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Demographic study of hypokalemic syndrome in dairy cows in and around Namakkal, Tamil Nadu

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Abstract
Hypokalemic syndrome in dairy cows refers that the serum potassium value less than normal reference value (3.9 to 5.8 mmol/L). A total of 3887 dairy cows were presented to Veterinary Clinical Complex, Namakkal in Tamil Nadu during the period March 2022 to May 2023. Out of 3887 cows, 227 cows (5.83%) were affected with hypokalemic syndrome. Out of 227 dairy cows, 118 dairy cows were selected for the present study based on the subsequent presentation of dairy cows to the unit for follow up. These cows were analysed for prevalence and etiologies for hypokalemic syndrome. Highest prevalence of hypokalemic syndrome was noticed in Holstein Friesian crossbred cows, cows in the third parity and periparturient period. The various etiologies observed for hypokalemia in present study included theileriosis (n=24, 20.33%), recumbent dairy cows (n= 24, 20.33%), traumatic reticuloperitonitis (n= 20, 16.94%), over use of isoflupredone acetate in case of ketosis (n= 15, 12.70%), excessive administration of sodium bicarbonate in the treatment of ruminal lactic acidosis (n=11, 9.32%), ileus (n=10, 8.50%), botulism (n=8, 6.80%) and abomasal displacement (n=6, 5.08%). Salient clinical signs of hypokalemia in dairy cows were anorexia, suspended rumination, ruminal atony, sternal recumbency, lateral kinking of neck or S- shaped neck deviation or unable to lift its head from the ground, scanty dung, tachycardia. Dairy cows affected with hypokalemia revealed highly significant increase in aspartate aminotransferase, creatinine phosphokinase, magnesium, glucose and significant increase in bicarbonate and highly significant decrease in potassium and chloride values.

Keywords: Hypokalemic syndrome, dairy cows, serum potassium

1. Introduction
Hypokalemic syndrome in dairy cows refers that the serum potassium value less than normal reference value (3.9 to 5.8 mmol/L) (Constable *et al*., 2017) [1]. Potassium is a major intracellular cation and its availability in the plasma is playing a vital role in the development of hypokalemic syndrome in cattle. There is no feedback mechanism for potassium homeostasis. Hypokalemia is one of the common electrolyte deficiencies in adult lactating cattle when they are anorectic for more than two days. Lactating dairy cows are more susceptible to hypokalemia due to loss of potassium in milk or treatment of ketosis with corticosteroids (isoflupredone acetate). Mineralocorticoid activity of corticosteroids enhanced the renal and gastrointestinal losses of potassium. The other common etiological factors associated with hypokalemia are metabolic alkalosis, abomasal disorders, hyperinsulinemia with hyperglycaemia, sympathetic activation, and excess administration of bicarbonate during ruminal acidosis (Peek *et al.*, 2000) [2]. Hypokalemia is leading to recumbency in dairy cattle due to muscular weakness. Clinical signs of hypokalemic animals should not be overlooked because it influences the recovery and prognosis. Estimation of serum potassium will confirm the diagnosis of hypokalemia. This study was undertaken to record the prevalence, etiologies and haematobiochemical alterations in hypokalemic syndrome in dairy cows which were presented to Veterinary Clinical Complex, Veterinary College and Research Institute, Namakkal in Tamil Nadu.

2. Materials and Methods

Cows with clinical signs of anorexia, tachycardia, emaciation, chronic diarrhoea, recumbency, ruminal atony, abdominal distension presented to the large animal medicine unit of Veterinary Clinical Complex, Veterinary College and Research Institute, Namakkal were screened. They were subjected to detailed clinical examination and haemato-biochemical examination. Based on the clinical sign and haemato-biochemical examination, the dairy cows with hypokalemia were classified into different categories. Two millilitre of blood was collected in vacutainers containing ethylene diamine tetra acetic acid (EDTA) as anticoagulants for the estimation of haemoglobin, packed cell volume, red blood cells, white blood cells, differential leucocyte count, platelets, mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration as per standard method (Jain, 1986) [3]. Five millilitre of blood was collected in vacutainers without any anticoagulant for serum biochemistry. The electrocardiography and ultrasonography were also performed in needy cases for the identification of different etiological factors associated with hypokalemia. The data obtained were statistically analysed (Snedecor and Cochran, 1994) [4].

3. Results and Discussion

3.1 Prevalence

A total of 3887 cattle were presented to Veterinary Clinical Complex, Veterinary College and Research Institute, Namakkal during from March 2022 to May 2023. Out of 3887 cows, a total of 227 cows (5.83%) were found to be affected with hypokalemia based on clinical signs and serum biochemistry. Out of 227 dairy cows, 118 dairy cows were selected for the study based on the subsequent presentation of dairy cows to the unit for follow up. Highest prevalence of hypokalemic syndrome in dairy cows was noticed in third parity (36.44%) followed by fourth parity (25.42%) and second parity (21.20%). The prevalence of hypokalemic syndrome in cows in Holstein Friesian crossbred, Jersey crossbred and native breed were 53.38 per cent, 29.67 per cent and 16.95 per cent, respectively. Periparturient dairy cows (44.92%) had highest incidence of hypokalemic syndrome when compared to the lactating (37.5%) and pregnant dairy cows (16.66%). Sattler *et al.,* (1998)[5] and Peek *et al.,* (2000) [2] also recorded that the four to five years age group Holstein Friesian crossbred cows were more susceptible to the hypokalemic syndrome. Dairy cows in the periparturient period would be in negative energy balance due to decreased feed intake. Holstein Friesian crossbred is one of the high milk yielding cattle breed. These findings were supported by Dracley (1999) [6], Schneider *et al.* (2016) [7] and Constable *et al.* (2017) [1].

3.2 Etiology

A total of 118 dairy cows affected with hypokalemic syndrome were classified based on the etiologies. Theileriosis (n=24, 20.33%), recumbent cows with hypokalemia (n=24, 20.33%), traumatic reticuloperitonitis (n=20, 16.94%), over use of isoflupredone acetate in ketosis (n= 15, 12.70%), excessive administration of sodium bicarbonate in the treatment of ruminal lactic acidosis (n=11, 9.32%), ileus (n=10, 8.50%), botulism(n=8, 6.80%) and abomasal displacement (n=6, 5.08%) were the major etiological factors identified in the present study (Fig 1). Hypokalemia in dairy cows with theileriosis could be due to decreased feed intake, intestinal malfunction and kidney damage (Hasanpour *et al.,* 2008) [8]. Hypokalemia in recumbent cows occurred due to muscle ischaemia and the prolonged recumbency increased the cell membrane permeability of muscle fibres and allowed loss of potassium from the cell (Andrew *et al.,* 1992) [9]. Traumatic reticuloperitonitis was also causing the hypokalemia, it might be due to ruminal hypomotility and/or vagal indigestion. Hypokalemia might be attributed to anorexia, but might also be exacerbated by ion exchange caused by alkalosis and/or abomasal reflux into the rumen (Ghanem, 2010) [10]. Over use of isoflupredone acetate in ketosis was causing hypokalemia in dairy cows due to mineralocorticoid activity equal to that of aldosterone and it could alter the external as well as the internal balance of potassium by urinary excretion and exacerbate hypokalemia (Sielman *et al.,* 1997) [11]. Therapy with excess use of sodium bicarbonate in ruminal lactic acidosis caused hypokalemia and it might be due to the excess loss of electrolytes by urinary excretion (Adeva-Andany *et al.,* 2014) [12]. Trefz *et al.* (2015) [13] reported that administration of hypertonic sodium bicarbonate solution intravenously would decrease serum potassium by increasing the redistribution of potassium ions into cells. Hypokalemia also occurred due to botulism toxicosis in dairy cows and it might be due to anorexia and hyperglycemia. Hypokalemia was found in ileus condition and it could be due to sequestration of ingesta, third space losses and abomasal reflux (Hussain *et al.,* 2015) [14]. Hypokalemia associated with abomasal displacement could be attributed to abomasal atony continued secretion of hydrochloric acid into abomasum and impairment of flow into the duodenum (Dezfouli *et al.,* 2013) [15].

3.3 Clinical findings

In the present study, the dairy cows affected with hypokalemia showed anorexia, pale pink mucus membrane, ruminal atony, scanty dung, sternal recumbency, lateral kinking of neck, unable to lift its head from ground, S-shaped deviation of neck, and tachycardia. The clinical findings were in accordance with Yogespriya and Selvaraj (2018) [16].

3.4 Haematobiochemical findings

Dairy cows affected with hypokalemia revealed highly significant (p<0.01) increase in monocytes. However, the values were within the reference value of cattle. Dairy cows affected with hypokalemia revealed highly significant (p<0.01) increase in aspartate aminotransferase, creatinine phosphokinase, magnesium, glucose and significant (p<0.05) increasein bicarbonate and highly significant (p<0.01) decrease in potassium and chloride values. These findings were supported by Peek *et al.* (2000) [2], Kachhawaha and Tanwar, (2010)[17] and Sivaraman *et al.* (2019) [18] who reported significantly higher serum AST, ALT and CPK in downer cows. It might be due to prolonged recumbency that causes ischaemic necrosis of muscle resulted increased permeability of cell membrane allowing seepage of AST, ALT and CPK enzymes into circulation. The relation of hypokalemia and hyperglycaemia was based on the function of the ATP-sensitive potassium channel in islet cells of pancreas. Hypokalemia is associated with the development of hyperglycaemia through the impairment of potassium-dependent insulin release in response to glucose overload (Gloyn *et al.,* 2004) [19].

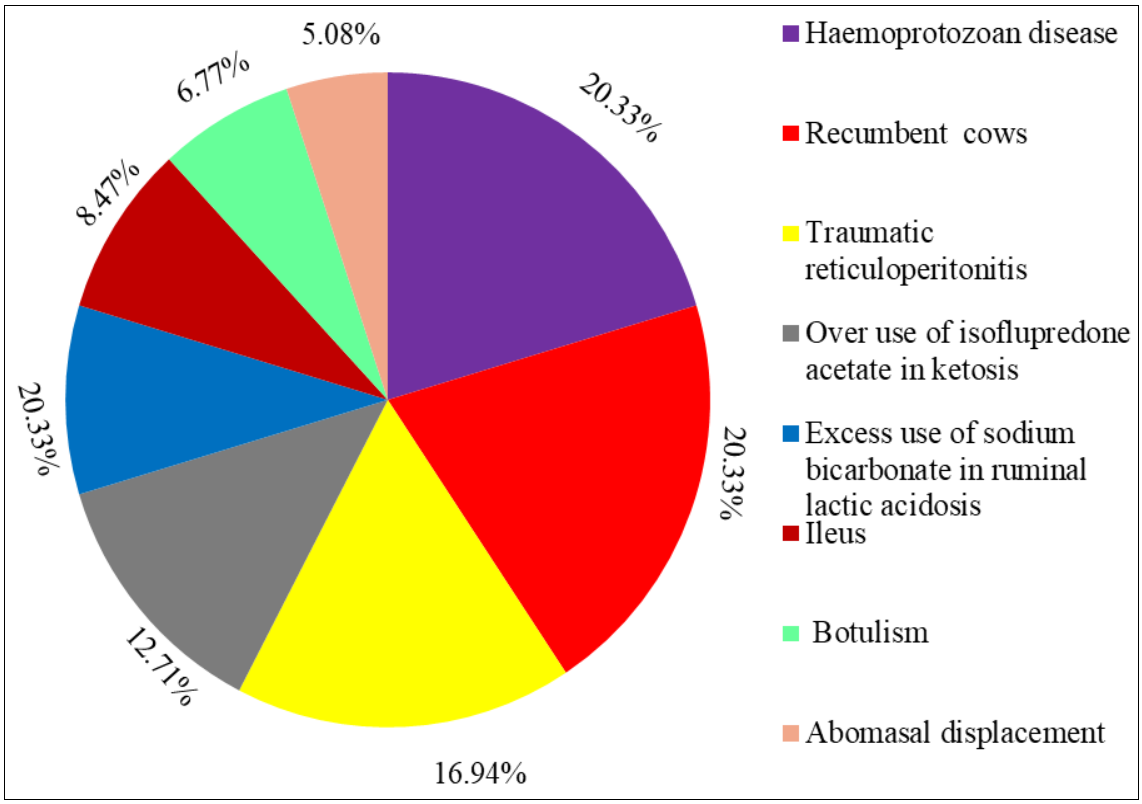

Fig 1: Etiology of hypokalemic syndrome in dairy cows

Table 1: Haematology of apparently healthy and hypokalemic dairy cows (Mean ± SE)

Parameters	Healthy animals (n=6)	Hypokalemic animals (n=118)	P value
Haemoglobin (g/dl)	9.04±1.05	8.43±1.04	0.25
Packed cell volume (%)	30.02±1.04	30.09±1.03	0.96
Red blood cells ($X10^6$/cumm)	5.61±1.04	5.30±1.04	0.29
White blood cells ($X10^3$/cumm)	9.74±1.06	10.99±1.03	0.08
Lymphocytes (%)	61.83±1.09	67.32±1.05	0.40
Neutrophils (%)	30.42±1.22	44.27±1.06	0.12
Monocytes (%)	3.77±1.08	2.69±1.03	0.001
Platelets (/µl)	6.17±1.07	6.50±1.02	0.06
MCV (fl)	53.47±1.04	56.80±1.04	0.26
MCH (pg)	16.10±1.02	15.91±1.03	0.74
MCHC (g/dl)	30.11±1.04	27.37±1.03	0.08

(p<0.01) – Highly significant
(p<0.05) - Significant

Table 2: Serum biochemistry of apparently healthy and hypokalemic dairy cows (mean±S.E)

Parameters	Healthy animals (n=6)	Hypokalemic animals (n=118)	P Value
Total protein (g/dl)	5.24±1.10	5.74±1.02	0.12
Albumin (g/dl)	3.25±1.06	3.39±1.03	0.06
AST (U/L)	61.73±1.08	163.77±1.07	0.001
CPK (U/L)	141.47±1.05	228.02±1.04	0.001
Calcium (mg/dl)	11.81±1.07	10.97±1.01	0.08
Phosphorus(mg/dl)	4.13±1.09	5.17±1.02	0.04
Magnesium(mg/dl)	2.25±1.03	3.00±1.02	0.001
Glucose (mg/dl)	44.63±1.06	86.78±1.03	0.001
Sodium (mEq/L)	143.51±1.03	140.83±1.04	0.721
Potassium (mEq/L)	4.31±1.03	2.35±1.03	0.001
Chloride (mEq/L)	105.28±1.05	68.56±1.03	0.001
Bicarbonate (mEq/L)	23.15±1.06	27.60±1.03	0.02

(p<0.01) – Highly significant
(p<0.05) - Significant

4. Conclusion

Hypokalemia was the one of the major causes of recumbency in dairy cows and was mostly under diagnosed in the field conditions. The occurrence of hypokalemia was mainly due to theileriosis, recumbency, traumatic reticuloperitonitis, over use of isoflupredone acetate in ketosis, excess bicarbonate administration in ruminal lactic acidosis, ileus, botulism and abomasal displacement. Reduced intake of potassium due to anorexia and loss of potassium through milk during early lactation were the main reasons for hypokalemia in dairy

cows. Hypokalemia is considered as one of the differential diagnosis in recumbent cattle particularly in animals with the history of prolonged anorexia associated with chronic refractory ketosis and corticosteroid administration.

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