

## 1 Introduction and the objectives of the study

The extracellular fluid compartment of the organism (ECF) or homeodynamic status creates assumptions for the physiological course of all cellular functions. Several systems in the body such as physiological fluids volume, osmolality, and physiological colloid osmotic pressure are involved to provide homeodynamic status. Therefore, the ionic composition of body fluids is maintained within narrow limits. Hydrogen ions ( $H^+$ ) are among the ions that determine the acidity or alkalinity of the body fluids. In the body, hydrogen ion concentration  $[H^+]$  is measured as pH, which is known as the negative logarithm of  $[H^+]$ ,  $pH = -\log [H^+]$ . Daily, intermediary metabolism produces approximately 285 mmol of  $H^+$  per kilogram metabolic body weight ( $BW_{kg}^{0.75}$ ) (DiBartola, 1992). For a calf weighing 50 kg, intermediary metabolism produces about 752 mmol of  $H^+$  per day and about 1168 mmol of  $H^+$  per day for a young camel weighing 90 kg. Under physiological conditions, acids and bases are added continuously to the body fluids, either by their ingestion or as a result of their production in the cellular metabolism. However, the relatively constant extracellular fluid  $[H^+]$  is the result of a balance between the production and the elimination of acids and bases in the body.

Acid-base physiology is known to play a major role in human and veterinary medicine because it provides important information about body fluids homeodynamics, heart, lungs and kidney diseases. Furthermore, acid-base disorders are common clinical problems resulting of a wide variety of pathophysiological conditions in humans and animals. In veterinary medicine, a practical acid-base physiology is linked to the relationship between acid-base balance and animal nutrition, in particular during pregnancy and lactation. An important practical application is the manipulation of the diet in order to prevent the hypocalcaemic post parturient paresis of dairy cows. The manipulation of dietary cation-anion difference (DCAD) makes it possible to maintain the cows in mild metabolic acidosis during the critical period that precedes calving, presumably via a mechanism that involves the strong ion difference in ECF.

Acid-base physiology has also implications in neonatal and metabolic diseases which are reflected on productivity. Neonatal diarrhoea is known as an important disease that affects health and productivity in animals, in particular cattle. A close relationship has been reported between neonatal calf diarrhoea and acid-base disorders. Neonatal diarrhoea in calves is a serious problem and an important cause of economic loss because of high mortality, treatment cost and poor growth in the cattle industry.

The camel is an important animal in arid and semi arid areas. Camel population in Sudan exceeds 3 million raised mainly in a belt north of 12° N Latitude. The most densely populated areas are Kordofan, Eastern Darfur (Western Sudan), followed by other regions in the central, eastern and northern Sudan. The camels are owned mainly by migratory pastoralists as a source of milk and meat, as well as a pack and riding animal. Therefore, there is upsurge of excitement in the problems related to health and productivity in camels. An important condition which affects health and productivity in camels is neonatal diarrhoea, which is characterised by marked changes in acid-base balance. This disease is the major cause of reduced herd growth in Sudan. High calf mortality is a major constraint to increasing productivity of camels.

Evaluation of acid-base status has traditionally been accomplished with analysis of blood gases and application of the Henderson-Hasselbalch equation to describe the relationship between pH, partial pressure of carbon dioxide ( $P_{CO_2}$ ) and bicarbonate ( $HCO_3^-$ ). Therefore, many investigators used the traditional approach to characterise acid-base status in healthy and diarrhoeic calves (Omole et al., 2001; Varga et al., 2001). Other investigators used the base excess (BE) concept to determine the presence of metabolic disturbances in calves (Stocker et al., 1999). Furthermore, the anion gap concept has been used to classify acid-base status in healthy and diarrhoeic calves (Constable et al., 1997). Recently, evaluation of acid-base disturbances in calf diarrhoea has been documented by using total concentration of carbon dioxide ( $TCO_2$ ) (Berchtold, 1998).

More recently, application of Stewart's model (strong ion difference approach) has been established previously in healthy and diarrhoeic calves using venous blood (Grove-White and Michell, 2001; Constable et al., 2005). The use of the Stewart model has improved our understanding of the pathophysiological conditions that lead to marked changes in acid-base balance. Furthermore,  $P_{CO_2}$ , strong ion difference (SID) and total plasma concentration of non-volatile weak acid ( $A_{tot}$ ) are biological variables that are regulated mainly by ventilation, metabolism, renal tubular transport and intestinal absorption and secretion.

Various studies have investigated acid-base balance in calves and the calculation of the physiological acid-base parameters has been well applied to humans (Wooten, 2003; Himpe et al., 2003) and domestic animals (Szenci, 1985; Roussel et al., 1998). However, little information is available regarding acid-base balance in camels. Therefore, this study provides additional information about acid-base balance in calves in relation to their age after inducing an experimental metabolic acidosis using intravenous infusion of 5 molar ammonium chloride (5M  $NH_4Cl$ ). This study also provides new information about acid-base balance in young

camels in their natural tropical environment and the factors that may influence acid-base balance in camels in comparison with calves. Therefore, the objectives of the present study are:

1. To evaluate the use of intravenous infusion of 5M  $\text{NH}_4\text{Cl}$  ( $\text{pH} = 5.05$ , osmolality = 893 mOsmol/kg) to induce metabolic acidosis in calves and young camels by the determination of:
  - 1.1 The alterations in blood acid-base parameters on the basis of the parameters of the Henderson-Hasselbalch model ( $\text{pH}$ ,  $\text{P}_{\text{CO}_2}$ ,  $[\text{HCO}_3^-]$  and  $[\text{BE}]$ ) and Stewart's strong ion model ( $\text{P}_{\text{CO}_2}$ ,  $[\text{SID}_3]$  and  $[\text{A}_{\text{tot}}]$ ).
  - 1.2 The response of acid-base regulatory mechanisms (pulmonary and renal regulation) in calves and young camels during the first 8 hrs, 24 and 48 hrs after the beginning of the experimentally induced metabolic acidosis by estimating acid-base parameters in the blood and urine.
2. To estimate the alterations in acid-base parameters and serum metabolic components in calves and young camels in relation to their age after the experimentally induced metabolic acidosis.
3. To recommend the suitable model for veterinarians that could be used for the clinical diagnosis of acid-base disturbances in calves and young camels.