

Blood Mineral Profile During Late Gestation, Pre-Pregnancy Reproductive Characteristics, and Birth Outcomes in Indonesian Local Cattle

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Abstract. This study descriptively characterized blood mineral profiles, pre-pregnancy reproductive characteristics, and birth outcomes in Indonesian local cattle during late gestation under uniform management conditions. An observational descriptive cross-sectional study was conducted using a total sampling approach, with no intention of performing comparative evaluation between breeds or parity groups. Eleven pregnant Indonesian local cattle comprising Ongole Grade (PO) (n = 7) and Pasundan (n = 4) cattle were enrolled. The collected data included reproductive history, serum calcium (Ca), phosphorus (P), and magnesium (Mg) concentrations during late gestation, and birth outcomes. The recorded pre-pregnancy reproductive characteristics, including service per conception, calving interval, and days open, generally reflected normal reproductive performance among the enrolled animals, although individual variation associated with parity and reproductive history was observed. Serum macromineral concentrations remained within published physiological reference values (Ca: 8.98–9.26 mg/dL; P: 5.18–5.30 mg/dL; Mg: 2.95–3.24 mg/dL), indicating stable mineral homeostasis during the periparturient period. Gestation length and birth weight were within the expected physiological ranges, while two postpartum events (one retained placenta and one stillbirth) were recorded in the study population. In conclusion, the enrolled cattle exhibited physiological serum macromineral concentrations during late gestation under the observed management conditions. The recorded reproductive characteristics and birth outcomes generally reflected normal physiological conditions, although individual variation and isolated postpartum events were observed. These findings provide preliminary descriptive baseline information for the enrolled cattle under the observed management conditions and may serve as a reference for future studies involving larger and more homogeneous populations.

Keywords: birth outcomes, blood minerals, Indonesian local cattle, late gestation, reproductive performance

Abstrak. Penelitian ini bertujuan untuk mendeskripsikan profil mineral darah, karakteristik reproduksi sebelum kebuntingan, dan kelahiran pada sapi lokal Indonesia pada akhir kebuntingan yang dipelihara dalam kondisi manajemen seragam. Penelitian ini menggunakan desain observasional deskriptif dengan pendekatan potong lintang (*cross-sectional*) dan metode total sampling, tanpa maksud membandingkan antarras atau kelompok paritas. Sebanyak 11 ekor sapi bunting, terdiri atas sapi Peranakan Ongol (PO) (n = 7) dan sapi Pasundan (n = 4), diikutsertakan dalam penelitian ini. Data yang dikumpulkan meliputi riwayat reproduksi, konsentrasi serum kalsium (Ca), fosfor (P), dan magnesium (Mg) pada akhir kebuntingan, serta kelahiran. Karakteristik reproduksi sebelum kebuntingan, meliputi *service per conception*, *calving interval*, dan *days open*, secara umum menunjukkan performa reproduksi yang normal, meskipun terdapat variasi individu yang berkaitan dengan paritas dan riwayat reproduksi. Konsentrasi makromineral serum berada dalam kisaran referensi fisiologis (Ca: 8,98–9,26 mg/dL; P: 5,18–5,30 mg/dL; Mg: 2,95–3,24 mg/dL), yang menunjukkan bahwa homeostasis mineral tetap terjaga selama periode periparturien. Lama kebuntingan dan bobot lahir berada dalam kisaran fisiologis, sedangkan dua kejadian pascapartus, yaitu satu kasus retensio plasenta dan satu kasus lahir mati, tercatat pada populasi penelitian. Disimpulkan bahwa sapi yang diteliti menunjukkan profil makromineral serum dalam kisaran fisiologis pada akhir kebuntingan. Temuan ini menyediakan data dasar deskriptif yang dapat menjadi acuan bagi penelitian selanjutnya dengan jumlah sampel yang lebih besar dan populasi yang lebih homogen.

Kata kunci: kebuntingan akhir, kelahiran, mineral darah, performa reproduksi, sapi lokal Indonesia

Introduction

Indonesian Ongole Grade (PO) and Pasundan play a strategic role in smallholder farming systems, contributing to the national beef supply and being suitable for low-input production environments. These breeds are valued for their adaptability to tropical climates, feed resource efficiency, and resilience to heat stress and endemic diseases, attributes widely recognized as essential for sustainable livestock development in tropical regions (Asmarasari et al., 2023; Hariyono et al., 2025; Hastarina et al., 2025). Despite their importance, scientific information on reproductive physiology during late gestation remains limited for Indonesian local cattle, including Ongole Grade (PO) and Pasundan cattle. This gap contrasts with the extensive reproductive datasets available for dairy breeds such as Holstein–Friesian and for exotic beef breeds, including Simmental and Limousin.

The third trimester of gestation is a physiologically critical period marked by rapid fetal growth, increased maternal metabolic demand, and preparation of the reproductive and endocrine systems for parturition (Maquivar and Galina, 2009; Ribeiro et al., 2018). Optimal metabolic balance during this phase is essential to support fetal development, colostrum synthesis, the onset of lactation, uterine contractility, and the prevention of periparturient reproductive disorders (Goff and Horst, 1997). Key parameters, such as animal characteristics, pre-pregnancy reproductive history, serum mineral concentrations, and calving outcomes, serve as fundamental indicators of maternal physiological status and reproductive performance. However, comprehensive assessments integrating these parameters in PO and Pasundan cattle are largely absent from the current scientific literature.

Serum macrominerals—notably calcium (Ca), phosphorus (P), and magnesium (Mg)—play essential roles in supporting maternal and fetal

physiology during late gestation. Calcium is crucial for neuromuscular function and colostrum production; phosphorus supports energy metabolism and skeletal growth, while magnesium regulates neuromuscular conduction and parathyroid hormone activity. Imbalances in these minerals are associated with hypocalcemia, reduced feed intake, impaired fetal growth, dystocia, and postpartum metabolic disorders (Goff, 2014; Reinhardt et al., 1988; Stenhouse et al., 2022). Given their physiological importance, baseline physiological data on serum macrominerals are important for supporting nutritional and reproductive management in Indonesian local cattle.

Therefore, this study aimed to descriptively characterize blood mineral profiles during late gestation together with pre-pregnancy reproductive characteristics and birth outcomes in Indonesian local cattle managed under uniform field conditions. This observational, descriptive, cross-sectional study used a total sampling approach and was designed to provide a descriptive physiological profile of the enrolled animals. The study was not intended to perform comparative evaluation between breeds or parity groups; therefore, observed variation among animals was described at the individual or population level rather than interpreted as evidence of breed- or parity-related differences.

Materials and Methods

Ethics Approval

This study was approved by the Institutional Animal Ethics Committee of the University, with Approval Number 872/UN6.KEP/EC/2025.

Study Location and Period

This study was conducted at the UPTD BPPIB Ternak Sapi Potong, Ciamis – DKPP Central Java Province, and at Universitas Padjadjaran, from September to December 2025.

Study Design

This study utilized an observational, descriptive, cross-sectional design with a total sampling approach. The primary data consisted of blood mineral concentrations (calcium, phosphorus, and magnesium) measured during late gestation. These data were supplemented by secondary records, which included sample characteristics, pre-pregnancy reproductive performance metrics (such as service per conception, calving interval, days open, and breeding history), feed management practices, and birth-related outcomes (including gestation length, birth weight, and postpartum reproductive disorders). The cross-sectional approach aimed to provide a descriptive physiological snapshot of serum mineral profiles in pregnant cows during late gestation and to characterize reproductive and birth-related variables under the observed management conditions. This study was designed to furnish descriptive physiological information and was not intended to compare different breeds or parity groups.

Animals and Sampling Technique

This study involved 11 female Indonesian local cattle in late gestation (third trimester), which included seven Ongole Grade (PO) cows and four Pasundan cows. A total sampling approach was utilized, enrolling all pregnant Indonesian local cattle that met the predefined inclusion and exclusion criteria during the study period. Therefore, the sample accurately represented the entire accessible population that fulfilled the eligibility criteria at that time.

The inclusion criteria were as follows: (1) local female cattle in the third trimester of pregnancy, (2) complete reproductive and health records, (3) animals maintained under consistent management conditions—including feeding, watering, and housing systems—and (4) animals that could be safely subjected to blood collection. The exclusion criteria included (1) cows exhibiting severe systemic diseases, (2)

cows for which blood sampling could not be performed, and (3) animals with incomplete reproductive or health histories. The inclusion of both Ongole Grade (PO) and Pasundan cattle was intended to reflect the composition of the eligible study population and was not meant to establish or test differences between the breeds. Additionally, parity was recorded as part of the animals' reproductive characteristics but was not used for comparative analysis.

All selected animals were managed with uniform feeding practices, given ad libitum access to clean drinking water, and housed in similar pen structures to ensure consistency in environmental and nutritional factors throughout the study. Feed provided in the pregnancy barn consisted of concentrate and forage, administered twice daily—once in the morning and once in the afternoon. The forages included Taiwan elephant grass and corn leaves, totaling 10% of each animal's body weight. In contrast, concentrate was supplied at 1% of the animal's body weight, using a specially formulated concentrate for breeding cows. The housing system was a monitored colony barn with a head-to-head layout, accommodating a maximum of four animals per pen.

Blood-Serum Collection Procedures and Laboratory Analysis

Blood samples were collected from each cow via either the jugular vein or coccygeal vein using a sterile vacutainer system equipped with a 21G × 1" needle and 3-mL plain blood collection tubes (OneMed). Following collection, the tubes were kept in a cool box for approximately 6 hours to allow clot formation before serum separation. Samples were then centrifuged at 2,500 rpm for 15 minutes to obtain clear serum. The harvested serum was transferred to 0.5 mL microtubes and stored at -20°C until laboratory analysis.

Serum mineral concentrations, including calcium (Ca), phosphorus (P), and magnesium (Mg), were analyzed using an atomic absorption

spectrophotometer (AAS; ThermoScientific Genesys 20). Measurements were conducted at wavelengths from 520 to 650 nm using commercial reagent kits (DSI Magnesium XL FS, DSI DiaSys Calcium AS FS, and DSI Phosphate FS) according to the manufacturers' protocols. All laboratory procedures were performed under controlled conditions to ensure sample integrity and analytical accuracy.

Data Collection and Recorded Variables

This study recorded both primary and secondary variables, organized into four main categories to provide a comprehensive description of the animals' reproductive and physiological profiles.

1. Animal characteristics, including breed, age, parity, lactation stage, and management of feeding, watering, and housing.
2. Pre-pregnancy reproductive records, consisting of the date of the last artificial insemination, service per conception, calving interval, days open, breeding history, and previous reproductive disorders. Pregnancy confirmation before late gestation was obtained from farm records based on routine rectal palpation.
3. Gestational variables, including serum concentrations of calcium (Ca), phosphorus (P), and magnesium (Mg) measured during late gestation.
4. Birth-related outcomes, including gestation length, birth weight, postpartum reproductive disorders, and neonatal viability.

Breed and parity were recorded to describe the characteristics of the enrolled population and provide contextual information for interpreting individual reproductive records. These variables were not designated as comparative grouping factors. All secondary reproductive and management data were retrieved from official UPTD farm logs, while primary physiological data were generated

through direct measurement and laboratory analysis. Physiological data were generated through direct measurement and laboratory analysis.

Data Analysis

Blood mineral concentrations (calcium, phosphorus, and magnesium) were summarized using the mean, standard deviation, and range. Reproductive variables, including service per conception, calving interval, days open, breeding history, gestation length, birth weight, and postpartum disorders, were presented descriptively based on the available records.

Consistent with the observational descriptive cross-sectional design and total sampling approach, no inferential statistical tests were conducted. Specifically, no statistical comparisons were made between Ongole Grade (PO) and Pasundan cattle or among parity groups. Data were summarized descriptively, and any observed variation among the enrolled animals was not interpreted as evidence of breed- or parity-related differences. The findings were interpreted as a descriptive physiological and reproductive profile of the enrolled late-gestation cattle under uniform management conditions, rather than as evidence of differences or associations between breed, parity, and the measured outcomes.

Results and Discussion

Animal Characteristics

The characteristics of the Indonesian local cattle are presented in Table 1. The data describe the characteristics of the enrolled animals and should not be interpreted as formal comparisons between breeds. Reporting baseline animal information is essential to ensure appropriate interpretation of the findings, as physiological status and individual variation may influence both metabolic and reproductive responses during late gestation (Ding et al., 2024; D'Occhio et al., 2019).

Table 1. Baseline Characteristics and Management Conditions of the Enrolled Cattle

Variable	Ongole Grade (PO) (n=7)	Pasundan (n=4)	Total (n=11)
Age (month), mean $\pm$ SD	66.76 $\pm$ 40.53	126.57 $\pm$ 6.00	88.51 $\pm$ 43.67
Gestational age (months), mean $\pm$ SD	8.35 $\pm$ 0.57	8.11 $\pm$ 1.24	8.26 $\pm$ 0.82
BCS (1–5 scale), mean $\pm$ SD	3.00 $\pm$ 0.00	3.50 $\pm$ 0.58	3.18 $\pm$ 0.40
Lactation number, min-max	0-5	4-5	0-5*
Feeding system	Forage + concentrate	Forage + concentrate	Forage-based, supplemented with concentrate
Forage type	Taiwan elephant grass and corn leaves	Taiwan elephant grass and corn leaves	Taiwan elephant grass and corn leaves
Forage provision	10% of body weight/day	10% of body weight/day	10% of body weight/day
Concentrate provision	1% of body weight/day	1% of body weight/day	1% of body weight/day
Water Availability	Ad libitum	Ad libitum	Ad libitum
Housing system	Intensive; monitored colony barn, head-to-head layout	Intensive; monitored colony barn, head-to-head layout	Intensive; monitored colony barn, head-to-head layout; maximum 4 animals/pen

* Lactation number 0 represents heifers that had not undergone a previous lactation cycle.

As presented in Table 1, the enrolled cattle exhibited variability in age, parity, lactation status, and body condition score. The Ongole Grade (PO) group comprised both heifers and multiparous cows, while the Pasundan group included only multiparous cows. This distribution was a reflection of the available study population, which was enrolled through total sampling rather than through predefined experimental groupings. Therefore, the variations in age and reproductive status characterize the enrolled animals rather than create balanced experimental groups. All animals were sampled during the third trimester of gestation, with gestational ages ranging from 8.11 to 8.35 months. This timing ensured that blood mineral measurements were obtained at a comparable physiological stage. Given that the final trimester is marked by rapid fetal growth, increased nutrient demands, and significant metabolic adaptations, sampling during this similar stage of pregnancy provides an appropriate physiological context for the descriptive evaluation of serum mineral concentrations (Sammad et al., 2022; Zhelavskiy et al., 2024).

The Body Condition Score (BCS) for both breeds ranged from 3 to 4 on a scale of 1 to 5, indicating an optimal nutritional status for cows nearing parturition. A BCS within this range has been linked to a reduced risk of metabolic disturbances, dystocia, and impaired postpartum lactation performance (Gobikrushanth et al., 2019; Rojas Canadas et al., 2020; Wang et al., 2019). The variation in lactation status reflects the differences in parity among the enrolled animals, with both heifers and multiparous cows included in the study population. These physiological differences should be taken into account when interpreting reproductive characteristics, as parity is known to influence reproductive performance and metabolic responses (Wathes et al., 2007; Yehia et al., 2020). All animals were managed under a consistent husbandry system that included intensive housing, provision of forage and concentrate-based diets, and unrestricted access to water. Maintaining consistency in management practices is crucial for minimizing environmental confounding effects on physiological parameters (Collier et al., 2006; Fernandez-Novo et al., 2020).

Table 2. Pre-pregnancy reproductive characteristics of the enrolled Indonesian local cattle

Variable	Ongole Grade (PO) (n=7)	Pasundan (n=4)	Total (n=11)
Service per conception (S/C), mean $\pm$ SD	2.00 $\pm$ 1.15	2.00 $\pm$ 1.15	2.00 $\pm$ 1.10
Calving interval (days)	803.67 $\pm$ 262.02	637.25 $\pm$ 175.81	708.57 $\pm$ 215.06, Heifers (calving interval = 0) included four PO cattle
Days open (days), mean $\pm$ SD	498.33 $\pm$ 256.31	341.5 $\pm$ 178.8	408.71 $\pm$ 211.93, Heifers (days open = 0) included four PO cattle
Breeding method	-	-	All animals bred via AI
Breeding sire identity	-	-	Recorded for all animals
Previous reproductive disorders	-	1 case of uterine prolapse	1 case of uterine prolapse
Previous metabolic diseases	-	-	No case

Pre-Pregnancy Reproductive Characteristics

The pre-pregnancy reproductive characteristics of the enrolled animals are presented in Table 2. Documentation of these parameters is important because reproductive history before conception has been recognized as an important determinant of subsequent fertility, pregnancy maintenance, and periparturient reproductive performance (Diskin and Kenny, 2016, 2014). The variables recorded comprised service per conception (S/C), calving interval (CI), days open (DO), breeding method, sire identity, and the presence of previous reproductive or metabolic disorders.

Based on Table 2, the recorded service per conception values averaged 2.00 ± 1.15 , which falls within the expected physiological range for beef cattle managed under tropical production systems. This indicates satisfactory reproductive efficiency following artificial insemination (AI) (Ervandi et al., 2020; Salman et al., 2021; Sumaryadi et al., 2021). All cows were bred via AI, and sire identity was clearly documented, reducing variation attributable to semen quality or genetic background and ensuring comparability across the animals.

Variation was noted in calving interval and days open among the multiparous cows included in this study. These variables were not applicable to heifers and were therefore only available for animals with previous calving records. The

observed variability likely reflects differences in parity, postpartum reproductive resumption, and individual reproductive history within the study population rather than predefined experimental grouping. Prolonged calving intervals and days open have been associated with postpartum anestrus, reduced estrus detection efficiency, nutritional imbalances during the transition period, and residual effects of previous reproductive disturbances (Caixeta and Omontese, 2021; Cardoso Consentini et al., 2021; Villar et al., 2025; Walsh et al., 2011). Although no clinical metabolic disorders were identified in the current dataset, differences in physiological maturity and parity between heifers and older cows likely contributed to the observed variability.

The prevalence of historical reproductive disorders within the sample was low. Only one Pasundan cow had a history of uterine prolapse, which occurred well before the current pregnancy, without apparent residual effects on reproductive function. No clinical metabolic diseases—such as clinical hypocalcemia, ketosis, or displaced abomasum—were documented in any of the animals. This suggests that the endocrine and metabolic background of the study population prior to pregnancy was generally stable, making it unlikely to confound the interpretation of mineral-related physiological responses during late gestation.

Overall, the pre-pregnancy reproductive characteristics observed in this study indicate that the local Indonesian cattle included in the dataset had reproductive profiles within normal physiological ranges, albeit with some variability attributable to parity and breed-specific reproductive dynamics. These baseline conditions are crucial for contextualizing the late-gestation mineral serum profiles discussed later in the manuscript, as pre-pregnancy reproductive and metabolic status is known to influence mineral homeostasis, endocrine regulation, and vulnerability to periparturient disorders (Jan et al., 2021; Stenhouse et al., 2022). Understanding these antecedent reproductive conditions strengthens the biological interpretation of the experimental findings.

Blood Mineral Profile During Late Gestation (Ca, P, Mg)

The serum concentrations of calcium (Ca), phosphorus (P), and magnesium (Mg) measured during late gestation are presented in Table 3. The data are presented descriptively and are not intended to compare breeds. Overall, serum macromineral concentrations recorded in the enrolled animals remained within published physiological reference ranges for beef cattle during pregnancy (Grünwaldt et al., 2005), indicating that mineral homeostasis during the final trimester was adequately maintained under the prevailing management system.

Serum calcium concentrations ranged from 8.98 to 9.26 mg/dL, remaining within published physiological reference values for beef cattle during late gestation (Grünwaldt et al.,

2005). These findings suggest that Ca homeostasis was adequately maintained during a physiological phase marked by an abrupt rise in Ca requirements to support colostrum synthesis, fetal skeletal mineral accretion, and enhanced neuromuscular activity preceding parturition (Harvey et al., 2021; Silva et al., 2024). Adequate Ca availability during this period is essential to prevent periparturient hypocalcemia, which can disrupt uterine smooth muscle contractility, prolong the first and second stages of labor, increase the likelihood of dystocia, and precipitate postpartum reproductive disorders including retained placenta and delayed uterine involution (Chetan Kumar et al., 2025; Hoffmann da Silva et al., 2025; Smail et al., 2025).

Serum phosphorus concentrations ranged from 5.18 to 5.30 mg/dL, which were likewise within physiological reference values. Phosphorus is essential for energy metabolism, ATP synthesis, nucleic acid production, and fetal skeletal development during late gestation (Stenhouse et al., 2022). Phosphorus plays an indispensable role in energy transfer and fetal osteogenesis (Horst, 1986). Inadequate phosphorus supply during this stage is associated with reduced feed intake, suboptimal fetal growth, muscular weakness at birth, immune dysfunction, and an extended postpartum anestrous interval (Cohrs et al., 2018; Eisenberg et al., 2019). Conversely, excessive dietary P can impair Ca absorption via competitive intestinal interactions and may increase the risk of urolithiasis, particularly in animals receiving high concentrate diets (Grünberg et al., 2019).

Table 3. Serum Macromineral Concentrations (Ca, P, Mg) During Late Gestation

Parameter	Reference range*	Ongole Grade (PO) (mean ± SD)	Pasundan (mean ± SD)	Overall (mean ± SD)
Calcium (mg/dL)	8.42 ± 0.80	8.98 ± 0.30	9.26 ± 0.52	9.08 ± 0.39
Phosphorus (mg/dL)	4.03 ± 1.24	5.30 ± 0.15	5.18 ± 0.28	5.26 ± 0.20
Magnesium (mg/dL)	2.67 ± 0.73	3.24 ± 0.46	2.95 ± 0.23	3.12 ± 0.40

Note: *(Grünwaldt et al., 2005)

Table 4. Birth Outcomes of the enrolled Indonesian local cattle

Variable	Ongole Grade (PO) (n=7)	Pasundan (n=4)	Total (n=11)
Gestation length (days), mean $\pm$ SD	299.00 $\pm$ 9.64	295.75 $\pm$ 6.08	297.82 $\pm$ 8.34
Birth weight (kg), mean $\pm$ SD	27.49 $\pm$ 2.67	20.50 $\pm$ 4.20	24.95 $\pm$ 4.69
Postpartum disorders	-	2 cows (1 retained placenta, one stillbirth)	2 cows (1 retained placenta, one stillbirth)

Serum magnesium concentrations ranged from 2.95 to 3.24 mg/dL, remaining within published physiological reference values for late gestation cattle. Magnesium serves as a critical cofactor for numerous enzymatic systems, influencing neuromuscular excitability (Glombowsky et al., 2017), and is essential for the activation of parathyroid hormone (PTH), thereby indirectly regulating Ca mobilization from bone and renal reabsorption (Martens et al., 2018). Subclinical Mg deficiency during late gestation may impair PTH responsiveness, reduce Ca mobilization at the onset of lactation, and predispose cows to periparturient hypocalcemia, whereas excessive Mg intake can depress Ca–P interactions and negatively affect ruminal fermentation dynamics (Goff, 2014; Schonewille, 2013).

Overall, the serum concentrations of calcium, phosphorus, and magnesium measured in the enrolled animals remained within published physiological reference ranges throughout late gestation. Because this study employed a descriptive cross-sectional design with a limited and heterogeneous study population, the observed mineral profiles should not be interpreted as evidence of similarities or differences between breeds. Instead, these findings provide preliminary baseline physiological information on serum macromineral status in Indonesian local cattle managed under the observed field conditions and may support future studies involving larger and more homogeneous populations.

Birth Outcomes

Observations of birth outcomes in the enrolled Indonesian local cattle are summarized

in Table 4. The evaluated parameters comprised gestation length, birth weight, and the occurrence of postpartum disorders, including stillbirth. These indicators are critical for assessing maternal–fetal well-being, evaluating prenatal nutritional adequacy, and identifying potential periparturient risks that may affect neonatal survival (Caton et al., 2020; Szenci, 2023). The recorded gestation lengths ranged from 295.75 to 299.00 days, which fall within the expected physiological range for *Bos indicus*-influenced cattle (approximately 285–300 days) (Chenoweth, 1994). These findings suggest that the pregnancy duration in the enrolled animals was generally consistent with normal physiological development. Gestation length is influenced by various maternal, fetal, and environmental factors, including endocrine regulation and fetal maturation (Redifer et al., 2023).

Birth weights ranged from 20.50 to 27.49 kg, remaining within the anticipated physiological range reported for Indonesian local beef cattle. Birth weight is significantly influenced by maternal nutrition, placental efficiency, and fetal hormonal regulation (Vonnahme et al., 2018; Zago et al., 2019). The values recorded for both breeds are within normal ranges for local Indonesian cattle and do not indicate pathological intrauterine growth restriction.

During the study period, two postpartum events were recorded, including one case of retained placenta and one stillbirth. These events occurred in separate animals and should be interpreted descriptively, as the study was not designed to assess the incidence or risk factors associated with postpartum disorders. Retained placenta has been linked to impaired

immune function, mineral imbalances, and periparturient stress (Bernardi et al., 2019; Qu et al., 2014), while stillbirth is recognized as a multifactorial outcome influenced by fetal, maternal, and intrapartum factors (Mee, 2020; Parikh et al., 2024). Given the limited sample size and descriptive study design, no causal relationship between serum mineral concentrations and postpartum events can be established.

Overall, the recorded birth outcomes generally indicated normal physiological conditions in the enrolled animals, despite the observation of isolated postpartum events. These findings provide preliminary descriptive information regarding gestation length, birth weight, and postpartum outcomes under the observed management conditions and may serve as baseline data for future studies involving larger and more homogeneous populations.

Study Limitations

This study has several limitations that should be considered when interpreting the findings. First, the sample size was limited ($n = 11$) due to a total sampling approach, meaning all animals meeting the predefined inclusion and exclusion criteria during the study period were enrolled. No additional animals with complete reproductive records, serum mineral measurements during late gestation, and comparable management conditions were available for inclusion. Second, the study population was heterogeneous concerning breed and parity, consisting of Ongole Grade (PO) and Pasundan cattle with varying parity. This heterogeneity, along with the small sample size, restricts the generalizability of the findings and prevents meaningful comparative evaluations between breeds or parity groups. Therefore, the findings should be viewed as descriptive observations of the enrolled animals under the observed management conditions rather than as representative estimates of the

broader Indonesian local cattle population. Future studies with larger and more homogeneous populations, adequately representing breed and parity groups, are needed to validate and expand on these preliminary descriptive observations.

Conclusions

This descriptive cross-sectional study demonstrated that the enrolled Indonesian local cattle exhibited serum calcium, phosphorus, and magnesium concentrations within published physiological reference ranges during late gestation under the observed management conditions. The recorded pre-pregnancy reproductive characteristics and birth outcomes generally reflected normal physiological conditions, although individual variation related to parity and reproductive history, as well as isolated postpartum events, was noted. These findings provide preliminary descriptive baseline information on blood mineral profiles, reproductive characteristics, and birth outcomes specifically for the enrolled animals and should not be generalized to the broader Indonesian local cattle population. Further studies involving larger and more homogeneous populations are necessary to determine whether these observations are consistent across different breeds, parity groups, and management conditions.

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