

Colostrum fatty acid composition and its association with reproductive traits in sows under tropical conditions

Dwi Sunu Datrianto^{1,2} Kunaporn Homyog³ Surasak Jittakhot³ Padet Tummaruk^{1,4*}

Abstract

Colostrum provides essential nutrients and immune factors that newborn piglets can absorb only within the first 24 h after birth. Fatty acids are essential for neonatal physiology, supporting thermoregulation, neurodevelopment, and immune function, and serving as a key energy source to reduce hypothermia and mortality in piglets. However, information on the fatty acid composition of sow colostrum under tropical conditions and its relationship with reproductive performance remains limited, warranting further investigation to improve piglet survival. This study evaluated the fatty acid profile of sow colostrum under tropical production conditions and examined its associations with reproductive traits. Colostrum samples were collected within 1 h postpartum from 30 Landrace × Yorkshire sows in a commercial herd in Thailand. Samples were obtained from 4–6 randomly selected teats per sow (≥15 ml), stored at 4°C during collection, and frozen at -20 °C until analysis. Fatty acid composition was determined by gas chromatography using a Supelco SP-2560 capillary column. Sows were classified according to parity, gestation length, farrowing duration, litter size, and oxytocin use during farrowing. On average, sows farrowed 13.1 ± 3.2 piglets per litter, with 11.8 ± 2.7 piglets born alive, and a mean farrowing duration of 206 ± 102 min. The predominant fatty acids in colostrum were oleic acid (C18:1n9c; 35.6 ± 2.2 g/100 g total fatty acids), palmitic acid (C16:0; 28.3 ± 2.0 g/100 g), and linoleic acid (C18:2n6c; 22.5 ± 1.9 g/100 g). Oleic acid was positively correlated with total piglets born ($r = 0.417$, $P = 0.022$) and piglets born alive ($r = 0.467$, $P = 0.009$), whereas palmitic acid was negatively correlated with total piglets born ($r = -0.467$, $P = 0.009$), piglets born alive ($r = -0.489$, $P = 0.006$), and farrowing duration ($r = -0.532$, $P = 0.003$). Linoleic acid was positively correlated with gestation length ($r = 0.497$, $P = 0.005$) and farrowing duration ($r = 0.539$, $P = 0.002$). Palmitic acid was negatively associated with both oleic acid ($r = -0.610$, $P < 0.001$) and linoleic acid ($r = -0.513$, $P = 0.004$). These results indicate that colostrum fatty acid composition is associated with maternal reproductive traits and may influence early neonatal energy supply under tropical conditions.

Keywords: colostrum, fatty acid, parity, piglet, sow

¹Department of Obstetrics, Gynaecology and Reproduction, Faculty of Veterinary Science, Chulalongkorn University, Bangkok 10330, Thailand

²Department of Internal Medicine, Faculty of Veterinary Medicine Universitas Gadjah Mada, Yogyakarta, Indonesia

³Center for Veterinary Diagnosis, Faculty of Veterinary Science, Mahidol University, Nakhon Pathom 73170, Thailand

⁴Centre of Excellence in Swine Reproduction, Chulalongkorn University, Bangkok 10330, Thailand

*Correspondence: Padet.t@chula.ac.th (P. Tummaruk)

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Introduction

The early postnatal period is critical for piglet survival, growth, and immune development (Adi *et al.*, 2024b; Adi *et al.*, 2025). Sow colostrum, secreted only during the first 24 h after parturition, provides essential nutrients, energy-dense lipids, immunoglobulins, and growth factors that support neonatal adaptation (Le Dividich *et al.*, 2005; Juthamane and Tummaruk, 2021). Its composition, particularly fat, lactose, and immunoglobulin G (IgG), supplies energy for thermoregulation, enables passive immune transfer, and promotes gastrointestinal maturation through bioactive molecules such as growth factors and cytokines. However, insufficient colostrum intake, often resulting from large litter sizes and management limitations, increases the risk of hypothermia, starvation, and mortality (Juthamane and Tummaruk, 2021; Adi *et al.*, 2025; Chaiyapatmaatee *et al.*, 2025).

Fatty acids are essential to neonatal physiology, contributing to thermoregulation, neurodevelopment, and immune function (Innis, 2007). As the primary energy source immediately after birth, their oxidation supports body temperature maintenance and early mobility, thereby reducing the risk of hypothermia and early mortality, particularly in piglets with limited energy reserves (Farmer *et al.*, 2006; Martin, 2015; Gorelik *et al.*, 2019; Adi *et al.*, 2024a,c).

Colostrum composition, particularly its fatty acid profile, is influenced by factors including diet, parity, breed, and environmental conditions (Reis *et al.*, 2021). Beyond serving as an important energy source for neonatal piglets, fatty acids play critical roles in cell membrane structure, inflammatory regulation, and reproductive function (Innis, 2007). Environmental stressors, especially heat stress typical of tropical climates, can disrupt lipid metabolism and mammary gland physiology, thereby potentially modifying colostrum composition and impairing neonatal performance (Adi *et al.*, 2024b,c). However, data on the fatty acid composition of sow colostrum under tropical conditions and its association with reproductive performance remain scarce. Elucidating these relationships may provide insight into maternal metabolic status and inform nutritional or management strategies aimed at improving piglet survival in hot environments. Therefore, the objective of this study was to characterize the fatty acid profile of sow colostrum and to examine its associations with key reproductive traits under tropical production conditions.

Materials and Methods

Animals, experimental design and sample collection:

This study was approved by the Institutional Animal Care and Use Committee (protocol no. 1531053) and was conducted in accordance with Chulalongkorn University's animal care policies and the guidelines of the National Research Council of Thailand. A total of 30 colostrum samples were obtained from 30 Landrace × Yorkshire sows raised in a commercial herd in eastern Thailand, as previously described (Tospitakkul *et al.*, 2019). All sows had a good body condition score (body condition score = 3), with an average backfat

thickness of 17.6 ± 2.8 mm before farrowing, and were classified according to reproductive traits, including parity, gestation length, farrowing duration, and litter size. Specifically, sows were categorized by parity (primiparous, $n = 14$; multiparous, $n = 16$), gestation length (≤ 113 days, $n = 6$; ≥ 114 days, $n = 24$), farrowing duration (short, ≤ 150 min, $n = 11$; moderate, 151–250 min, $n = 11$; long, > 250 min, $n = 8$), and litter size (≤ 10 piglets, $n = 7$; 11–13 piglets, $n = 9$; ≥ 14 piglets, $n = 14$). In addition, because some sows received oxytocin during the second half of farrowing after the birth of the seventh piglet, sows were categorized based on oxytocin use during farrowing as either no oxytocin administration ($n = 9$) or oxytocin administration ($n = 21$).

Colostrum was collected within the first hour after parturition. Before milking, the teats were disinfected with an antiseptic solution and thoroughly dried. If colostrum could not be collected, 10 IU of oxytocin was administered intramuscularly to stimulate milk letdown. Samples were obtained from 4–6 randomly selected teats per sow, with a minimum volume of 15 ml collected into sterile plastic bottles. During collection, samples were maintained at 4 °C and subsequently stored at -20 °C until analysis. Milk fat was extracted using a solvent-based method, and fatty acid composition was determined by gas chromatography equipped with a Supelco SP-2560 capillary column (Supelco, Bellefonte, PA, USA). The major fatty acids in sow colostrum were quantified, and factors associated with their concentrations were evaluated.

General management: Sows were housed in a conventional open-housing system equipped with fans and individual water sprinklers for heat mitigation. During the study period, the mean ambient temperature was 25.9 ± 1.6 °C (range: 20.3–28.1 °C), and the mean relative humidity was $81.8 \pm 7.7\%$ (range: 61.0–98.0%). During gestation, gilts and sows were housed in individual conventional stalls (1.2 m²/sow) within the open-housing facility. Animals were hand-fed twice daily according to a standardized feeding regimen, receiving an average of 2.3 kg of feed per sow per day. The commercial gestation diet, based on rice, corn, and soybean meal, contained 15.0% crude protein, 0.8% lysine, 2890 kcal/kg metabolizable energy, and 6.7% fiber, and was formulated to meet or exceed NRC (2012) requirements. Water was provided *ad libitum* via a nipple drinker positioned adjacent to the feeder in each stall. Sows were moved to the farrowing house approximately one week before the expected farrowing date. Each sow was housed in a conventional stall (1.2 m²) located at the centre of a 4.5 m² pen. During lactation, sows were hand-fed twice daily, with feed allowance gradually increased during the first week to 5–6 kg/day. The commercial lactation diet, also based on rice, corn, and soybean meal, contained 18.0% crude protein, 1.0% lysine, 3200 kcal/kg metabolizable energy, and 4.0% fibre. Both sows and piglets had *ad libitum* access to water through separate nipple drinkers. According to standard farm practice, sows received enrofloxacin (7.5 mg/kg, intramuscular; Syvaquinol® 100, Syva Laboratory, León, Spain), tolafenamic acid (Tolfédine®, Vétoquinol,

France), and a vitamin supplement (Fercobseang®, Vétoquinol, France) for 3 days postpartum (Tummaruk 2013). Weaning was performed at 24 ± 3 days of lactation.

Milk fat extraction and fatty acid analysis: Milk fat was extracted using a solvent-based technique. The fatty acid composition was analysed by gas chromatography fitted with a Supelco SP-2560 capillary column (Supelco, Bellefonte, PA, USA). Briefly, a measured volume of milk was combined with a chloroform-methanol mixture (2:1, v/v) and thoroughly homogenized to ensure complete dissolution of lipids. The mixture was left to allow phase separation, followed by centrifugation. The lower organic layer containing the fat was carefully collected and washed with either saline solution or distilled water to remove non-lipid impurities. The solvent was then evaporated under a nitrogen stream or by rotary evaporation, and the extracted fat was stored at -20°C until subsequent analysis.

Fatty acid profiles were determined by gas chromatography according to the procedure described by O'Fallon *et al.* (2007). Briefly, samples were placed in screw-cap Pyrex culture tubes and reacted with 10N KOH in water and methanol. The tubes were incubated in a 55°C water bath for 1.5 h, with manual shaking for 5 sec every 20 min to ensure thorough permeation, dissolution, and hydrolysis. After cooling to below room temperature, 24N H_2SO_4 was added, and the tubes were re-incubated at 55°C for another 1.5 h with periodic shaking. Following the formation of fatty acid methyl ester (FAME), the tubes were cooled under running tap water, and hexane was added. The samples were vortexed for 5 min, centrifuged at 3000 rpm for 5 min, and the upper hexane layer, containing the FAME, was transferred into GC vials, sealed, and stored at -20°C until analysis. The FAME composition was analysed using capillary gas chromatography (GC) equipped with a Supelco SP-2560 capillary column ($100\text{ m} \times 0.25\text{ mm} \times 0.20\text{ }\mu\text{m}$). The oven temperature was programmed to start at 140°C for 5 min, then increase to 260°C at $4^\circ\text{C}/\text{min}$, and hold at 260°C for 20 min. Helium served as the carrier gas at a flow rate of 0.5 ml/min and a column head pressure of 280 kPa. The injector and detector were maintained at 260°C , operating at a split ratio of 100:1. Fatty acids were identified by comparing their retention times with those of a Supelco 37-component FAME standard mixture. Fatty acids were quantified based on relative peak areas (area under the curve) obtained from chromatographic analysis. Fatty acid values were expressed as g per 100 g of total fatty acids.

Statistical analyses: Statistical analyses were performed using SAS software (version 9.4; SAS Institute Inc., Cary, NC, USA). Descriptive statistics, including the number of non-missing observations, means, standard deviations (SD), and ranges, were calculated for all variables. Categorical data were analysed using the FREQ procedure. Pearson's correlation analysis was used to evaluate relationships between reproductive traits (gestation length, total piglets born, piglets born alive, and farrowing duration) and the major fatty acid components of sow

colostrum. The effects of gestation length (≤ 113 and ≥ 114 days), parity (primiparous and multiparous), litter size (<10 , 11–13, and ≥ 14 piglets), farrowing duration (<150 , 150–250, and >250 min), and oxytocin use (yes and no) on colostrum fatty acid concentrations were evaluated using the general linear model (GLM) procedure. All factors were included simultaneously in the model. Least-squares means were calculated and compared using the Tukey-Kramer adjustment for multiple comparisons. A P value < 0.05 was considered statistically significant.

Results

Descriptive statistics: Reproductive performance data are summarized in Table 1. On average, sows farrowed 13.1 ± 3.2 total piglets and 11.8 ± 2.7 piglets born alive per litter. Mean gestation length and farrowing duration were 114.4 ± 1.1 days and 206 ± 102 min, respectively. Backfat thickness before farrowing averaged 17.6 ± 2.8 mm. Oxytocin was administered in 21 of 30 sows (70.0%), primarily due to dystocia or prolonged intervals between births (>30 min). Colostrum fatty acid composition is presented in Table 2. Oleic (C18:1n7c), palmitic (C16:0), and linoleic (C18:2n6c) acids were the predominant fatty acids, whereas stearic, myristic, palmitoleic, and arachidonic acids were present in smaller amounts.

Factors associated with the composition of fatty acids in colostrum: Table 3 shows significant associations between colostrum fatty acid composition and reproductive traits. Oleic acid concentration was positively correlated with total piglets born ($r = 0.417$, $P = 0.022$) and piglets born alive ($r = 0.467$, $P = 0.009$). In contrast, palmitic acid concentration was negatively correlated with total piglets born ($r = -0.467$, $P = 0.009$), piglets born alive ($r = -0.489$, $P = 0.006$), and farrowing duration ($r = -0.532$, $P = 0.003$). Linoleic acid concentration was positively correlated with gestation length ($r = 0.497$, $P = 0.005$) and farrowing duration ($r = 0.539$, $P = 0.002$), but showed no association with litter traits or sow backfat thickness ($P > 0.05$). Moreover, palmitic acid was negatively correlated with both oleic acid ($r = -0.610$, $P < 0.001$) and linoleic acid ($r = -0.513$, $P = 0.004$).

Colostrum fatty acid composition, including oleic, palmitic, and linoleic acids, according to farrowing duration is presented in Table 4. Mean farrowing duration ($\pm$ SD) was 124.8 ± 18.2 , 179.7 ± 27.0 , and 353.5 ± 74.8 min for sows with short, moderate, and long durations, respectively. Farrowing duration significantly affected palmitic acid concentration, with lower levels observed in sows with long durations compared with moderate ($P = 0.049$) and short durations ($P = 0.018$). Parity ($P = 0.195$), gestation length ($P = 0.900$), and total number of piglets born per litter ($P = 0.425$) were not associated with palmitic acid concentration.

Colostrum fatty acid composition according to gestation length is presented in Table 5. The mean gestation length ($\pm$ SD) of sows with short and normal gestation lengths was 112.3 ± 0.5 days and 114.9 ± 0.4 days, respectively. Oleic acid concentration was significantly affected by gestation length ($P = 0.025$).

and tended to be associated with parity ($P = 0.073$). Sows with shorter gestation lengths had higher oleic acid concentrations than those with longer gestations ($P = 0.025$), and primiparous sows tended to have higher concentrations than multiparous sows ($P = 0.073$) (Table 6). Farrowing duration ($P = 0.484$) and total number of piglets born per litter ($P = 0.870$) were not associated with oleic acid concentration.

Gestation length also significantly affected linoleic acid concentration ($P = 0.003$, Table 5). Linoleic acid

concentration was higher in sows with normal gestation lengths than in those with shorter gestations ($P = 0.003$). Parity ($P = 0.151$), farrowing duration ($P = 0.238$), and total number of piglets born per litter ($P = 0.220$) were not associated with linoleic acid concentration.

Oxytocin administration during parturition did not affect the concentrations of major fatty acids in sow colostrum, including oleic acid ($P = 0.244$), palmitic acid ($P = 0.706$), and linoleic acid ($P = 0.343$).

Table 1 Descriptive statistics of reproductive performance in Landrace × Yorkshire crossbred sows.

Variables	Means ± SD	Range
Parity number	1.9 ± 0.9	1–4
Gestation length (days)	114.3 ± 1.1	112–116
Backfat thickness at 109 days of gestation (mm)	17.6 ± 2.8	14.0–23.5
Total number of piglets born per litter	13.1 ± 3.2	6–19
Number of piglets born alive per litter	11.8 ± 2.7	6–17
Stillborn piglets (%)	3.7 ± 4.4	0–13.3
Mummified fetuses (%)	4.9 ± 7.2	0–27.3
Farrowing duration (min)	206 ± 102	94–470

Table 2 Descriptive statistics on colostrum fatty acid (g per 100 g of total fatty acid) profile in Landrace × Yorkshire crossbred sows.

Fatty acid	Means ± SD	Range
Oleic acid	35.6 ± 2.2	31.5–40.5
Palmitic acid	28.3 ± 2.0	24.4–33.7
Linoleic acid	22.5 ± 1.9	17.4–25.7
Stearic acid	4.7 ± 0.8	3.6–7.5
Myristic acid	3.2 ± 0.7	1.6–4.5
Palmitoleic acid	2.3 ± 0.5	1.7–3.6
Arachidonic acid	1.2 ± 0.2	0.5–1.7
Others	4.4 ± 0.6	2.7–5.7

Table 3 Pearson correlation coefficients (r) between major colostrum fatty acids (oleic, palmitic, and linoleic acids) and reproductive traits in Landrace × Yorkshire sows.

Reproductive traits	Oleic acid	Palmitic acid	Linoleic acid
Gestation length (days)	NS	NS	0.497**
Backfat thickness at 109 days of gestation (mm)	NS	NS	NS
Total number of piglets born per litter	0.417*	-0.467**	NS
Number of piglets born alive per litter	0.467**	-0.489**	NS
Stillborn piglets (%)	NS	NS	NS
Mummified fetuses (%)	NS	NS	NS
Duration of farrowing (min)	NS	-0.531**	0.539**

Levels of significance are indicated as follows: * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$, and NS = not significant ($P > 0.05$).

Table 4 Colostrum fatty acid composition (g per 100 g of total fatty acid), including oleic, palmitic, and linoleic acids, in sow colostrum according to farrowing duration (least squares mean ± SEM).

Fatty acids	Farrowing duration classes			P value
	Short	Moderate	Long	
Oleic acid	35.7 ± 0.7	35.9 ± 0.7	37.0 ± 1.1	0.484
Palmitic acid	29.2 ± 0.6 ^a	29.0 ± 0.6 ^a	26.8 ± 0.9 ^b	0.052
Linoleic acid	21.3 ± 0.5	21.6 ± 0.5	22.7 ± 0.8	0.238

Values with different superscripts (a, b) within a row differ significantly ($P < 0.05$).

Table 5 Colostrum fatty acid composition (g per 100 g of total fatty acid), including oleic, palmitic, and linoleic acids, in sow colostrum according to gestation length (least squares mean ± SEM).

Fatty acids	Gestation length (days)		P value
	≤113	≥114	
Oleic acid	37.4 ± 0.9	35.0 ± 0.4	0.025
Palmitic acid	28.4 ± 0.8	28.3 ± 0.4	0.900
Linoleic acid	20.6 ± 0.7	23.0 ± 0.3	0.003

Table 6 Colostrum fatty acid composition (g per 100 g of total fatty acid), including oleic, palmitic, and linoleic acids, in sow colostrum according to parity number classes (least squares mean $\pm$ SEM).

Fatty acid	Parity number classes		P value
	Primiparous	Multiparous	
Oleic acid	37.0 $\pm$ 0.8	35.4 $\pm$ 0.6	0.073
Palmitic acid	27.9 $\pm$ 0.7	28.8 $\pm$ 0.5	0.195
Linoleic acid	21.4 $\pm$ 0.6	22.3 $\pm$ 0.5	0.151

Discussion

Major fatty acids in sow colostrum: The predominant fatty acids identified in porcine colostrum were oleic, palmitic, and linoleic acids, which together accounted for the majority of the total fatty acid content. Oleic acid, a monounsaturated fatty acid, was the most abundant, reflecting its important role in energy provision and membrane fluidity in neonatal piglets (Tian *et al.*, 2025). Palmitic acid, the principal saturated fatty acid, contributes substantially to the caloric density of colostrum, whereas linoleic acid, an essential polyunsaturated n-6 fatty acid, supports immune function and tissue development (Bondoc *et al.*, 2023). This fatty acid profile is consistent with previous reports in swine, confirming that sow colostrum is rich in long-chain fatty acids that are critical for thermoregulation, energy metabolism, and early postnatal growth (Ren *et al.*, 2023; Wensley *et al.*, 2023; Rosengart *et al.*, 2026).

Comparative analyses across species reveal both similarities and distinctions in colostrum lipid composition. The high oleic acid content in sow colostrum is comparable to that reported in human and bovine colostrum, where it serves as a major energy source and helps maintain membrane integrity (Tian *et al.*, 2025). In contrast, bovine colostrum typically contains a higher percentage of palmitic acid, whereas human colostrum is characterized by greater levels of polyunsaturated fatty acids, particularly docosahexaenoic acid (DHA; C22:6n3), which is relatively low in pigs. Linoleic acid occurs consistently across species, although its percentage in porcine colostrum appears intermediate between that of ruminants and humans (Pawlak *et al.*, 2020; Ren *et al.*, 2023). These interspecies variations likely reflect differences in lipid metabolism, placental transfer mechanisms, and neonatal energy requirements. Overall, the balanced composition of saturated, monounsaturated, and polyunsaturated fatty acids in sow colostrum appears well-adapted to support rapid growth, immune development, and thermoregulation in newborn piglets.

Oleic acid: In the present study, oleic acid (C18:1n9c) was the most abundant fatty acid in sow colostrum, accounting for 35.6% of total fatty acids, with individual values ranging from 31.5% to 40.5%. This proportion is slightly higher than that reported in temperate regions but remains within the physiological range (Ren *et al.*, 2023; Rosengart *et al.*, 2026). Oleic acid, a monounsaturated omega-9 fatty acid, is a major component of animal fats and vegetable oils and plays an important role in energy metabolism and membrane structure. Its predominance in colostrum is therefore consistent with the high energetic demands of neonatal piglets.

Consistent with previous reports, oleic acid represented approximately 28–37% of total fatty acids in sow colostrum and milk (Bondoc *et al.*, 2023). In the present study, higher colostrum oleic acid concentrations were associated with larger litter size, suggesting a potential link between maternal lipid metabolism and reproductive performance. In addition, sows with shorter gestation lengths produced colostrum with a higher proportion of oleic acid, which may reflect differences in lipid mobilization or mammary lipid synthesis during late gestation. Because colostrum lipid composition is strongly influenced by maternal diet, these differences may also be partially attributable to variation in nutrient intake or metabolic status before parturition (Meng *et al.*, 2019; Adi *et al.*, 2024c; Tian *et al.*, 2025).

Beyond its nutritional role, oleic acid has been reported to modulate ovarian function through effects on fatty acid transport, triglyceride synthesis, and steroidogenesis (Zhou *et al.*, 2022; Tian *et al.*, 2025). Although causality cannot be inferred from the present observational data, these mechanisms provide a plausible biological basis for the observed associations between colostrum oleic acid concentration and reproductive traits. Collectively, the findings suggest that oleic acid may serve as a metabolic indicator of maternal condition and colostrum quality, with potential implications for neonatal energy supply and early postnatal performance.

Palmitic acid: In the present study, palmitic acid (C16:0) was the second most abundant fatty acid in sow colostrum, accounting for 28.3% of total fatty acids. As a saturated long-chain fatty acid, palmitic acid serves as an important energy source for neonatal piglets and contributes to membrane structure and early growth (Ayala *et al.*, 2024). The proportion of palmitic acid in colostrum is strongly influenced by dietary fat sources. Sows fed palm oil, which is rich in C16:0, exhibit higher palmitic acid concentrations in colostrum and milk than those fed other fat sources, such as soybean or coconut oil (Bai *et al.*, 2017; Laws *et al.*, 2018). Maternal dietary fat supplementation can also influence fetal development and metabolic indicators associated with litter performance. For example, palm oil inclusion has been shown to increase colostrum fat content but may also elevate plasma glucose concentrations and disrupt glucose homeostasis (Tanghe *et al.*, 2014; Laws *et al.*, 2018).

Palmitic acid is readily mobilized from adipose tissue and preferentially oxidized during periods of increased energy demand, such as parturition. Farrowing imposes substantial metabolic stress and elevated energy requirements due to uterine contractions and prolonged labor (Adi *et al.*, 2022; Taechamaeteekul *et al.*, 2025), resulting in enhanced

lipolysis and increased circulating non-esterified fatty acids (NEFA) (Theil *et al.*, 2014). Under these conditions, saturated fatty acids, particularly palmitic acid, serve as major substrates for β -oxidation and energy production, whereas oleic acid (C18:1) is more commonly associated with triglyceride storage and membrane structure and is less readily oxidized. Accordingly, the negative association between palmitic acid concentration and farrowing duration suggests that increased utilization of palmitic acid for energy during parturition may reduce its availability in colostrum (Feyera *et al.*, 2018; Liu *et al.*, 2021). Collectively, these findings support the importance of balanced dietary fat composition, rather than excessive saturated fatty acid intake, to optimize farrowing efficiency and neonatal outcomes.

Linoleic acid: In the present study, linoleic acid (C18:2n6c) was the third most abundant fatty acid in sow colostrum, accounting for 22.5% of total fatty acids. Linoleic acid, an essential omega-6 fatty acid, plays an important role in immune modulation and tissue development (Innis, 2007). In this study, linoleic acid concentration was positively correlated with gestation length, indicating that higher levels of this essential fatty acid were associated with longer pregnancies. The linoleic acid content of colostrum is strongly influenced by dietary fat sources, as supplementation with soybean oil or other linoleic acid-rich ingredients increases its concentration (Holen *et al.*, 2023). Similarly, supplementation with conjugated linoleic acid (CLA) during late gestation has been shown to increase CLA isomers in colostrum (Krogh *et al.*, 2012; Liu *et al.*, 2018).

The biological basis for these associations may involve the regulation of prostaglandin synthesis. Linoleic acid has been reported to enhance prostaglandin E_2 (PGE₂) production, a luteotropic factor that supports corpus luteum function and progesterone secretion, while reducing prostaglandin $F_{2\alpha}$ (PGF_{2 α}), which promotes luteolysis and uterine contractions (Cheng *et al.*, 2004; Baryla *et al.*, 2024). Such shifts in prostaglandin balance may favor pregnancy maintenance and delay the onset of parturition. Comparable associations between higher dietary intake of essential fatty acids and prolonged gestation or improved neonatal outcomes have also been reported in humans (Bernard *et al.*, 2017; Masina *et al.*, 2023).

In addition, linoleic acid concentration was positively correlated with farrowing duration, suggesting a potential association between elevated levels of this fatty acid and prolonged uterine relaxation, possibly mediated by increased PGE₂ activity. Although supplementation with linoleic and α -linolenic acids has been associated with improved litter size and farrowing rate (Rosero *et al.*, 2016), larger litters are also inherently linked to longer farrowing durations (Adi *et al.*, 2022). Collectively, these findings suggest that higher linoleic acid availability may be associated with improved reproductive outcomes, while potentially extending gestation and farrowing duration as part of a physiological trade-off.

Factors associated with the composition of fatty acids in colostrum: The associations observed between farrowing duration, gestation length, and colostrum fatty acid composition likely reflect underlying differences in maternal energy balance and lipid metabolism during late gestation and parturition under tropical conditions. Prolonged farrowing is associated with increased physical exertion, inflammatory activation, and oxidative stress, which may elevate maternal energy demands and promote mobilization of body lipid reserves (Liu *et al.*, 2021; Akkhaphan *et al.*, 2025; Taechamaeteekul *et al.*, 2025). In this context, the lower palmitic acid concentration observed in sows with extended farrowing durations may indicate preferential utilization or altered mammary uptake of saturated fatty acids to support muscular activity and thermoregulation during parturition. Similarly, variation in gestation length may influence the timing and extent of mammary lipid synthesis and colostrogenesis. Sows with longer gestations exhibited higher linoleic acid concentrations, suggesting more complete mammary gland maturation and enhanced incorporation of essential fatty acids into colostrum, which are critical for neonatal immune function and membrane development. Conversely, the higher oleic acid concentrations observed in primiparous sows and those with shorter gestations may reflect differences in lipid mobilization and desaturation activity, potentially driven by metabolic adaptation to heat stress and limited body reserves. Heat stress typical of tropical environments is known to disrupt endocrine regulation, reduce feed intake, and modify lipid metabolism, which may further exacerbate these effects during the periparturient period (Tummaruk *et al.*, 2023). Collectively, these findings suggest that farrowing dynamics and gestation length interact with maternal metabolic status to shape colostrum fatty acid composition, with potential implications for neonatal energy supply and early-life survival in tropical pig production systems.

Study limitations: A limitation of the present study is the relatively small sample size ($n = 30$) and the imbalance between subgroups (e.g., gestation length ≤ 113 days, $n = 6$; > 114 days, $n = 24$), which may increase the risk of overfitting and reduce the stability and generalizability of the estimates. Although efforts were made to standardize the experimental design by balancing sows according to parity (primiparous vs. multiparous), other performance-related variables, including gestation length, litter size, and farrowing duration, could not be controlled and instead occurred naturally under field conditions. Consequently, the observed associations should be interpreted with caution, and future studies with larger and more balanced populations are warranted to validate these findings. In addition, the present study lacked comprehensive heat stress indicators. Environmental conditions were assessed using ambient temperature only, without incorporating additional indices such as the temperature-humidity index (THI) or physiological measures (e.g., respiration rate, rectal temperature, or hormonal stress markers). As a result, the level of heat stress experienced by individual sows

could not be accurately quantified. Future studies should include both environmental and animal-based indicators to better characterize heat stress exposure and its potential effects on reproductive performance and colostrum composition.

In conclusion, the predominant fatty acids in sow colostrum under tropical conditions were oleic, palmitic, and linoleic acids. Colostrum fatty acid composition was associated with several reproductive traits. Higher oleic acid concentrations were associated with larger litter sizes, whereas higher palmitic acid concentrations were associated with smaller litters. In contrast, increased linoleic acid concentrations were associated with longer gestation and farrowing durations. Overall, these findings provide insight into the fatty acid profile of sow colostrum under tropical conditions and may serve as a reference for the development of colostrum replacers that more closely reflect the natural fatty acid composition of sow colostrum. From an applied perspective, the results may also inform nutritional strategies during late gestation aimed at optimizing maternal lipid metabolism to support colostrum quality and neonatal performance in tropical pig production systems.

Credit authorship contribution statement

Dwi Sunu Datrianto: Writing – review & editing, Validation, Investigation. **Kunaporn Homyog:** Validation, Investigation. **Surasak Jittakhot:** Validation. **Padet Tummaruk:** Conceptualization, Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation.

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Declaration of Artificial Intelligence Use

During the preparation of this work, the author(s) used ChatGPT 5.1 (<https://chat.openai.com>) to perform grammatical checks. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the publication's content.

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