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تغيرات الالكتروليتات فى سوائل جسم الأبقار السليمة والمصابة ببعـض الأمراض

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استهدفت هذه الدراسة تقدير مستوى أيونات الصوديوم والكلوريد والبوتاسيوم والكالسيوم فـى سائل الكرش ومصل الدم والبول للأبقار الالمانية السليمة اكلينيكيا وتلك المصابة بأمراض القلب والكبد والكلى بالاضافة الى مناقشة العلاقة بين تغير مستوى هذه العناصر فى مصل الدم لهذه الحيوانات والمستوى المقابل فى سائل الكرش والبول .

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MAJOR ELECTROLYTE ELEMENTS IN THE BOVINE BODY FLUIDS IN HEALTH AND SOME DISEASED CONDITION

(With 4 Tables & 4 Figs.)

By

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SUMMARY

Ruminal, blood serum and urinary sodium, chloride, potassium and calcium levels were determined in clinically healthy black spotted cows, and those with heart, liver and kidney diseases. Moreover the correlation between studied electrolytes in blood serum and ruminal juice and urine was discussed.

INTRODUCTION

The role of electrolytes in the animal body is diverse, as there are almost no metabolic processes that are not affected by or dependent upon electrolytes. This arroused the interest of many scientists to trace body fluid electrolytes changes under various physiological factors such as type of ration (BENNINK, et al., 1978) lactation state (SEIDEL & SCHROTER, 1970), species (SELLERS & DOBSON, 1960; BAILY, 1961 and PHILLIPS, 1970) and age of the animal (VERZGULA, 1963; CARTER, 1969 and BOEHNCKE, et al., 1976). The influence of various animal diseased conditions on the body electrolytes was aimed by many investigators. Most of the work was directed towards the influence of digestive diseases, especially enteritis on body fluid electrolytes (McSHERRY & GRINYER, 1954; ROY, et al., 1959; DALTON, et al., 1965; OPLISTIL, 1968 a&b; FISHER & DE LA FUENTE, 1972; MOTTELIB, 1972; TENNANT, et al., 1972; FISCHER & BUTTE, 1974; SCHWEIZER, 1976 and HAFEZ, 1979).

Little interest was directed to the influence of other systemic disturbances as respiratory ones on animal body fluid electrolytes (SCHOTMAN, 1971). The influence of heart, liver or kidney diseases on animal body fluids electrolytes was poorily discussed. Furthermore nearly most, if not all studies, on electrolyte status in animal body fluids either in health or disease, are directed to blood electrolytes (CHRISTENSEN, 1969; BAR, et al., 1970; EHRENTRAUTT, et al., 1970; SCHOTMAN, 1971 and GREEN, 1975). Ruminal juice electrolyte state was studied by less few authers. Most of this work was directed to rather healthy animals under various physiological factors as diet, species, time of sampling or animal age (LAMBILA, 1965; FENNER, et al., 1969; POUTIAINEN, 1970 a&b and ABDEL SALAM, 1981).

Urinary electrolytes changes under physiological or pathological conditions were pourily discussed (JONAS, 1971; HARRY, 1973 and ROSENBERGER, 1977).

Meanwhile the correlation between ruminal juice, serum and urine electrolytes in health and disease were not fully investigated (HAFEZ, 1979).

It is the aim of the present study to follow up serum, ruminal juice and urinary electrolyte changes in heart, liver and kidney diseases in cattle. Furthermore the correlation between rumen, blood serum and urine electrolyte changes in healthy and abovementioned diseases was also traced.

MATERIAL and METHODS

This study was carried out on 65 black spoted cows, 4-6 years old at Veterinary High School Clinic for Cattle Diseases, Hannover, Western Germany. These animals manifested by the clinical and laboratory findings - heart (18 cases), liver (30 cases) and kidney diseases (17 cases). Another 20 apparently healthy cows were served as control.

All animals belonged to different farms around the city of Hannover. The rations of the animals were hay and concentrates as taken from the history. Drinking water was ad libtum. Ruminal juice, blood and urine samples were collected nearly two hours after morning feed, directly before treatment. Ruminal juice samples were collected with the SORENSEN & SCHAMBYE (1955) apparatus and centrifuged at 3000 r.p.m. for 10 minutes. The supernatant fluid was separated and directly analysed. Blood samples were taken from the jugular vein into clean dry centrifuge tubes and allowed to stand 30 minutes at 37°C until clotted. The serum was then separated by centrifugation at 3000 r.p.m. for about 20 minutes and frozen for later analysis. Urine samples were obtained at the same time from each animal by clean sterile catheters and then analysed. Sodium and potassium concentration in rumenal fluid, serum and urine were measured by flame photometer (Lange/Berlin, standard model) based on the method of HERRMANN & ALKEMADE (1960). Chloride concentrations in ruminal fluid, serum and urine were determined by the Chlor-O-Counter (Marius - Kronberg/Tauns). Calcium concentrations in these fluids were measured by atomic absorption spectrophotometer (3000 Southern Analytical, Camberg/England).

Conventional statistical methods were used to obtain the mean, standard deviations and range (SNEDECOR, 1956). The t-Test was also done to provide the degree of probability for significance against control group.

RESULTS

Electrolyte concentration in body fluids under the present diseased condition:

From the table (1) it appeared that there is a general decrease in serum sodium concentration in diseased animals as compared with the control ones. Values in all diseased groups were not greatly varied from each other. Sodium concentration in ruminal samples (table 1) behaved similarily. The level of sodium in urine of all diseased groups was significantly lower than the control ones. With regard to serum choride level in examined animals, it was recorded that its levels was generally the same as in control group (table 2 & Fig. 2). Ruminal juice chloride concentration, on the other hand, was significantly increased in all diseased conditions than the control animals. Maximum increase was recorded in liver diseased group. From table (2) it appeared that the present diseased conditions induced significant ($P<0.001$) decrease in urinary chloride concentration. Liver diseases was among the conditions inducing severe lowering in urinary chloride concentration. Potassium concentration in both ruminal juice and blood serum was not variably changed under the influence of the present diseased conditions (table 3). Urinary potassium level behaved similarly as the chloride ions.

The present data revealed that heart diseases have had no influence on serum calcium level while these diseased condition resulted in an increased urinary calcium level. Kidney diseases lowered significantly serum calcium level while it have had no significant effect on urinary calcium levels in comparison with control group. Liver diseases significantly lowered serum calcium level accumpanied by increased urinary calcium level. In ruminal fluid the calcium did not influenced by this present diseased condition (table 4).

Relation between ruminal juice, serum and urine electrolytes concentration in the present groups:

Sodium:

High sodium concentration was evident in blood serum of healthy cows followed by urine while the ruminal juice contained the lowest levels of sodium. This pattern of sodium distribution in body fluids in healthy animals was disturbed in the present diseased conditions. Thus in all diseased animals ruminal juice sodium concentration preceeded that in the urine.

Chloride:

In all animals whether healthy, heart, liver or kidney diseased, the highest chloride level was recorded in serum followed by urine and lastly by ruminal juice.

Potassium:

From the figure (3) it appeared that in all examined cases, with exception of the healthy conditions, urinary potassium level was high while serum potassium values were the lowest figures. Ruminal fluid occupied an intermediate position.

Calcium:

High levels of calcium were always recorded in ruminal juice of either healthy or diseased animal groups while the lowest values were detected in the urine. Serum calcium level lies in between the values of ruminal juice and urine Fig. (4).

DISCUSSION

Ruminal juice, blood serum and urine electrolyte changes in diseased condition.

Sodium:

In all diseased animal groups (heart, liver and kidney) there was a significant lowering in sodium concentration in all body fluids, in comparison with healthy animals (Table 1 & Fig. 1). A decrease of serum sodium concentration occurs most frequently because of excessive sodium loss. Sodium loss is most likely to occur form gastrointestinal tract through diarrhoea or vomiting or in renal diseases in which the sodium conservation mechanism is operating deficiently because of tubular damage (COLES, 1980). Meanwhile chronic nephritis induced excessive urinary sodium loss in human (BARON, 1973). In severe heart failure with secondary renal impairment there may be retention of sodium and water and a high plasma and extracellular fluid sodium value. Sodium retention is always more likely to occur in patients with heart, renal failure and hypoprotenemia (SODEMAN & SODEMAN, 1968; BARON, 1973 and COLES, 1980).

As the bulk of sodium entering the rumen comes from the saliva (LAMPILA, 1965; FENNER, et al., 1969), the marked fall of sodium concentration in the rumen fluid, in the present diseased conditions, suggested changes in the saliva. So although it appears from table (1) that all diseased condition induced lowered sodium concentration in both rumen, blood serum and urine in comparison with control group, yet if the calculation of sodium was based on rumen sodium concentration in each disease the following fact will be revelant. Elevation of sodium level in blood serum in diseased condition was a natural result of lowered sodium excretion by the urine.

Chloride:

As shown in table (2 & Fig. 2) the present diseased condition had no influence on serum chloride level. This could be based on the fact that the concentration of chloride in rumen was significantly increased in all diseased condition in comparison with the control group. Such condition was accompanied by lowered urinary chloride excretion. This lastly leaded to maintain rather similar serum chloride concentration irrespective of the diseased condition (HAFEZ, 1979 and HAFEZ & MOTTELIB, 1980). Chloride alterations generally follow these of sodium, as chloride is absorped, excreted and distributed passively according to electrical gradients established by active transport of sodium (TASKER, 1971). The concentration of chloride, however, is subject to somewhat greater variations than is that of sodium, since to a certain extent the organism can exchange chloride from other ions with the framework of a normal osmolar concentration especially for the other major anion of the plasma (OSER, 1979). HAFEZ, (1979) and HAFEZ & MOTTELIB, (1980) reported that following enteritis or abomasal disorders in cattle, ruminal fluid chloride level was increased while the urine level was lowered and serum chloride level in such cases was unchanged.

Potassium:

The study revealed that normal levels of potassium in both ruminal fluid and serum accumpanies cases of heart, liver and kidney diseases. Urinary potassium level on the other hand was significantly decreased following the present diseased condition (table 3 & Fig. 3). HAFEZ, (1979) established similar phenomena in enteric cattle. The auther attributed the normal potassium level in ruminal juice following enteritis in cattle, to wide range of the level of such electrolyte in animals. Serum level of potassium may not, in the openion of COLES (1980) reflect the true status of body potassium concentration. This occurs because most body potassium is in ICF and there is no constancy of relationship between ECF and ICF potassium. BARON (1973) reported that excessive potassium loss may occur in chronic pyelonephritis with many tubular disease.

Calcium:

Serum calcium concentration insignificantly decreased under the influence of heart diseases while its concentration in urine was significantly increased. Kidney and liver diseases significantly lowered serum calcium level. Urinary calcium level was elevated in animals with liver diseases than in healthy ones. Lowered urinary calcium level was recorded in kidney diseases. Decreases in total serum calcium concentration may follow vitamin D deficiency, hypoparathyrodism, parturient paresis and other diseases while hypercalcaemia occurs in hypervitaminosis D, primary hyperparathyroidism, bone neoplasia and hyperproteinaemia. The daily output of calcium in the urine depends generally upon the nature of the diet. The percentage of calcium present in the urine at any one time is no dependable index, as to the absorption of this element since it may be again excreted into intestine after absorption. Furthermore the acidity or alkalinity of the intestinal lumen, and the presence of substances such as phosphate and fatty acids, which insoluble calcium saltrs, determine to a considerable extent, the relation output of calcium in faeces and urine. High excretion of calcium is observed in some diseases of the bones e.g. osteomalacia. In others, as in rickets the urinary excretion may be very low.

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Table (1): Sodium concentration (mmol/L) in ruminal juice, blood serum and urine in healthy and diseased cows

no. of Cases	Condition	Ruminal Juice	Blood Serum	Urine
20	healthy	116.30±11.00	135.82±12.25	127.00±67.80
		(98.50-137.40)	(118.70-148.80)	(25.8-237.50)
18	with heart	§§ 95.68±31.88	§§§ 122.6±12.25	§§§ 27.39.±20.96
	diseases	(13.5-152.20)	(105.1-142.00)	(0.60-50.50)
30	with liver	§§§ 88.83±25.61	§§§ 124.16±15.20	§§§ 37.99±35.04
	diseases	(15.10-143.50)	(107.10-147.80)	(2.50-119.60)
17	with kidney	§§§ 86.97±1.32	§ 126.00±9.30	§§§ 25.15±13.33
	diseases	(49.80±123.20)	(108.70-139.10)	(5.00-45.30)

§ P ∠ 0.05. §§ P ∠ 0.01, §§§ P ∠ 0.001

Table (2): Chloride concentration (mmol/L) in ruminal juice, blood serum and urine in healthy and diseased cows

no. of cases	Condition	Ruminal Juice	Blood serum	Urine
20	healthy	16,85±4.21	94.80±4.30	89.00±41.30
		(9.30-25.40)	(88.60-104.50)	(35.80-223.40)
18	with heart	§§§ 27.13±10.71	93.43±6.62	§§§ 42.54±29.13
	diseases	(11.50-51.90)	(73.20-102.00)	(0.60-92.00)
30	with liver	§§§ 30.84±9.41	94.31±5.24	§§§ 28.36±40.31
	diseases	(19.10-69.00)	(75.80±101.50)	(0.60-168.10)
17	with kidney	§§ 25.09±9.53	95.16±5.87	§§§ 38.69±43.03
	diseases	(12.90-45.50)	(81.80-103.40)	(1.20-114.90)

§§ P ∠ 0.01, §§§ P ∠ 0.001

Table (3): Calcium cincentration (mmol/l) in ruminal juice, blood serum and urine in healthy and diseased cows

no. of cases	Condition	Ruminal Juice	Blood serum	Urine
20	healthy	21.90± 7.32	3.94±0.40	144.50±42.70
		(3.50-34.20)	(3.12-4.82)	(75.90-263.80)
18	with heart diseases	24.47±11.51 (10.40-54.50)	3.71±0.83 (2.30-6.00)	101.59±67.47 §§ (32.00-275.20)
30	with liver	24.25±9.73	3.68±0.77	69.93±54.51 §§§
	diseases	(11.20-40.30)	(2.30-5.10)	(13.50-253.20)
17	with kidney	23.09±8.31	3.85±0.72	69.55±45.88 §§§
	diseases	(10.40-40.30)	(2.60-5.10)	(16.00-163.70)

§§ P ∠ 0.01, §§§ P ∠ 0.001

Table (4): Calcium concentration (mmol/l) in ruminal juice, blood serum and urine in healthy and diseased cows

no. of cases	Condition	Ruminal Juice	Blood serum	Urine
20	healthy	2.75±1.41 (1.00-7.80)	2.43±0.16 (2.15-2.74)	0.65±0.67 (0.02-2.10)
18	with heart diseases	2.48±1.30 (0.80-5.20)	2.37±0.36 (1.90-3.30)	2.31±3.03 § (0.10-13.20)
30	with liver diseases	2.17±1.06 (0.30-4.50)	2.16±0.23 §§§ (1.50-2.60)	1.67±2.89 (0.10-13.50)
17	with kidney diseases	2.19±1.09 (1.10-5.20)	2.05±0.38 §§§ (1.50-2.90)	0.32±0.28 (0.10-1.10)

§ P $\angle$ 0.05, §§§ P $\angle$ 0.001

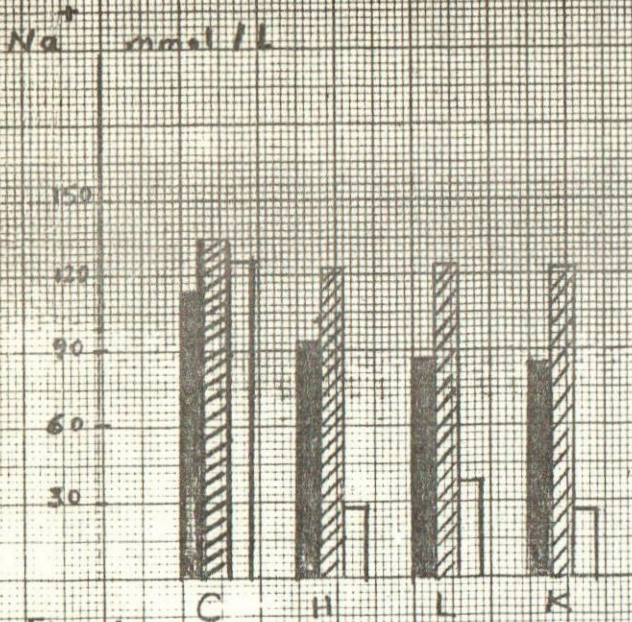
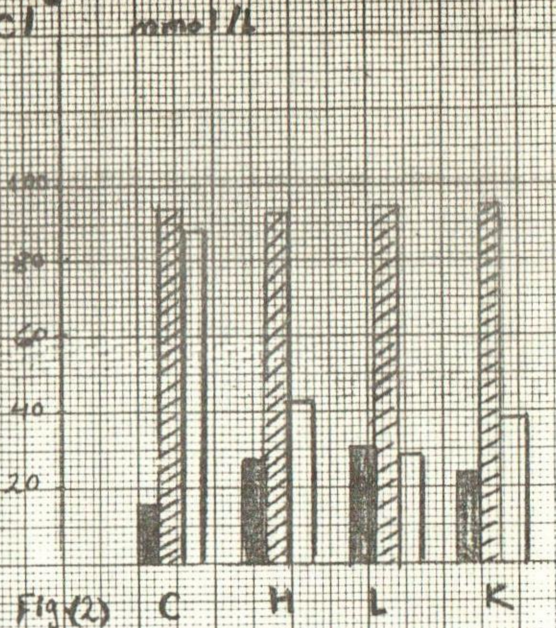


Fig.(1)

C = Control
H = Heart disease
L = Liver disease
K = Kidney disease

■ Ruminal fluid
▨ Blood serum
□ Urine



Fig(2)

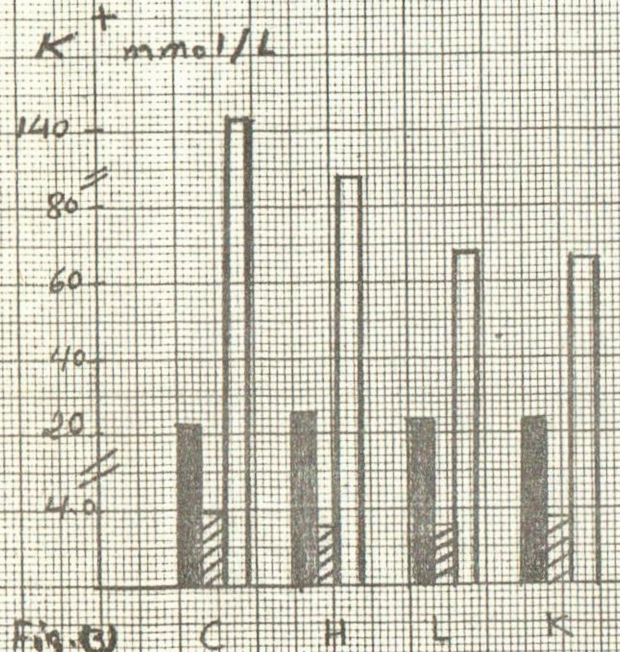


Fig.(3)

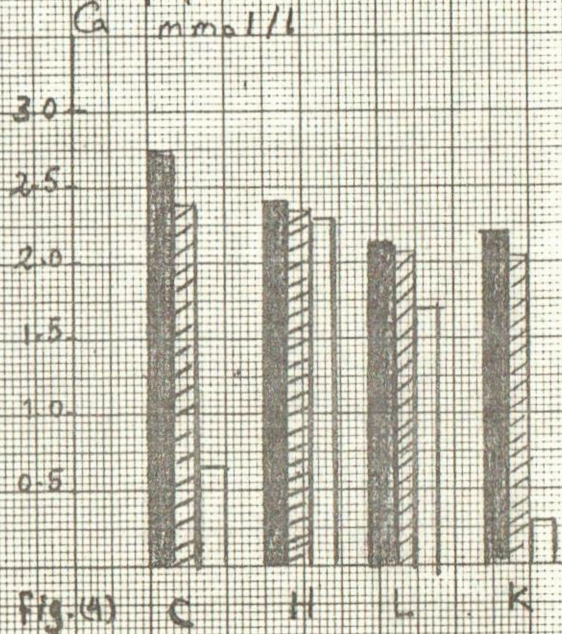


Fig.(4)