

Dept. of Biomedical Science,  
College of Veterinary Medicine,  
Sudan University of Science and Technology, Sudan.

**SOME BIOCHEMICAL PARAMETERS OF  
CEREBROSPINAL FLUID AND SERUM IN  
CLINICALLY HEALTHY SUDANESE CATTLE**  
(With 2 Tables)

By

**SHADIA A. OMER; S.H. AHMED and A.A. GAMEEL \***

\*Dep. of Pathology, Faculty of Veterinary Medicine,  
University of Khartoum, Sudan.

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**SUMMARY**

This study was undertaken to determine the values of some physiochemical parameters of cerebrospinal fluid (CSF) of healthy Sudanese steers and compare them with their corresponding serum values. The experimental animals were thirty clinically normal steers presented to the Slaughter House of The Animal Production Research Centre at Kuku. Cerebrospinal fluid samples were taken from the cisterna magna and blood was withdrawn from the jugular vein. Some electrolytes, metabolites and enzymes activities were determined in cerebrospinal fluid and serum. The mean values for CSF constituents were as follows; total protein(TP) ( $6.45 \pm 0.03 \text{mg}/100\text{ml}$ ), albumin ( $2.57 \pm 0.02 \text{mg}/100\text{ml}$ ), urea ( $17.97 \pm 0.25 \text{mg}/100\text{ml}$ ), Creatinine ( $1.17 \pm 0.021 \text{mg}/100\text{ml}$ ), glucose ( $47.67 \pm 0.26 \text{mg}/100\text{ml}$ ), Na ( $104.87 \pm 1.57 \text{mmol}/\text{L}$ ), K ( $3.09 \pm 0.03 \text{mmol}/\text{L}$ ), Ca ( $5.48 \pm 0.03 \text{mmol}/\text{L}$ ), and Mg ( $1.49 \pm 0.03 \text{mg}/100\text{ml}$ ), and the activities of the enzymes ALP ( $75.1 \pm 0.51 \text{ U}/\text{L}$ ), AST ( $20.13 \pm 0.37 \text{ U}/\text{L}$ ) and ALT ( $5.50 \pm 0.18 \text{ U}/\text{L}$ ) and their corresponding values in serum were ( $7920 \pm 0.03 \text{mg}/100\text{ml}$ ) ( $3920 \pm 0.03 \text{mg}/100\text{ml}$ ); ( $27.27 \pm 0.26 \text{mg}/100\text{ml}$ ); ( $1.36 \pm 0.02 \text{g}/\text{ml}$ ); ( $48.18 \pm 0.28 \text{mg}/100\text{ml}$ ); ( $113.20 \pm 0.99 \text{ mmol}/\text{L}$ ); ( $3.66 \pm 0.03 \text{ mmol}/\text{L}$ ); ( $7.72 \pm 0.02 \text{ mmol}/\text{L}$ ); ( $47.57 \pm 0.48 \text{ }\mu\text{g}/100\text{ml}$ ), ( $1.28 \pm 0.02 \text{mg}/100\text{ml}$ ); ( $84.08 \pm 0.29 \text{ U}/\text{L}$ ); ( $30.73 \pm 0.61 \text{ U}/\text{L}$ ) and ( $10.17 \pm 0.44 \text{ U}/\text{L}$ ) respectively. The mean values of all the studied parameters, except of Mg, were significantly lower in CSF than those in serum. The obtained results were discussed with previous reports in cattle

and other domestic animals. The values reported in this study can add to the reference value for Sudanese cattle.

**Key words:** *Sudanese cattle, cerebrospinal fluid, Serum, biochemical profile*

## INTRODUCTION

Cerebrospinal fluid (CSF) is a clear ultrafiltrate of plasma, mainly produced by the choroid plexus and ependymal lining cells of the brain ventricles. It probably serves as a nutritive medium for the brain and spinal cord, provides mechanical support, regulates the chemical environment of the brain and acts as vehicle for transport of biologically active compounds (Kaneko *et al.*, 1997).

CSF composition is strongly dependent on that of blood and is a reflection of the blood plasma constituents. Its composition subjects various environmental, physiological and pathological conditions (Al Sagair *et al.*, 2005 and Wells *et al.*, 1992). Normal values of CSF have been reported for many animal species including cattle, sheep, camels, and companion animals, (Stocker *et al.*, 2002; Ameri and Mousavian, 2007; Ahmed, *et al.*, 2009; Di Terlizzi and Platt, 2009).

The examination of the CSF has become an integral part of the assessment of the critically ill neurological or neurosurgical people (Venkatesh *et al.*, 2002). Also changes in CSF constituents related to CNS disorders, have been investigated in cattle (Tyler *et al.*, 1993; Braun *et al.*, 2003; Stoko *et al.*, 2009), horses (Sofaly *et al.*, 2002) and dogs (Garma and Tyler, 1999)

In the Sudan, there seems to be lack of information on normal values of CSF constituents in animals and standard values set elsewhere are usually consulted in neurological investigations. The objective of this study was to establish normal range values for CSF for Sudanese cattle in relation to serum which may be useful in clinical investigations of CNS diseases and in other pathophysiological studies.

## MATERIALS and METHODS

### **Animals:**

Serum and cerebrospinal fluid samples were taken from, thirty Sudanese (Baggara) steers, 2-3 years old and weighing between 260 and 300 kg. The animals were designated healthy based on the results of anti mortem examination, before slaughter at the Animal Production Research Centre, Hilat Kuku.

## **Sample Collection**

### **1. CSF 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. Samples were processed within 2 hrs after collection for measurement of glucose level and the rest were stored at -20°C pending analysis.

### **2. Blood collection:**

Blood samples were collected from the jugular vein in plain vacutainers. Blood for determination of serum glucose concentration was collected in vials containing sodium fluoride. Serum was harvested by centrifugation of the blood at 2500 rpm for 15 minutes. Non-hemolyzed clear serum samples were stored at -20°C pending analysis.

### **3. Laboratory Analysis:**

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

### **Statistical analysis:**

The data were presented as means, standard error of the means (SEM) and range values. Comparison between the means was performed by student's t-test as described by Gomez and Gomez, (1984).

## **RESULTS**

No pathological changes were seen at the postmortem examination in the animals from which blood and CSF were obtained. Cerebrospinal fluid was watery, clear and colorless. Mean (+SEM) and range of the studied parameters in CSF and serum samples are presented in Tables (1 and 2).

Total proteins and albumin concentrations in serum were significantly higher ( $P < 0.01$ ) than in the CSF. Urea, creatinine and glucose concentrations in CSF were insignificantly lower than in serum. The mean Ca, K, and Na concentrations in CSF were significantly lower than in serum, ( $P < 0.05$ ), while there was a non-significant increase in the level of Mg in the CSF than in the serum. The activities of the enzymes ALT, AST and ALP were significantly higher ( $P < 0.05$ ) in serum than in CSF.

**Table 1:** Means +SEM and ranges of Non-electrolytes, in CSF and Serum of Sudanese Cattle (No=30).

Parameters	CSF Mean±SEM+ ranges	Serum Mean±SEM+ ranges	Significance level
Total proteins mg/100ml	6.45±0.02 6.10-6.70	7.92±0.03 7.70-8.40	HS
Albumin mg/100ml	2.57±0.03 2.30-2.80	3.92±0.03 3.70-4.30	HS
Urea mg/100ml	17.97±0.25 16.00-20.00	27.27±0.26 25.00-30.00	NS
Creatinine mg/100ml	1.17 ±0.02 1.00-1.40	1.36±0.02 1.20-1.60	NS
Glucose mg/100ml	47.67±0.26 45.00-51.00	48.18±0.28 46.00-51.00	NS

HS: Sig. at P>0.01

NS: Not Sig.

**Table 2:** Mean +SEM and ranges of macro minerals and enzymes activity in CSF and Serum of Sudanese Cattle (No=30).

Parameters	CSF Mean±SEM+ Ranges	Serum Mean±SEM+ Ranges	Significance Level
Ca mg/100ml	5.48±0.03 5.10-5.80	7.72±0.02 7.50-7.90	S
Mg mg/100ml	1.49±0.03 1.25-1.80	1.28±0.02 1.10-1.50	NS
K mmol/L	3.09±0.03 2.90-3.30	3.66±0.03 3.20-3.90	S
Na mmol/L	104.87±1.57 89.00-122.00	113.20±0.99 103.00-121.00	S
AST U/L	20.13±0.37 16.00-24.00	30.73±0.61 20.00-35.00	S
ALT U/L	5.50±0.18 4.00-7.00	10.17±0.44 1.00-14.00	S
ALP U/L	75.1 ±0.51 70.00-79.00	84.08±0.29 81.00-87.00	S

S: Sig. at P>0.05

NS: Not Sig.

## DISCUSSION

CSF proteins are determined as an index of the integrity of the blood-brain barrier. In the present study CSF concentrations of TP was

Hiroshi and Miyuki (2001). The mean TP value in CSF reported here is within the range of Scott (1990); and are far lower than the values given for calves (St Jean *et al.*, 1997) and for adult cows (Soliman and El Amrousi, 2010). The present TP values are comparable with those reported in Sudanese camel, (Ahmed *et al.*, 2009); and are higher than that found in adult llamas (Welles *et al.*, 1994) Iranian dromedary camels (Nazifi and Maleki., 1998) sheep (Ameri and Mousavian, 2007) and rabbits (Jass *et al.*, 2008). CSF protein concentrations may vary with age and site of collection. In, horses (Rossdale *et al.*, 1982), cattle (Stocker *et al.*, 2002) and camels (Al-Sagair *et al.*, 2005) CSF protein concentrations was observed to vary with age. Higher protein levels were also reported in lumbosacral CSF when compared to atlantooccipital CSF, (Andrews *et al.*, 1994).

The CSF creatinine, and urea, concentration reported are insignificantly lower than those in serum, and this accord with the finding of Hiroshi and Miyuki, (2001) in cattle. The mean urea concentration in CSF obtained in this study is higher than those reported for Holstein calves (St Jean *et al.*, 1997) and is comparable with the values obtained for sheep and goats (Kaneko, 1997). In the present study CSF creatinine concentration is higher than the given values for Iranian camels (Nazifi and Maleki, 1998) and Sudanese camels (Ahmed *et al.*, 2009).

The CSF glucose concentration reported for the Sudanese cattle in this study is higher than the findings of Welles *et al.* (1992) in dairy and beef cattle, (Ahmed *et al.*, 2009) in Sudanese camels. Higher CSF glucose values than of the current work are reported in Holstein calves (St Jean *et al.*, 1997), camels (Al-Sagair *et al.*, 2005); and sheep (Ameri and Mousavian, 2007). This may be due to age and breed difference. Kaneko *et al.* (1997) reported that the concentration of CSF glucose depends upon the blood glucose concentration, the rate of glucose transport into the CSF, and the metabolic rate of the central nervous system; so this may explain the variation in the CSF glucose concentration between the present work and the other studies.

In this study, most serum electrolytes levels are higher than CSF electrolytes concentration. The level of some CSF electrolytes concentration is determined in view of their importance for diagnosis of salt poisoning and for assessment of fluid therapy (Welles *et al.*, 1992). Sodium and calcium are particularly important in the establishment of the thermal set point in the hypothalamus (Myers and Veale, 1970). Potassium and Na concentration in CSF are lower than their corresponding values in serum which is in line with other reports (Welles *et al.*, 1992; Duncan *et al.*, 1994; Jean *et al.*, 1997; Ahmed *et al.*, 2009). However, the CSF concentration of K, Na, and Ca in this study is comparable to the value

concentration of K, Na, and Ca in this study is comparable to the value reported in adult cattle (Fankhauser 1962; Welles *et al.*, 1992), buffaloes (Khadjeh *et al.*, 2005) but higher than those reported for horse, sheep and goat (Kaneko, 1989). The CSF magnesium concentration in this study is higher than that in serum and this agrees with the finding of Khadjeh *et al.* (2005). Comparable CSF magnesium mean values to the current work were obtained in buffaloes (Khadjeh *et al.*, 2005), and higher values were reported in cows, horses and sheep (Kaneko, 1989). The activities of the enzymes (ALP, ALT, AST) in the CSF are lower than those of the serum which is in the line with the observation of Ahmed *et al.* (2009) in Sudanese camels; but are much higher than those reported in Iranian camels (Nazifi and Malek, 1998).

The variations observed in the values obtained in this study when compared with those of other researchers can be attributed to differences in animal breed, age, species (Stocker *et al.*, 2000). Development of the brain blood barrier, site of sampling, time of analysis after sampling, storage conditions (Andrews *et al.*, 1994; Fry *et al.*, 2006) and or techniques used for biochemical analysis.

The present results may be used, together with other similar findings as reference values for serum and CSF constituents in Sudanese cattle.

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