the mucus, leading to a drop in body temperature below the normal physiological range (De *et al.,* 2024). Hypothermia resulting from this heat loss can significantly compromise piglet vitality and ultimately elevate the risk of neonatal mortality.

In contrast to other mammals such as cattle, goats and sheep, because of the presence of maternal licking behaviour serves to remove mucus and stimulate blood circulation in the neonate, but in sows do not exhibit this behaviour. Instead, sows typically only sniff their piglets after birth without providing any physical stimulation through licking (Mihaela *et al.*, 2011). The absence of maternal drying behaviour, combined with the lack of appropriate housing facilities such as heating lamps or thermal devices, can expose piglets to cold stress. This exposure may result in hypothermia and discomfort, ultimately increasing the risk of piglet mortality (Devillers *et al.*, 2011).

Newborn piglets that maintain a core body temperature within the range of 38–39°C during the first 24 hours after birth are considered to be in a state of thermal homeostasis, in which their bodies can sustain a stable and optimal temperature for physiological functions (Garcia *et al.*, 2021). However, the presence of mucus covering the piglet's body immediately after birth can impede efficient evaporation and hinder thermoregulation. Residual mucus keeps the skin moist, thereby increasing heat loss through evaporation from the wet skin surface, which can exacerbate hypothermic conditions. Prompt drying of the piglet's body after birth is expected to reduce excessive heat loss and help maintain body temperature within the ideal range for survival. Inadequate thermal conditions that fail to support the attainment of optimal body temperature are inconsistent with the principles of animal welfare, particularly the principle of "freedom from pain, injury, and disease" (Webster 2001).

Since sows do not perform drying behaviour and many housing facilities lack adequate heating systems, farmers must provide manual assistance to dry newborn piglets. One potential method is using cloth or adsorbent materials (Andersen *et al.*, 2009). Adsorbents are materials specifically designed to adsorb moisture or liquid, and in pig farming, they serve to assist in drying the piglets' bodies immediately after birth. These products are typically in the form of highly adsorbent powders that draw moisture from the piglets' skin, thereby helping to stabilize their body temperature and reduce the risk of hypothermia.

Providing drying assistance not only decreases the incidence of hypothermia but also reduces the likelihood of pain and distress in the animals. Moreover, dried piglets tend to be more active and are more likely to initiate suckling earlier, which is essential for colostrum intake and survival. Early suckling enables piglets to consume colostrum sooner, which is crucial for enhancing their immunity during the early stages of life. Andersen *et al.* (2009) reported that farmers who consistently assisted piglets in obtaining colostrum shortly after birth had a mortality rate approximately 3% lower than those who did not implement this practice. Successful suckling after birth is critical in determining the volume of colostrum intake, which plays a pivotal role in both the short-term and long-term survival and performance of piglets (Edwards 2002). Insufficient colostrum intake can result in conditions such as hypoglycemia and hypothermia, which are detrimental to piglet health (Devillers *et al.*, 2011).

Several studies have been conducted to evaluate the effects of drying on newborn piglets. Previous research has shown that keeping piglets warm using heat lamps or drying them with straw and paper towels can reduce mortality rates (Andersen *et al.*, 2009). However, no studies have specifically investigated the effectiveness of different drying methods on postnatal behaviour and weaning performance. Therefore, the present study was conducted to assess changes in body temperature and weaning performance following the application of a drying aid to remove birth mucus, as well as to evaluate the behaviour of piglets with and without the use of a drying aid.

RESEARCH METHODS

Ethics Approval

This study was approved by the Ethics Committee for Animal Research, Faculty of Animal Science, Sebelas Maret University, Surakarta (Decree No. 86/UN 27.14.1/PT/2024).

Location and Housing Conditions

This research was conducted at smallholder farms in Godean District, Sleman Regency, Yogyakarta, Indonesia. The study was conducted from February to May 2024. The cages used were semi-open group cages. The average cage temperature during the study was 27.5°C with a relative humidity of 74.3%. Cage cleanliness was maintained routinely by cleaning feces twice daily.

Animal

This study involved three different treatments for drying mucus on newborn piglets at birth, using a total of 66 newborn piglets belong to Landrace crossbred. These piglets were obtained from seven sows raised on a smallholder farm. Each treatment group was housed in a separate pen and remained with their respective sows in the same pen until the data collection was completed at six weeks of age (weaning).

Treatment and Data Collection

The treatments administered to the newborn piglets included: P1: no drying assistance; P2: drying assistance using a cloth to thoroughly wipe off all mucus from the piglet's body; and P3: drying assistance using a clay adsorbent. The clay adsorbent, which is commercially manufactured by PT Clariant Adsorbent Indonesia located in Gresik, East Java, Indonesia, which had a flour-like consistency, was placed in a container where the piglet was inserted and then sprinkled with the powder.

The observed variables included body temperature (measured at birth, after treatment, and at 60, 120, minutes and 24 hours after birth), postnatal behaviour (standing, suckling, and lying down), and pre-weaning performance (body weight, Average Daily Gain (ADG), body length, chest circumference, and mortality). Behavioural observations were conducted using Closed Circuit Television (CCTV) recordings, with video analysis performed for one hour at each time interval, starting from the time the piglets were returned to the sow after treatment and again at 24 hours after birth.

Data on body weight, body length, and chest circumference were recorded at birth and subsequently every two weeks until weaning. Average Daily Gain (ADG) was calculated for the intervals of 0–2 weeks; 0–4 weeks; and 0–6 weeks.

Statistical Analysis

Data on body temperature, drying time, suckling time and behaviour were analyzed using Analysis of variance (Anova). Performance data were analyzed using both Analysis of variance and Analysis of covariance (Ancova) in the R programming language. If a significant treatment effect was observed, Post-hoc comparisons were made by using Duncan's new multiple-range test.

RESULTS AND DISCUSSION

Piglets Body Temperature

The effect of the drying treatment on body temperature, including pre-treatment temperature, post-treatment temperature, the difference between pre- and post-treatment temperatures, and temperatures measured at 60, 120 minutes and 24 hours after birth, is presented in Table 1.
Body temperature at the 60^{th} minute after birth showed no significant differences. This may be attributed to the fact that the drying process may require more time to be fully effective. Additionally, the temperature measured at the 60^{th} minute was lower than the temperature recorded immediately after the treatment. Garcia *et al.* (2021) reported that piglets receiving colostrum within the first hour after birth experience an increase in rectal temperature by 1°C. Based on this finding, it can be inferred that the observed decrease in temperature may have resulted from sub-optimal colostrums consumption due to the drying process and the data collection, which was conducted immediately after birth. This reduced the time available for the piglets to consume colostrums. The lack of a significant decrease in body temperature at the 60^{th} minute after birth suggests that the drying treatment had not yet reached its full effectiveness, and the limited time for colostrums intake may have impacted the piglets' body temperature.

This was more evident in the temperature measurements taken at the

Table 1. Effect of mucus drying treatments on body temperature of piglet

Variable	Drying Treatment		
	P1	P2	P3
Before treatment (^{o}C)^{NS}	38.77±1.24	39.01±0.76	39.13±1.72
After treatment (^{o}C)^{NS}		37.93±0.67	38.34±1.84
difference before and after treatment (^{o}C)^{NS}		1.08±0.54	0.79±0.7
Piglet rectal temperature (°C)			
Time after birth (minute)			
60^{NS}	37.37±1.32	37.62±0.43	37.32±1.02
120**	36.63±1.17^{b}	37.35±0.39^{ab}	38.01±1.14^{a}
1440 (24 h)*	38.55±0.57^{a}	38.09±0.64^{ab}	37.89±0.79^{b}

NS = Non Significant; * : P<0.05; ** : P<0.01; *** : P<0.001; $^{a, b, ab}$ Means within rows with different superscripts significantly at *P*<0.05; P1 : no drying assistance; P2 : drying assistance using cloth; P3 : drying assistance using an adsorbent; Before treatment: Temperature prior to treatment application; After treatment: Temperature following treatment application.

120th minutes and 24 hours after birth, which showed significantly different results (p< 0.05). At the 120th minute, the highest temperature was recorded in piglets receiving the P3 treatment, but by the 24 h, the lowest temperature was observed. The drop in temperature at 24 hours was not considered a major concern, as the primary priority immediately after birth is to ensure the piglets receive colostrums for optimal immunity. This can be achieved if the piglets have sufficient energy to suckle. However, if the piglets are cold, the energy that should be used for suckling is redirected to maintaining a stable body temperature, causing the piglets to become lethargic, unable to move towards their mothers, and ultimately failing to consume colostrums. This finding aligns with the research report of Juthamanee and Tummaruk (2021), which showed that piglets with inadequate colostrums intake had lower rectal temperatures compared to those who received sufficient colostrums. Inadequate colostrums intake increases the piglets' susceptibility to disease (Devillers *et al.*, 2011).

Drying with clay adsorbents has shown advantages in maintaining piglet body temperature. Clay adsorbents are highly effective in quickly absorbing moisture, thereby reducing evaporation that could lead to heat loss. One of the key components of adsorbents is silicate minerals, which, according to Hasan *et al.* (2019), possess the ability to absorb water. In contrast, drying with cloth is less rapid and less effective in moisture absorption, particularly once the cloth becomes wet.

In piglets that did not receive any drying treatment, heat loss through evaporation persisted for a longer duration, resulting in lower body temperatures. Hypothermia occurs when piglets are exposed to low ambient temperatures and are unable to maintain their core body temperature within the optimal range of 38.5–39.0°C. This condition was evident in the P1 group, which recorded the lowest body temperature at 120 minutes compared to the other treatment groups. Consequently, piglets in this group were more likely to experience cold stress, which can compromise their immune system and increase the risk of disease.

Piglets Behaviour

The effect of mucus drying in piglets on the duration of behaviours during the first hour after being returned to the sow and at 24 hours after birth is presented in Tables 2. Observations of piglet behaviour during the first hour after being returned to the sow showed no significant differences between

Table 2. Effect of mucus drying treatments on the duration of piglet behaviours during the first hour after being returned to the sow and the first hour at 24 hours after birth (minutes/head/hour).

Behaviour	The first hour after being returned to the sow			Behaviour	the first hour at 24 hours after birth		
	P1 (N=6)	P2 (N=12)	P3 (N=14)		P1 (N=6)	P2 (N=12)	P3 (N=14)
Locomotor behaviours				Locomotor behaviours			
Walking^{NS}	16.6±10.3	12.73±12.16	16.21±9.5	Walking**	1.2±1.51^{c}	11.78±3.84^{b}	17.18±4.85^{a}
Running	0±0	0±0	0±0	Running	0±0	0±0	0±0
Standing^{NS}	0.75±1.2	1.05±2.64	0.14±0.39	Standing*	0.32±0.49^{b}	2.6±2.48^{a}	1.09±1.01^{ab}
Sniffing	0.04±0.09	0±0	0±0	Sniffing	0±0	0±0	0.15±0.44
Suckling behaviours				Suckling behaviours			
Searching for the sow’s teats^{NS}	18.05±7.29	22.48±19.36	24.08±9.07	Searching for the sow’s teats*	3.71±2.99^{b}	4.22±4.47^{ab}	7.65±3.31^{a}
Suckling on anterior teats^{NS}	21.46±5.29	22.6±14.91	16.34±11.41	Suckling on anterior teats^{NS}	3.4±1.97	9.55±9.79	5.14±3.97
Suckling on posterior teats^{NS}	0.15±0.34	3.09±9.21	1.14±2.78	Suckling on posterior teats^{NS}	0±0	2.78±4.08	1.58±2.7
Lying behaviours				Lying behaviours			
Alone	0±0	0±0	0.13±0.38	Alone^{NS}	0.14±0.35	7.37±9.82	6.45±8.11
Near the sow's body^{NS}	0±0	0±0	0.44±1.7	Near the sow's body^{NS}	17.24±22.93	3.12±5.47	8.7±8.53
With other piglets	0±0	0±0	0±0	With other piglets*	33.99±22.19^{a}	18.59±13.69^{b}	12.07±7.48^{b}
Rolling	0±0	0±0	0±0	Rolling	0±0	0±0	0±0

NS : Non Significant; * : P<0.05; ** : P<0.01; *** : P<0.001; $^{a, b, ab}$ Means within rows with different superscripts significantly at *P*<0.05; P1 : no drying assistance, P2 : drying assistance using cloth, P3 : drying assistance using an adsorbent.

Table 3. Effect of mucus drying treatments on the body size, ADG and mortality of piglets during pre-weaning period.

Variable	Drying Treatment		
	P1 (N=26)	P2 (N=23)	P3 (N=17)
Body length (cm)			
Birth[NS]	25.43±1.13	26.04±1.33	25±1.73
2 weeks[*]	33.42±2.57[ab]	32.67±2.74[b]	35±1.63[a]
4 weeks[**]	34.55±2.45[b]	37.18±2.9[a]	38.77±2.62[a]
6 weeks[NS]	41±3.02	43.5±3.06	44±3.46
Chest circumference (cm)			
Birth[NS]	23.53±1.06	23.96±1.3	23±1.84
2 weeks[*]	31±2.87[ab]	29.88±2.55[b]	32.15±1.95[a]
4 weeks[NS]	32.45±3.7	34.56±2.36	35.23±2.56
6 weeks[*]	36.13±2.75[b]	39.81±3.04[a]	39.83±4.26[a]
Body weight (g)			
Birth[NS]	1,424.57±231.6	1,304.78±179.93	1,382.06±177.02
2 weeks[**]	3,389.05±749.72[a]	2,668.1±524.25[b]	3,327.31±492.29[a]
4 weeks[NS]	4,547.78±1,297.94	4,222.06±877.15	4,529.62±831.45
6 weeks[NS]	6,312.19±1,689.36	5,996.88±1,166.28	5,935±1,306.09
Average Daily Gain (ADG) (g/day)			
0-2 weeks[**]	139.67±47.49[a]	98.23±37.87[b]	138.75±36.06[a]
0-4 weeks[NS]	110.39±41.79	105.55±31.31	112.32±31.41
0-6 weeks[NS]	115.1±35.7	112.56±27.76	111.8±30.62
Mortality (%)	21.74	30.43	13.33

NS : Non Significant; * : P<0.05; ** : P<0.01; *** : P<0.001; [a, b, ab] Means within rows with different superscripts significantly at *P*<0.05; P1 : no drying assistance, P2 : drying assistance using cloth, P3 : drying assistance using an adsorbent.

between treatment groups. This may be due to the fact that the effects of the drying process had not yet become apparent. Behavioural observations were conducted immediately after the treatment, which may not have allowed sufficient time for differences in behaviour to manifest. However, based on the data presented in the table, suckling was the behaviour exhibited for the longest duration across all groups.

Suckling is the primary behaviour observed in piglets immediately after birth, driven by the critical need to obtain colostrums. Colostrums provides essential energy, antibodies and nutrients that are crucial for immune system development, maintenance of body temperature and early growth. These findings are consistent with the observations of Balzani *et al.* (2016), who noted that newborn piglets begin searching for the sow's teats using nasal contact.

Observations of piglet behaviour during the first hour at 24 hours after birth showed that drying treatments had a significant effect on certain behaviours. Significant differences in walking behaviour were observed between treatment groups (p<0.05), with the P3 group exhibiting the highest level of walking activity. This suggests that the drying method used in P3, which involved the use of adsorbents, may have created warmer and more comfortable body conditions, thereby promoting increased activity in the piglets. In contrast, the P1 group showed the lowest average walking activity and the highest average duration of lying behaviour in close contact with other piglets.

This difference may be partially explained by the timing of the behavioural observation, during which piglets in the P1 group may have been in a resting phase. This reflects the natural activity pattern of newborn piglets, who exhibit frequent and extended sleep cycles during the early stages of life. The low activity level in the P1 group could also indicate that the piglets were still adjusting physiologically after birth and had not yet reached an optimal state for movement. Moreover, the absence of a drying intervention in P1 may have led to discomfort or cold stress, prompting the piglets to lie in groups to conserve body heat rather than move around.

In terms of lying behaviour, significant differences were observed ($p<0.05$) in the category of lying with other piglets, with the P1 group showing the highest average. According to Schormann and Hoy (2006), piglets tend to lie closely together when they feel cold or are exposed to low ambient temperatures. Similarly, Garcia *et al.* (2021), reported that when piglets huddle with others, their body temperature gradually increases due to shared body warmth. These findings suggest that the piglets in the P1 group may have experienced greater cold stress, leading to increased group-lying behaviour as a thermoregulatory strategy.

The high level of lying behaviour with other piglets in the P1 group indicates that these piglets relied on huddling to conserve body heat and enhance comfort. According to Huynh *et al.* (2005), pigs exhibit various behavioural responses to changes in environmental temperature, including lying down, defecating, urinating and wallowing. The predominance of resting behaviour in this group also supports the observed low walking activity, suggesting that during the observation period, piglets were predominantly in a sleep phase. This highlights the importance of considering the timing of behavioural observations, as piglet behaviour is heavily influenced by their pronounced sleep-wake cycles during the early postnatal period. The combination of a suboptimal drying method and the natural rest period likely contributed to the behavioural patterns observed in the P1 group.

Significant differences were also observed in standing behaviour ($p<0.05$), with the P2 group showing the highest average standing activity. The increased standing activity in P2 compared to P1 and P3 may reflect varying levels of physiological adaptation to the drying methods applied. Piglets in the P2 group may have experienced sufficient comfort to engage in standing behaviour in response to the post-treatment environmental conditions, but not enough to perform more dynamic activities such as walking, as observed in the P3 group. This may be attributed to the relative inefficiency of the cloth-drying method used in P2, which may have reduced surface moisture but was less effective in maintaining body warmth. As a result, the piglets were still undergoing thermoregulation and adjustment. Huynh *et al.* (2005) noted that an increase in humidity (from 50% to 80%) causes piglets to spend more time lying down and remaining inactive. In contrast, the P3 group, which exhibited the highest walking activity, likely achieved optimal body temperature more rapidly due to the more efficient moisture absorption and heat retention provided by the adsorbent drying method.

For searching the sow’s teat behaviour, a significant difference was observed ($p<0.05$), with the P3 group showing the highest mean. This behaviour is crucial, as it directly influences the piglets' ability to obtain colostrum. The high level of searching the sow’s teat behaviour in the P3 group suggests that the drying method used supports faster initiation of suckling. However, no significant differences were found in the behaviour of suckling at the upper versus lower nipple positions across treatments. This suggests that the drying treatment did not directly affect the piglets' preference for nipple position.

Preweaning Performance

The body weight, body length and chest circumference (Table 3) of two-week-old piglets showed significant differences ($p<0.05$). Piglets in the P3 treatment group exhibited the highest growth compared to the other groups. This superior growth in the P3 group is attributed to the drying method using clay adsorbents. Maintaining optimal body temperature enables piglets to conserve energy more efficiently, thereby supporting physical growth, including body weight, body length, and chest circumference. Body length and chest circumference are closely related to body weight in pigs (Djegho *et al.*, 2021). According to Bunok *et al.* (2020), the pre-weaning body weight of piglets is determined by factors such as birth weight, sow milk yield and the piglets' milk intake ability.

At weeks four and six, the results showed significant differences in several variables, while others remained insignificant. This suggests that the effect of the P3 treatment was more pronounced at week two but did not persist into weeks four and six. In other words, although drying with adsorbents had a significant positive impact on piglet growth at week two, the effect diminished in the following weeks.

The well-developed suckling ability of all piglets also contributed to this outcome, resulting in more stable and evenly distributed milk consumption. With a more balanced nutrient intake, body weight gain became more uniform, leading to no significant differences between treatments. Pinem *et al.* (2020) stated that three-week-old piglets consume a relatively consistent amount of milk each day, resulting in similar nutritional intake and, consequently, similar growth.

Average Daily Gain (ADG) of 0-2 weeks piglet showed significantly different results ($p<0.05$), while ADG 0-4 and ADG 0-6 weeks piglets showed no significant difference. The treatment group with the highest ADG 0-2 weeks piglets was P1. This could be because 0-2 weeks of age is the early phase of piglet life where they are highly dependent on their mother's milk. During this period, rapid access to mother's milk has a significant impact on their growth, resulting in a higher ADG than others. Manriquez *et al.* (2022) stated that piglets that received little colostrums intake would have lower ADG scores compared to those that received more colostrums.

Regarding the mortality rate, the piglet group treated with P3 had the lowest mortality, while the highest mortality was observed in the group treated with P2. The low mortality in the P3 group can be attributed to using adsorbent material, which effectively maintained the piglets' body temperature within the normal range during the early postnatal period. As a result, the piglets remained active and could suckle from their sows without difficulty. In contrast, when piglets experience cold stress, the energy that should be used for suckling is instead expended on maintaining body temperature. This causes the piglets to become weak, unable to reach their nipples sows to nurse, and ultimately fail to consume colostrums.

Colostrums consumption is critical for piglet survival, as it is rich in nutrients and antibodies that provide energy for thermoregulation and enhance immune protection. Failure to consume colostrums promptly can weaken the immune system and increase the risk of diseases such as hypothermia, which may ultimately lead to death. This aligns with the findings of Declerck *et al.* (2016), who emphasized that colostrums is essential for piglets with low energy reserves, as it supplies the necessary energy and facilitates passive immunity transfer from the sow. The colostrums especially important since piglets are born without immune protection. The higher mortality observed in the P2 group may be attributed to the drying method using cloth, which could have caused skin irritation and compromised the piglets' condition.

CONCLUSIONS

The use of clay adsorbents effectively

maintained piglet body temperature during the first 120 minutes after birth and positively influenced piglet performance in the early postnatal period. Additionally, the use of adsorbents effectively in supporting early adaptation reduced mortality rates and increased piglet activity levels.

SUGGESTION

Further research involving different pig breeds is warranted to evaluate the consistency of the effectiveness of clay adsorbents in maintaining body temperature, facilitating mucus drying, and enhancing piglet performance and behaviour during the early postnatal phase.

ACKNOWLEDGMENTS

This research was supported by PT. Clariant Adsorbent Indonesia. In addition, the authors thank Mr. Joko and Mr. Widodo from the pig farm for their kind support and cooperation during this research.

REFERENCES

Andersen IL, Haukvik IA, Boe KE 2009. Drying and warming immediately after birth may reduce piglet mortality in loose-housed sows. *Animals* 3: 592–597.

Balzani A, Cordell HJ, Edwards SA 2016. Relationship of sow udder morphology with piglet suckling behavior and teat access. *Theriogenology* 86: 1913–1920.

Bunok DKI, Lapian MTR, Rawung VRW, Rembet GDG 2020. Relationship between piglet birth weight and weight gain, weaning weight, mortality, and litter size at PT. Karya Prospek Satwa farm. *Zootec* 40: 260–270.

De K, Attupuram NM, Devi SJ, Paul S, Bhuyan G, Gupta VK. 2024. Thermal adaptability of neonatal piglets: Early life welfare crisis. *Journal of Veterinary Behavior* 73: 71–74.

Declerck I, Dewulf J, Sarrazin S, Maes D. 2016. Long-term effects of colostrum intake in piglet mortality and performance. *Journal Animal Science* 94: 1633–1643.

Devillers N, Dividich JL, Prunier A 2011. Influence of colostrum intake on piglet survival and immunity. *Animals* 5: 1605–1612.

Djegho Y, Kune P, Kihe JN 2021. Effect of sex on birth performance of Duroc crossbred piglets. *Jurnal Nukleus Peternakan* 8: 118–123.

Edwards SA 2002. Perinatal mortality in the pig: environmental or physiological solutions? *Livestock Production Science* 78: 3–12.

Garcia DV, Rojas DM, Burnes JM, Hernandez AO, Medina PM, Salmeron C, Gomez J, Boscato L, Perez OG, Cruz V, Reyes B, Lozano MG. 2021. Hypothermia in newly born piglets: Mechanisms of thermoregulation and pathophysiology of death. Malque Publishing. *Journal of Animal Behaviour and Biometeorology* 9(1): 2101. https://doi.org/10.31893/jabb.21001

Gunawan IND, Nindhia TS, Sampurna IP 2022. Mapping of management components for Landrace piglet rearing during the lactation period in Tabanan Regency. *Buletin Veteriner Udayana* 14: 160–167.

Hasan ASM, Osman NM, Ismail MKA, Albar A, Razali M 2019. Rock water interaction on the effect of drying and wetting to the mechanical and dynamic properties of tropical weathered granite. Institute of Physics Publishing. *Journal of Physics: Conference Series* 1349.

Hou L, Shi J, Cao L, Xu G, Hu C, Wang C 2017. Pig has no uncoupling protein 1. *Biochemical and Biophysical Research Communications* 487: 1–6.

Huynh TTT, Aarnink AJA, Gerrits WJJ, Heetkamp MJH, Canh TT, Spoolder HAM, Kemp B, Verstegen MWA 2005. Thermal behaviour of growing pigs in response to high temperature and humidity. *Applied Animal Behaviour Science* 91: 1–16.

Juthamanee P, Tummaruk P 2021. Factors associated with colostrum consumption in neonatal piglets. *Livestock Science* 251: 104 630.

Manriquez D, Poudevigne G, Roche E, Szkuta W 2022. Association between head-to-chest circumference ratio and intrauterine growth-retardation related outcomes during preweaning and postweaning. *Animals* 12: 1–14.

Mihaela LF, Palicica R, Rada O 2011. The behaviour of suckling pigletss. *Research Journal of Agricultural Science* 43: 168–173.

Mirkov M, Radovic I, Cincovic M, Horvatovic MP, Dragin S 2021. The influence of hypothermia prevention by application of skin moisture absorbent on the value of body temperature, body weight and blood parameters in piglets. Universidade Federal de Minas Gerais. *Arquivo Brasileiro de Medicina Veterinaria e Zootecnia* 73: 1058–1066.

Pinem ALRI, Aritonang SN, Khasrad 2020. Effect of weaning age on the performance of male Duroc pigs.. *Jurnal Peternakan Indonesia* 22: 73.

Katherine, Vande Pol, Tolosa Andres F, Shull Caleb, Brown Catherine B, Alencar Stephan AS, Michael E. 2021. Effect of drying and warming piglets at birth on preweaning mortality. *Translational Animal Science* 5: 1–12.

Schormann R, Hoy S. 2006. Effects of room and nest temperature on the preferred lying place of piglets-A brief note. *Applied Animal Behaviour Science* 101: 369–374.

Webster AJF 2001. Farm animal welfare: the five freedoms and the free market. *Veterinary Journal* 161: 229–237.