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Metabolites, Macro Elements and Enzymes Activity in Cerebrospinal Fluid of Sudanese Camels (*Camelus dromedaries*) and Cattle

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ABSTRACT

The objective of this study was to measure and compare the concentration of metabolites, some macro minerals (Ca, Mg, K, and Na), and enzymes activity (alanine amino transferase (ALT), alkaline phosphatase (ALP), and aspartate amino transferase (AST) in cerebrospinal fluid (CSF) of camel and cattle. Thirty clinically healthy male Sudanese dromedary camels and thirty Sudanese steers destined for slaughter were used in this study. Cerebrospinal fluid samples were collected into clean sterile containers immediately after slaughter, through puncture of the cerebellomedullary cistern using sterile 10 cc disposable syringes. On physical examination the CSF of the two species was clear and its viscosity was comparable to that of water. Higher mean CSF concentrations of the total proteins, albumin, urea, creatinine and glucose were observed in camel but were not statistically different between camel and cattle ($p>0.05$). Camel showed significant ($P<0.05$) higher concentration of Ca, Mg, K and Na in CSF than cattle, and their values are as follows of Ca (5.65±0.12, versus 5.48±0.19) mg/100ml, Mg (2.28±0.13, versus 1.49±0.18) mg/100ml, K (3.53±0.37, versus 3.09±011 mmol/L) and Na (121.37±3.38, versus 104.87±8.63 mmol/L). Moreover, camel registered significantly higher concentrations of AST (7.37±0.96 U/L versus 5.5±12 U/L) than cattle. No significant ($P>0.05$) difference was found between camel and cattle in ALT concentration (21.13±1.59 U/L) versus (20.13±2.05U/L) and in ALP (76 ±2 U/L versus 75.1±2.81). The values reported in this study can serve as a reference values for Sudanese camel and cattle.

Keywords: Major minerals, CSF composition. Metabolites

INTRODUCTION

CSF is clear, colourless, free of flocculent material, and with the same viscosity as water (Smith and George, 2002; Ameri and Mousavian, 2007), containing ions and different substances to serve as an intracerebral transport medium for nutrients, neuroendocrine substances and neurotransmitters, and is produced mainly by the choroid plexus and ependymal lining cells of the brain ventricles by ultra filtration from blood plasma (Kaneko *et al.*, 1997). CSF composition is strongly dependent on that of blood and is a reflection of the blood plasma constituents. Its composition is subject to various environmental, physiological and pathological conditions (Thompson, 1988, Wells *et al.*, 1992, Sagair *et al.*, 2005). Values of normal CSF have

been determined for a wide range of large and small animal species including camels, buffalos cattle, sheep, horses, ferrets and companion animals (Mayhew *et al*., 1977, Wells *et al*., 1994, Stocker *et al.*, 2002; Simon *et al.*, 2004; Khadiga *et al.*, 2005: Ameri and Mousavian, 2007; Shamseldein *et al*., 2009 and Di Terlizzi and Platt, 2009). Collection and evaluation of cerebrospinal fluid is one of the most important aspects in investigation and diagnosis of various diseases in different animals with involvement of central nervous system and spinal cord (Vineet and Naveen, 2012).

The examination of the CSF has become an integral part of the assessment of the critically ill neurological cattle (Tyler *et al.*, 1993, Braun *et al.*, 2003, and Stoko *et al.* 2009), horses (Sofaly *et al.*, 2002) and dogs (Garma and Tyler, 1999).

The objective of this study was to measure and compare the concentration of metabolites, some macro minerals (Ca, Mg, K, and Na) and enzymes activity in cerebrospinal fluid (CSF) of camel and cattle.

MATERIALS AND METHODS

Animals:

A total number of 60 clinically healthy camels and cattle (30 for each species) were selected for this study.

CSF samples collection:

CSF samples (5ml) were collected from each animal into clean sterile containers, immediately after slaughter, through puncture of the cerebellomedullary cistern using sterile 10 cc disposable syringes. Unclear, colored, flocculent material CSF samples were discarded. Samples were processed within 2 hrs after collection for measurement of glucose level and the rest were stored at -20°C bending analysis.

CSF concentration of total protein (TP), albumin (Alb), glucose, Creatinine, Urea, Uric acid, Mg , Ca, and the activity of the enzymes Alanine Amino Transferase (ALT), Alkaline Phosphatase (ALP), and Aspartate Amino Transferase (AST) were performed by spectrophotometric methods using commercial kits(Linear Chemicals Ltd.- Spain), following the procedures set by the manufacturer. K and Na were determined by a flame photometer (Corning 400, England),

Statistical analysis:

was carried out using the software SAS version 2004, to verify the effect of species on each CSF parameter. The t-test was used to compare the means of the effect of species.

RESULTS

The means, standard deviation and range of measured metabolites in CSF of Sudanese camel and cattle are shown in Table (1). Higher mean CSF concentrations of the total proteins, albumin, urea, creatinine and glucose were observed in camel but were not statistically different between camel and cattle ($p>0.05$).

Mean ±the standard deviation of CSF macro elements of Sudanese camels and cattle are presents in Table (2). The camels showed a significantly ($P<0.05$) higher CSF concentration for Mg, K and Na.

The CSF enzymes activity of alanine amino transferase (ALT), aspartate amino transferase (AST) and alkaline phosphatase (ALP) are shown in Table 2. CSF concentration of aspartate amino transferase (AST) was significantly ($P<0.05$) higher in camel as compared with cattle, and no significant difference was observed in the concentration of alanine amino transferase (ALT) and alkaline phosphatase (ALP) in CSF between camels and cattle.

Table 1: Mean+SD and range of some metabolites, in CSF of Sudanese camels and cattle

Parameters	Number of animal	Camel Mean±SD+ range	Cattle Mean±SD+ range	Sig. Level
Total proteins mg/100ml	30	66.07±0.16 63.3 - 69.2	64.5±0.16 61.0 - 67.2	N S
Albumin mg/100ml	30	26.33±0.12 28 - 24	25.73±0.14 23 - 28	N S
Urea mg/100ml	30	17.93±1.46 16.2 - 21.1	17.97±1.35 16.3 - 20.1	N S
Creatinine mg/100ml	30	1.38±0.11 1.2-1.6	1.17±0.10 1 - 1.4	N S
Glucose mg/100ml	30	60.3±.0.23 48.4-67.5	56.9±.70 44.2—66.8	N S

NS=indicate statistically not significant differences (P>0.05)

Table 2: Mean±SD and range of macro elements and enzymes activity in CSF of Sudanese camels and cattle

Parameters	Number of animal	Camel Mean±Sd	Cattle Mean±Sd	Sig. Level
Ca mg/100ml	30	5.65±0.13 5.5 - 5.9	5.48±0.19 5.1 - 5.8	NS
Mg mg/100ml	30	2.28±0.13[a] 2.1 --2.6	1.49±0.18[b] 1.2 - 1.8	**
K mmol/L	3o	3.53±0.37[a] 2.9 - 4.1	3.09±011 [b] 2.9 - 3.3	*
Na mmol/L	30	121.37±3.38[a] 110 - 127	104.87±8.63[b] 89 - 122	**
ALT U/L	30	21.13±1.59 19.2 - 24.1	20.13±2.05 16 - 24	NS
AST U /L	30	7.37±0.96[a] 6.3 - 9.4	5.5±12[b] 4.3 - 7.3	**
ALP U /L	30	76 ±20 70.2 - 79.5	75.1±2.81 70.5 - 79.6	NS

* indicate statistically significant differences (P<0.05)
NS=indicate statistically not significant differences (P>0.05)

DISCUSSION

This study may be the first to determine such a wide range of cerebrospinal constituent of camel and cattle in Sudan. All the cerebrospinal fluid samples were collected stored and analyzed using the standard procedure.

The data on cerebrospinal fluids total protein, glucose, albumin, urea, and creatinine of camel was comparable with those reported by other researchers. The values of the above CSF parameters obtained in camel and cattle were within the physiological limit described elsewhere. CSF total protein concentration is one of the most sensitive indicators of a pathological process within the central nervous system. The protein concentration determined in the CSF of camel (66.07 mg/dl) and cattle (64.5±0.16 mg/dl) reported in the present study is an agreement with values reported by George, (1996) in sheep (8–70 mg/dl), cattle (23.4– 65.3 mg/dl; Welles *et al.*, 1992), and in the dog and cat (11-55 mg/dl; Hoerlein, 1978: Roberta and Simon, 2006), but was lower than values reported by Kulkarni *et al.*, (2009) in healthy sheep, cow, goat, horse, dog and, cat, calves of Holstein,(Jean,1997) ,and cattle with central nervous system disorder (Bellino *et al.*, 2015).

In this study non significant higher concentration of glucose was found in camel as compare with cattle, (60.3±.0.25 versus 57.9±.70), similar finding has been reported in normal cow, sheep, goat, horse, cat and dog, (Kulkarni *et al.*, 2009), that the concentration of the glucose in CSF is approximately 60-70 % of blood glucose level and ranges from 40-80 mg/100 ml in normal CSF. Moreover, George, (1996) reported similar results in sheep (48–109 mg/dl), cattle (20–40 mg/dl) and goats (24–40 mg/dl), and Hoerlein, (1978) found that the concentration of glucose in CSF of dogs was 61-116 mg/dl. In the present study no difference in albumin concentration was detected among the camel and cattle studied, (26.33±0.12 versus 25.73±0.14), which was lower than that detected in Holstein calves, (Jean, 1997). The concentration of urea in this study was 17.93±1.46 mg/dl and 17.97±1.35 mg/dl, in camel and cattle respectively, which is lower than that reported for camel, (Nazifi and Maliki, 1998), cow (Swarup and Maiti 1991), sheep and goat (Aminlari and Mehran 1988) and horse (Mayhew *etal* 1977). Creatinine concentration in CSF of camel and cattle was 1.38±0.11 mg/dl,and 1.17±0.10 mg/dl respectively. Swarup and Maiti (1991) reported that the concentration of creatinine in CSF of calves was 67.5 pmol litre^{-1}. The normal concentration of creatinine in CSF is approximately two-thirds that of plasma (Kaneko 1989). Comparing the metabolites concentration of in the CSF did not show any variation between the Sudanese camel and cattle; this can be attributed to the fact that the studied animals may have the same homeostatic mechanism which kept a similar concentration of the studied CSF metabolites.

The values of calcium found in the CSF of Sudanese camel and cattle were 5.65±0.13 mg/dl and 5.48±0.19 mg/100ml respectively, which is higher than that reported for cow,(Kaneko,1989: camel (Nazife and Maleiki, 1998), sheep (Vehan,1981) , and for Buffalos (Khadiga *etal*,2005). The study showed that the mean of CSF magnesium was 2.28±0.13 mg/100ml and1.49±0.18 mg/100ml for camel and cattle respectively. The CSF magnesium concentration reported here for Sudanese camel and cattle was higher than that reported in horse, cow and sheep (Kaneko,1989: Mogabi *et al.*, 2000), camel (Nazife and Maleiki, 1998), and Buffalos (Khadiga, 2005). The mean CSF concentration of potassium in Sudanese camel and cattle was3.53±0.37 mmol/L and 3.09±011 mmol/L respectively, which is similar to that reported in Buffalos (Khadiga *etal*, 2005), and higher than that reported for horse, cow and sheep ,(Kaneko,1989),but lower than camel (Nazife and Maleiki, 1998), and Holstein calves, (Jean, 1997). The present study showed that the CSF sodium concentration was 121.37±3.38 mmol/L and 104.87±8.63 mmol/L in camel and cattle respectively. The CSF in Sudanese camel and cattle was lower than that reported for in horse (Mayhew *et al.*, 1977) cow and sheep (Kaneko, 1989), cattle (Mogabi *et al.*, 2000), camel (Nazife and Maleiki, 1998), and, Buffalos (Khadiga, 2005).

The observed macro-mineral concentration values of camel and cattle CSF were within the physiological limit described elsewhere and the variation observed between the results and those from the previous studies may be attributed to difference in breed, nutrition, husbandry, and environment.

CSF enzyme activities of spartate aminotransferase (AST), alanine aminotransferase, (ALT), alkaline

phosphatase (ALP) found in camel in this study fall within the normal range and are in reasonable agreement with the values reported by Kulkarni *etal* , (2009) ,but higher than that reported by Nazifi, and Maleki, (1998) in Iranian camel, llama (Andreasen and Rickard, 1993), sheep and goats (Aminlari and Mehran 1988), and was higher than the value reported for horses (Mayhew *et al*. 1977). The discrepancy between the results of the current study and that of previous researchers work may be due to many factors known to affect the blood constituents such as age of the animals and feed, environmental conditions, the sampling technique and /or inter-laboratory variations. Nevertheless; all the studied parameters were within the normal range; and this is due to the wide range of these parameters in the blood.

CONCLUSION AND RECOMMENDATIONS

In conclusion, higher CSF concentrations of the total proteins, albumin, urea, creatinine and glucose were observed in camel but were not statistically different between camel and cattle, moreover, camel showed significant ($P<0.05$) higher concentration of Ca , Mg, K and Na in CSF than cattle. The values obtained from CSF of Sudanese camel and cattle can serve as reference range for Sudanese camel and cattle and may be form a useful baseline for clinical evaluation studies in camel and cattle.

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