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Etiological Categorization and Metabolic Disorders Associated with Recumbency in Dairy Cows in the Cauvery Delta Region of Tamil Nadu

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ABSTRACT

The present investigation was conducted from March, 2023 to November, 2023 at the Veterinary Clinical Complex (VCC), Veterinary College and Research Institute, Orathanadu, situated in the Cauvery delta zone of Tamil Nadu, India. Recumbent cow syndrome continues to be a major clinical and economic problem in dairy herds, especially during the transition period when metabolic demands are markedly increased. The study aimed to identify the etiological factors associated with recumbency and to evaluate the pattern of metabolic disorders contributing to downer cow syndrome in the Cauvery delta region of Tamil Nadu. A total of 156 recumbent dairy cows presented to the Teaching Veterinary Clinical Complex, Orathanadu, were included in the study. Detailed clinical examinations were performed, followed by serum biochemical analysis of calcium, phosphorus, magnesium, potassium, glucose, β-hydroxybutyrate and non-esterified fatty acids. Etiological classification revealed that metabolic disorders were the leading cause of recumbency, accounting for 59.6% of cases, followed by musculoskeletal, gastrointestinal, reproductive, infectious, and toxic conditions. Among the metabolic abnormalities, hypocalcaemia (40.1%) and concurrent hypocalcaemia with hypophosphatemia (25.8%) were most frequently observed, whereas hypophosphatemia, hypokalaemia, and hypomagnesemia constituted the remaining cases. Metabolic recumbency was significantly higher in post-parturient cows highlighting the increased susceptibility during the transition period. The findings emphasize the need for early metabolic profiling, balanced nutrition, and strategic mineral supplementation to reduce recumbency and improve dairy herd health in the region.

KEYWORDS: Recumbent cow syndrome, metabolic disorders, hypocalcaemia, hypophosphatemia, hypokalaemia

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1. INTRODUCTION

Dairy farming constitutes a major livelihood activity in India and plays a vital role in ensuring nutritional security, income stability and socio-economic resilience of rural households (Senthilkumar et al., 2014; Jayalakshmi et al., 2025). The productivity and health of dairy cattle are influenced by husbandry practices, nutritional balance, stage of lactation and production-related diseases (Begum et al., 2014). Metabolic disorders occurring during the transition period, defined as three weeks before to three weeks after calving, remain a major constraint as cows undergo marked physiological, endocrine and nutritional adjustments to support parturition and onset of lactation (Radostits et al., 2007).

Recumbent cow syndrome is one of the most alarming and economically consequential conditions of the transition period. It is clinically characterised by the inability of a cow to rise or stand without assistance for more than 24 hours (Curtis et al., 1970; Andrews, 1983). Although affected cows may initially remain alert, prolonged recumbency results in rapid deterioration due to ischemic muscle necrosis and nerve compression (Cox, 1988; Poulton et al., 2016). Diagnosis under field conditions is challenging due to animal size, limited laboratory access, overlapping clinical signs and frequent concurrence of metabolic and musculoskeletal abnormalities (Radostits et al., 2007; Constable et al., 2017).

The etiology of recumbent cow syndrome is multifactorial. Hypocalcaemic parturient paresis remains the most frequently reported precursor, particularly when treatment is delayed or inadequate (Menard and Thompson, 2007). In addition, disturbances in phosphorus, magnesium and potassium homeostasis impair neuromuscular function and muscle strength (Goff, 2000; Sattler and Fecteau, 2014; Zelal, 2017). Cows with concurrent hypocalcaemia and hypophosphatemia show delayed recovery and often progress to downer status despite calcium therapy (Grunberg et al., 2006; Leduc et al., 2023). Hypokalaemia due to anorexia, metabolic alkalosis, aggressive fluid therapy or corticosteroid administration further compromises muscle excitability in early lactation cows (Constable et al., 2017; Bairwa et al., 2023). Metabolic stress during the transition period is compounded by negative energy balance, resulting in increased lipid mobilisation, elevated non-esterified fatty acids and β-hydroxybutyrate concentrations, which are strongly associated with ketosis, fatty liver and recumbent cow syndrome (Adewuyi et al., 2005; Kalaitzakis et al., 2010). Hyperketonaemia and hepatic lipidosis reduce muscular energy availability and weaken postural reflexes (Guyot et al., 2017). Climatic stress, nutritional deficiencies and calving-related complications such as dystocia, retained placenta, mastitis and metritis further increase susceptibility (Correa et al., 1993; Green et al., 2008).

Secondary complications including ischemic myonecrosis, obturator or sciatic nerve paralysis, hip dislocation and radial nerve injury often determine prognosis and may be more detrimental than the primary metabolic insult (Poulton et al., 2016; Alzaidi et al., 2022; Holschbach et al., 2023). Once pressure-induced muscle and nerve damage occurs, recovery rates decline sharply (Menard and Thompson, 2007; Burton et al., 2009). Epidemiologically, the syndrome is most common in high-yielding multiparous cows during early lactation, particularly under tropical conditions where heat stress and limited green fodder availability exacerbate mineral imbalances (Erb and Grohn, 1988; Soto et al., 2003; Senthilkumar, 2016; Xu et al., 2021). Indian studies highlight inadequate mineral supplementation and unbalanced rations as major risk factors (Yogeshpriya et al., 2019). Given its multifactorial nature, effective management requires integration of clinical findings with haematological, biochemical and electrolyte profiling (Clark and Henderson, 1987; Shpigel et al., 2003; Weber et al., 2019). In this context, the present study was undertaken to investigate the metabolic determinants associated with recumbent cow syndrome in the Cauvery delta region of Tamil Nadu.

2. MATERIALS AND METHODS

2.1. *Study area, animals and clinical evaluation*

The present investigation was conducted at the Veterinary Clinical Complex (VCC), Veterinary College and Research Institute, Orathanadu, located in the Cauvery delta zone of Tamil Nadu, India. The study was carried out from March 2023 to November 2023, encompassing both peak summer and north-east monsoon seasons, during which metabolic stress and production-related disorders are frequently encountered in dairy herds of the region. A total of 156 recumbent dairy cows presented to the Large Animal Medicine unit during the study period were included in the investigation. The animals consisted of Jersey crossbred, Holstein–Friesian crossbred and indigenous breeds of varying ages, parities and physiological stages. Animals below two years of age and those lacking complete clinical history or diagnostic records were excluded.

Recumbency was defined as the inability of an animal to stand unassisted for more than 24 hours. Based on physiological status at presentation, recumbent cows were categorized into pre-calving (pregnant) cows (n=54) and post-calving cows (n=102) to evaluate the influence of the transition period on etiological factors and biochemical alterations. Each animal underwent a comprehensive clinical examination including assessment of rectal temperature, heart rate, respiratory rate, rumen motility, mucous membrane characteristics, limb reflexes, ability to maintain sternal recumbency, musculoskeletal trauma, calving-related complications and signs suggestive of systemic illness. Detailed anamnesis regarding feeding practices, mineral supplementation, management system, duration of recumbency, stage of lactation and prior treatment history was obtained from the owners. This combined clinical and historical assessment facilitated preliminary differentiation between metabolic and non-metabolic causes of recumbency.

2.2. Laboratory investigations, etiological classification and data analysis

Blood samples were collected aseptically from the jugular vein into plain vacutainers for serum biochemical analysis and fluoride–oxalate vacutainers for glucose estimation. Serum was separated by centrifugation at 3000 rpm for 10 minutes and stored at −20°C until analysis. Serum biochemical parameters including blood urea nitrogen, creatinine, total protein, albumin, globulin, total bilirubin, liver enzymes (AST, ALT, ALP), muscle enzymes (creatine kinase and lactate dehydrogenase), and mineral and electrolyte concentrations such as calcium, phosphorus, magnesium, potassium, sodium, and chloride were analysed using a fully automated biochemistry analyser (Selectra Pro XS Automatic Biochemistry Analyser, ELITECH, Netherlands) with commercially available reagent kits, following manufacturer recommendations.

Based on detailed clinical examination, laboratory findings and ancillary diagnostic procedures, recumbent cows were classified into six major etiological groups: metabolic disorders, musculoskeletal and peripheral nerve disorders, gastrointestinal disorders, reproductive conditions, infectious causes, and intoxication. Metabolic disorders were further categorized based on mineral imbalances such as hypocalcaemia, hypophosphatemia, hypokalemia, hypomagnesemia, hypermagnesemia, and combined metabolic abnormalities. The etiological distribution was analysed separately for pre-calving and post-calving animals to evaluate the influence of physiological stage on recumbency.

Descriptive statistical methods including frequency distribution, percentage calculation, and determination of biochemical ranges were employed for data summarisation. Tables and graphical representations were prepared to illustrate etiological distribution, occurrence patterns, metabolic abnormalities, and serum biochemical profiles of recumbent cows. As the study was primarily descriptive, no inferential statistical tests were applied.

3. RESULTS AND DISCUSSION

A total of 156 recumbent dairy cows were examined and categorized into six major etiological groups based on detailed history, clinical examination, and laboratory evaluation. Metabolic disorders emerged as the predominant cause of recumbency, accounting for 93 cases (59.6%), followed by musculoskeletal and nervous disorders (14.1%), gastrointestinal disorders (10.2%), reproductive conditions (8.3%), infectious causes (5.7%), and intoxication (1.9%). The detailed categorization across physiological stages is presented in Table 1, and the distribution of causes is illustrated in Figure 1. Metabolic disorders were the most common contributor to recumbency in both pre- and post-calving dairy cows; however, their prevalence was markedly higher in post-calving animals (41.0%) compared with pre-calving cows (18.5%), indicating the heightened vulnerability of the transition period. These findings highlight the multifactorial nature of recumbent cow syndrome while clearly establishing metabolic disturbances as the principal etiological factor influencing recumbency in dairy production systems of the Cauvery delta region.

Evaluation of occurrence patterns provides valuable insight

Table 1: Etiological categorization of recumbent cows according to physiological stage

Etiological Category	Pre-calving (n=54)	Post-calving (n=102)	Total (n=156)
Metabolic causes	29 (18.5%)	64 (41.0%)	93 (59.6%)
Musculoskeletal and nervous disorders	8 (5.1%)	14 (8.9%)	22 (14.1%)
Gastrointestinal disorders	5 (3.2%)	11 (7.0%)	16 (10.2%)
Reproductive issues	8 (5.1%)	5 (3.2%)	13 (8.3%)
Infectious causes	3 (1.9%)	6 (3.8%)	9 (5.7%)
Intoxication	1 (0.6%)	2 (1.2%)	3 (1.9%)

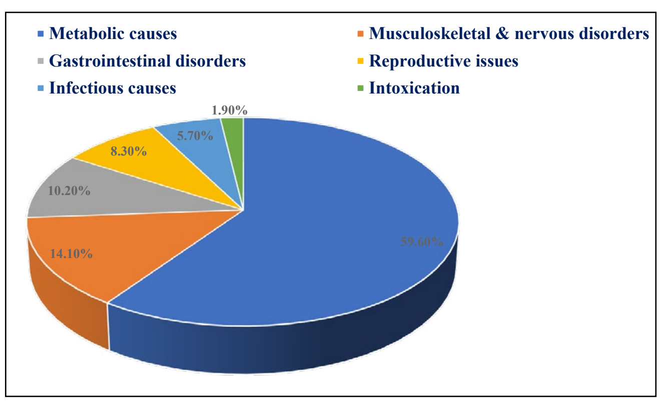

Figure 1: Distribution of etiological factors associated with recumbent cow syndrome

into disease distribution within a particular region and serves as baseline information for planning effective preventive, therapeutic, and management strategies. In the present study, 65.4% of recumbent cows were presented after calving, whereas 34.6% were pregnant animals, further confirming increased susceptibility during the periparturient period. This observation is consistent with previous reports indicating a higher incidence of recumbency associated with hypocalcemia and hypokalemia during early lactation, characterized by generalized muscle weakness, depression, and reduced gastrointestinal motility (Constable et al., 2013). Cox and Onapito (1986) similarly reported that approximately 58% of recumbent cases occurred within one day of parturition in association with milk fever, while Kalaitzakis et al. (2010) observed that nearly 88% of downer cows with fatty liver syndrome developed recumbency soon after calving. However, in contrast, Guyot et al. (2017) reported a higher mean incidence of recumbent cow syndrome during the dry period compared with postpartum and lactation periods, suggesting that herd management practices, nutritional status, and environmental factors may influence the timing of disease occurrence.

The present study further revealed that recumbency occurring after calving was predominantly associated with metabolic disturbances such as clinical hypocalcemia, hypokalemia, and hypophosphatemia, followed by musculoskeletal and nervous disorders and reproductive complications. These findings agree with Kvart et al. (1982), who identified hypocalcemia and other metabolic disorders as the most frequent causes of recumbency during the post-calving period. Correa et al. (1993) also reported that clinical hypocalcemia and stillbirth significantly increase the risk of downer cow syndrome during the postpartum period. Additional postpartum disorders including mastitis, ketosis, metritis, hip dislocation, and nerve paralysis have also been implicated as contributing factors to recumbency (Cox, 1988; Kalaitzakis et al., 2010; Constable et al., 2017; Poulton et al., 2019).

Dairy animals experience considerable metabolic load during the transition period due to negative energy balance, endocrine adjustments, increased nutritional demand, and physiological adaptation to lactation, which predispose them to both metabolic and infectious diseases (Green et al., 2008). These factors collectively explain the increased susceptibility to recumbent cow syndrome during the post-calving period observed in this study. The findings indicate that recumbent cow syndrome in dairy cattle of the Cauvery delta region is strongly influenced by metabolic stress associated with the transition period, and underline the importance of improved transition cow management, balanced mineral supplementation, nutritional monitoring, and timely veterinary intervention to reduce disease incidence and associated economic losses in tropical dairy production systems.

The physiological stage significantly influenced the occurrence of recumbency, with 54 (34.6%) cases recorded in pre-calving cows and 102 (65.4%) cases occurring after parturition, confirming the higher vulnerability during the transition period. Breed-wise analysis indicated that Jersey crossbred cows constituted the majority of recumbent cases, followed by Holstein–Friesian crossbreds and indigenous breeds. Seasonal variation was also evident, with peak occurrence observed during the summer months, particularly May, whereas the lowest incidence was recorded during November (Table 2). These observations are consistent with earlier reports indicating a higher incidence of recumbency during early lactation due to hypocalcemia and hypokalemia, which result in generalized muscle weakness, depression, and reduced gastrointestinal motility (Constable et al., 2013). Similarly, Kvart et al. (1982) identified metabolic disorders, particularly hypocalcemia, as the predominant cause of recumbency during the post-calving period, while Correa et al. (1993) reported that clinical hypocalcemia and stillbirth significantly increased the risk of downer cow syndrome postpartum. Other postpartum conditions such as mastitis, ketosis, metritis, hip dislocation, and nerve paralysis have also been implicated as contributing factors to recumbency (Cox, 1988; Kalaitzakis et al., 2010; Constable et al., 2017; Poulton et al., 2019).

Table 2: Occurrence pattern and distribution of recumbent dairy cows

Parameter	Observation
Total recumbent cows examined	156
Pre-calving cows	54 (34.6%)
Post-calving cows	102 (65.4%)
Most affected breed	Jersey crossbred (69.8%)
Holstein–Friesian crossbred	25.0%
Indigenous breeds	5.1%
Peak occurrence month	May
Lowest occurrence month	November

Seasonal influences observed in the present study corroborate earlier findings demonstrating a significant association between recumbent cow syndrome and summer stress conditions (Erb and Grohn, 1988). Heat stress has been reported to reduce feed intake, predispose dairy cattle to metabolic diseases such as ketosis and milk fever, and thereby increase the risk of recumbency (Soto et al., 2003). In tropical production systems, additional factors such as scarcity of green fodder and climatic stress may further aggravate metabolic imbalances, contributing to increased incidence of downer cow syndrome during summer months (Senthilkumar, 2016).

Breed susceptibility observed in this study also aligns with previous reports indicating higher incidence of milk fever–associated recumbency in Jersey cattle compared with Holsteins (Chiwome et al., 2017). Radostits et al. (2007) similarly reported greater susceptibility of Jersey breeds to parturient paresis, possibly related to age and physiological differences in calcium metabolism. Goff (2008) suggested that Jersey cattle possess lower intestinal calcitriol receptor concentrations than Holstein Friesians, which may impair calcium absorption and predispose them to hypocalcemia. The relatively higher incidence in Jersey crossbred cows observed in the present study may additionally reflect their increased population in the region due to widespread artificial insemination practices.

Metabolic abnormalities constituted the largest diagnostic category, affecting 93 recumbent cows, with hypocalcaemia being the most frequently encountered disorder (40.1%), followed by concurrent hypocalcaemia with hypophosphatemia (25.8%), isolated hypophosphatemia (15.0%), hypokalemia (12.9%), hypomagnesemia (4.3%), and occasional hypermagnesemia (1.1%) (Table 3). The predominance of hypocalcaemia aligns with the classical pathophysiology of periparturient paresis, wherein the sudden increase in calcium demand during parturition and early lactation exceeds the animal's homeostatic capacity (Goff, 2000; Radostits et al., 2007). Furthermore, the substantially higher metabolic recumbency rate observed in post-calving animals (68.8%) compared with pre-calving cows (45.2%) supports the critical metabolic adjustments associated with the onset of lactation, including negative energy balance, accelerated lipid mobilization, and endocrine changes (Adewuyi et al., 2005).

Table 3: Distribution of metabolic abnormalities in recumbent cows

Metabolic disorder	Percentage occurrence
Hypocalcaemia	40.1%
Hypocalcaemia+hypophosphatemia	25.8%
Hypophosphatemia	15.0%
Hypokalemia	12.9%
Hypomagnesemia	4.3%
Hypermagnesemia	1.1%

The high proportion of cows with combined hypocalcaemia and hypophosphatemia in this study emphasizes the multifaceted nature of metabolic recumbency. Phosphorus is essential for ATP synthesis, neuromuscular activity, and rumen function, and its deficiency exacerbates the severity of recumbency even after calcium correction (Grunberg et al., 2006; Leduc et al., 2023). The presence of hypophosphatemia as an isolated defect in 15% of recumbent cows indicates dietary inadequacy or intracellular shifts, particularly in high-producing dairy animals. Hypokalemia, observed in 12.9% of metabolic downers, is known to cause profound muscle weakness, neck drooping, and inability to attain sternal posture. Earlier reports attribute hypokalemia to prolonged anorexia, alkalinizing therapy, and metabolic acidosis in transition cows (Sattler and Fecteau, 2014; Constable et al., 2017). Though detected at lower frequencies, hypomagnesemia remains clinically relevant due to its strong association with neuromuscular dysfunction and impaired parathyroid hormone action, which further compounds hypocalcaemia.

Musculoskeletal and nervous disorders accounted for 22 cases (14.1%), with hip dislocation being the most common condition (50.0%). Other causes included leg fractures (22.7%), obturator nerve paralysis (18.1%), and radial nerve paralysis (9.0%). These injuries were more frequently encountered in post-calving cows (63.6%), consistent with trauma associated with difficult calving, prolonged straining, or slipping in inadequate flooring systems. Although significant, these causes were secondary to metabolic factors in overall frequency, paralleling earlier field observations within tropical dairy systems (Radostits et al., 2007; Yadav et al., 2019).

Reproductive problems were responsible for 13 cases (8.3%), with dystocia (46.1%) and uterine prolapse (38.4%) being the most important contributors. Interestingly, reproductive-associated recumbency occurred predominantly in pre-calving cows (61.6%), indicating that severe calving-related complications play a role in precipitating non-ambulatory status. Infectious causes constituted 9 cases (5.7%) and included haemoprotozoan infections (55.5%), mastitis (33.4%), and septicaemia (11.1%). These causes were more common in post-calving cows, likely due to increased susceptibility to systemic infections during the early lactation period.

Gastrointestinal disorders accounted for 16 cases (10.2%), dominated by acid indigestion (43.7%), ruminal impaction (25.0%), and traumatic reticuloperitonitis (12.5%), with isolated cases of intussusception, bloat, and ileus. These disorders impair rumen motility, reduce nutrient supply, and predispose cows to secondary electrolyte imbalances, thereby contributing to recumbency. Intoxication was the least common category (1.9%) and included cases of oil intoxication and organophosphorus poisoning, both known to depress neuromuscular activity and general responsiveness.

Further, the serum biochemical, enzyme, mineral, and electrolyte profiles of recumbent dairy cows revealed distinct metabolic alterations between pre-calving (n=54) and post-calving (n=102) animals (Table 4), reflecting the physiological stress associated with the transition period. Renal biochemical indices showed mild elevation, with blood urea nitrogen generally ranging between approximately 22.8–27.7 mg dl^{-1} in pre-calving cows and 23.3–27.8 mg dl^{-1} in post-calving animals, while creatinine values varied between 0.9 and 1.7 mg dl^{-1}. Such elevations are commonly associated with dehydration, reduced feed intake, and muscle catabolism during prolonged recumbency, conditions frequently described in downer cow syndrome (Constable et al., 2017).

Table 4: Serum biochemical, enzyme, mineral and electrolyte ranges in pre- and post-calving recumbent dairy cows

Parameter	Pre-calving cows (n=54)	Post-calving cows (n=102)
Blood urea nitrogen (BUN) (mg dl^{-1})	22.8–27.7	23.3–27.8
Creatinine (mg dl^{-1})	0.9–1.7	0.9–1.7
Total protein (g dl^{-1})	4.8–5.5	5.1–5.7
Albumin (g dl^{-1})	2.3–2.7	2.5–2.9
Globulin (g dl^{-1})	2.4–2.8	2.2–2.7
Total bilirubin (mg dl^{-1})	0.3–1.2	0.4–0.9
AST (U l^{-1})	74–182	80–194
ALT (U l^{-1})	44–117	33–105
ALP (U l^{-1})	136–284	127–206
CK (U l^{-1})	373–969	192–336
LDH (U l^{-1})	1400–4250	2440–6525
Total calcium (mmol l^{-1})	1.7–2.2	1.6–2.5
Ionized calcium (mmol l^{-1})	1.05–1.32	0.95–1.42
Phosphorus (mg dl^{-1})	2.6–4.0	2.4–4.5
Potassium (mmol l^{-1})	3.0–4.4	2.7–4.3
Magnesium (mg dl^{-1})	2.4–3.0	2.4–2.9
Sodium (mmol l^{-1})	134–140	133–138
Chloride (mmol l^{-1})	97–104	100–105

Serum protein fractions showed moderate variation, with total protein remaining broadly within physiological limits (approximately 4.8–5.7 g dl^{-1}), while albumin concentrations ranged from about 2.3–2.9 g dl^{-1}. Slight reductions in albumin may indicate nutritional stress, hepatic adaptation, or inflammatory responses during the periparturient period. Total bilirubin values remained relatively low (approximately 0.3–1.2 mg dl^{-1}), suggesting mild hepatic involvement possibly related to anorexia or fatty liver changes, which have been reported in transition dairy cows experiencing metabolic imbalance (Adewuyi et al., 2005).

Serum enzyme activities indicated tissue and muscle involvement associated with recumbency. AST activity ranged approximately from 74–182 U l^{-1} in pre-calving cows and up to about 194 U l^{-1} in post-calving animals, while ALT showed comparatively smaller variation. Marked elevations in muscle-associated enzymes were evident, particularly creatine kinase and lactate dehydrogenase, with CK reaching approximately 373–969 U l^{-1} and LDH levels extending up to about 6525 U l^{-1} in some post-calving cases. Elevated muscle enzymes are well recognized indicators of muscle ischemia, pressure necrosis, and nerve injury associated with prolonged recumbency in cattle (Radostits et al., 2007; Constable et al., 2017).

Mineral profiling highlighted the importance of calcium and phosphorus imbalance in the pathogenesis of recumbency. Total calcium levels generally ranged from about 1.6–2.5 mmol l^{-1}, with lower values predominantly observed in post-calving cows, consistent with hypocalcemia occurring during the periparturient period when calcium demand for lactation increases abruptly (Goff, 2000). Phosphorus concentrations ranged approximately between 2.4 and 4.5 mg dl^{-1}, suggesting that concurrent hypophosphatemia may contribute to impaired neuromuscular function and delayed recovery. Potassium concentrations occasionally decreased to around 2.7 mmol l^{-1} in post-calving cows, indicating hypokalaemia as an additional factor contributing to muscle weakness and recumbency, as previously described in transition dairy cattle (Constable et al., 2017).

Overall, the etiological distribution observed in this study underscores the dominance of metabolic abnormalities as the principal cause of recumbency in dairy cows of the Cauvery delta region. These findings reflect the ongoing challenges in mineral nutrition, transition cow management and dairy herd health monitoring in tropical production systems. The prominence of multi-mineral imbalances, particularly combined calcium–phosphorus deficiency, highlights the necessity for comprehensive metabolic profiling of recumbent cows. Furthermore, the clear predominance of post-calving recumbency reinforces the importance of targeted nutritional strategies, improved calving management and timely veterinary intervention to reduce morbidity and associated economic losses. The results collectively suggest that early biochemical assessment and prompt correction of mineral imbalances can significantly improve recovery outcomes in downer cows.

4. CONCLUSION

The present study identified metabolic disorders as the major cause of recumbent cow syndrome in dairy cattle of the Cauvery delta region, particularly during the post-calving period.Hypocalcaemia, alone or with hypophosphatemia, was the predominant metabolic abnormality. Breed, season and concurrent systemic disorders also contributed to recumbency. Altered biochemical and electrolyte profiles reflected severe metabolic stress. Early diagnosis, routine metabolic monitoring, balanced mineral supplementation, and improved transition cow management are essential to reduce recumbency and enhance recovery outcomes.

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