

The concentration of some of the inorganic constituents in the plasma of healthy Ayrshire cattle

By E. W. FISHER

Veterinary School, University of Glasgow

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The abnormal cannot be detected before the normal is known. The study of nutrition and of disease demands a yardstick which we call normal. Definitive standards have still to be achieved for the normal concentrations of some of the inorganic constituents of bovine plasma.

Since the work of Little & Wright (1925) on hypocalcaemia and of Sjollem & Seekles (1929) on hypomagnesaemia much information has been gathered about the normal concentrations of calcium, magnesium and phosphorus in the serum of dairy cattle. There is also in the literature information on the concentration of some of the other inorganic constituents of the plasma or serum of cattle. These values are summarized in Table 1. For comparison the concentrations of calcium and magnesium given in many of the papers cited have been converted from mg/100 ml into m-equiv./l.

It will be observed from the table that few authors have made determinations of the concentrations of sodium, potassium, calcium, magnesium and chloride of plasma.

This paper gives the results of the analysis of the plasma of healthy Ayrshire dairy cattle and calves for sodium, potassium, magnesium, calcium and chloride.

EXPERIMENTAL

Animals and sampling

The adult animals from which the blood samples were taken were all normal members of the University herd. They were either dry cows or cows in various stages of lactation. The lactating cows were sampled immediately after their morning milking. Dry cows present in the byre were sampled at the same time. The milking cows were out at grass during the spring and summer and received a production ration of a mixture of oats, beans and a proprietary cattle cake. During the winter, when they were housed, they received silage, roots, a small quantity of hay and the same production ration. Mineral licks were provided in the byre. At all times the cows had free access to water.

The calves were bled after their morning feed. They were normal animals separated from their mothers within the 1st week of life. Thereafter they were housed in individual pens and bucket-fed with Ostermilk (Glaxo Laboratories Ltd) (1 lb/gal water), the ration being 3–4 pints twice daily. At 3 weeks of age the calves were given hay to pick at, and at 4 weeks the Ostermilk was decreased and calf-weaner nuts were

introduced. By the time the calves were 5 weeks old they were completely weaned and on a diet of calf-weaner nuts, hay and water *ad lib*. A variety of antibiotic supplements was given prophylactically. Diarrhoea occurred in some calves but no values for plasma samples from diarrhoeic animals have been included.

Table 1. *Summary of the results of other authors for the concentrations in m-equiv./l. of some of the inorganic constituents in the plasma of cattle*

Reference	Cl ⁻	Na ⁺	K ⁺	Ca ²⁺	Mg ²⁺	Total cation
Anderson, Gayley & Pratt (1930)	—	—	—	6.3 s (5-8)	—	—
Brown (1946)	108 s	—	—	—	—	—
Craige (1947)	99 s (90-109)	—	—	4.5 s (3.6-5.1)	—	—
Craige, Johnson & Blackburn (1949) (three cows studied over parturition)	108-89 p 104-96 p 100-95 p	—	—	—	—	—
Dale, Goberdhan & Brody (1954)	—	162 p	5.1 p	7.5 p	3.2 p	177.8
Dukes (1947)	—	—	—	4.5-6 s	—	—
Duncan, Huffman & Tobin (1939)	97.3 p (93-105)	—	—	5.3 p (4.7-5.9)	2.4 p (1.6-3.1)	—
Evans & Phillipson (1957)	—	140 p (139-144)	4.5 p (4.2-4.6)	—	—	—
Godden & Allcroft (1932)	93 s (85-98)	—	—	5.0 s (4.0-5.8)	—	—
Lengemann, Aines & Smith (1952)	104.2 p (96.6-110)	—	—	—	—	—
McSherry & Grinyer (1954)						
Eighty-six adults	103.7 ± 3.5 s	142 ± 5.0 s	4.85 ± 0.47 s	5.42 ± 0.34 s	—	—
Twenty calves	103.0 ± 2.5 s	142 ± 4.0 s	5.25 ± 0.54 s	5.08 ± 0.22 s	—	—
Reihart (1939)	—	155 s (151-165)	6.3 s (6.1-6.4)	5.7 s (5.5-5.8)	1.6 s (1.5-1.8)	—
Sampson & Hayden (1935)	—	—	—	5.6 s (4.6-6.2)	—	—
Sellers & Roepke (1951 a, b)	103 p	144 p (139-146)	4.0 p (3.9-4.4)	4.9 p	1.8 p	154.7
Spector (1958)	104 s (97-111)	142 s (132-152)	4.8 s (3.9-5.8)	5.4 s (4.7-6.1)	2.0 s (0.8-2.4)	154.2
Ward, Blosser, Adams & Crilly (1953)	98 s (90-107)	—	—	4.7 s (3.8-5.3)	—	—

s, serum; p, plasma.

The blood samples were obtained by direct puncture of the brachial artery at the root of the neck (Fisher, 1956). This method of obtaining blood samples from cattle has been found to cause less excitement than the conventional puncture of the jugular or mammary vein. Arterial blood is more consistent in composition than venous blood, which may differ between different areas of the body. The blood samples were collected under mineral oil in heparinized centrifuge tubes, which were then sealed with soft rubber bungs. The samples were centrifuged as soon as possible at room temperature and the plasma was separated immediately and placed in clean Pyrex tubes for subsequent analysis.

Biochemical methods

Plasma sodium and plasma potassium were determined with an EEL flame photometer. Plasma calcium was determined by the method of Clark & Collip (1925), plasma magnesium by the titan yellow method as modified by Neely & Neill (1956), and plasma chloride by the method of Schales & Schales (1941).

RESULTS

The results obtained are given in Tables 2 and 3. In Table 2 the figures given for total cation were obtained by addition of the mean values of the individual cations.

Table 2. Mean values with standard deviations and the standard error of the difference between adult and calf means of some of the inorganic constituents in the plasma of Ayrshire cattle

Constituent	Adult animals			Calves			Difference between means (m-equiv./l.)
	No.	Concentration		No.	Concentration		
		m-equiv./l.	mg/100 ml		m-equiv./l.	mg/100 ml	
Sodium	94	142.2 ± 2.0	327	65	141.8 ± 3.5	326	0.4 ± 0.5
Potassium	92	4.4 ± 0.3	17.2	59	5.1 ± 0.4	19.9	0.7 ± 0.2
Calcium	94	5.0 ± 0.6	10	22	4.9 ± 0.2	9.8	0.1 ± 0.07
Magnesium	57	1.46 ± 0.4	1.75	29	1.14 ± 0.3	1.37	0.32 ± 0.07
Total cation		153			152.9		
Chloride	140	103.3 ± 5.0	367	59	100.3 ± 3.5	356	3.0 ± 0.4

Table 3. Mean values with standard deviations for the magnesium concentration in the plasma of pregnant, non-pregnant, lactating and dry Ayrshire cows and of calves

Cows	No. of animals	Mean magnesium concentration (m-equiv./l.)	Standard deviation
Lactating: Non-pregnant	28	1.34	± 0.33
Pregnant	25	1.57	
Dry: Non-pregnant	None		
Pregnant	4	1.59	
Calves	29	1.14	

DISCUSSION

A strict comparison of values in Tables 1 and 2 is not possible, since the results in Table 1 are for samples obtained from venous blood, whereas those in Table 2 are for samples obtained from arterial blood. Moreover, few authors state how the blood was obtained or what precautions were taken to prevent autolysis or diffusion from the red cells into plasma of anions and cations or diffusion from plasma into the cells. However, with the exception of sodium concentrations given by some authors, the results in this investigation are similar to those found by others (Table 1).

It will be observed from Table 2 that significant differences exist between the potassium and chloride concentrations of cows and calves. It will be observed from Tables 2

and 3 that a highly significant difference exists between the magnesium concentration in the plasma of cows and calves. Significant differences were not detected for any other constituent in the plasma of lactating compared with dry cows or of pregnant compared with non-pregnant cows with the exception of magnesium for which a highly significant difference was found between the concentration in the plasma of pregnant lactating cows and in that of non-pregnant lactating cows. There was, however, no significant difference between the magnesium concentration in the plasma of pregnant lactating and of pregnant dry cows.

SUMMARY

1. Plasma derived from arterial blood of Ayrshire cows and calves was analyzed for sodium, potassium, calcium, magnesium and chloride.
2. The mean concentrations in the plasma of adult cows were: sodium 142.2, potassium 4.4, calcium 5.0, magnesium 1.46 and chloride 103.3 m-equiv./l.
3. The plasma of the calves showed a significantly higher concentration of potassium, 5.1 m-equiv./l., a significantly lower concentration of chloride, 100.3 m-equiv./l., and a significantly lower concentration of magnesium, 1.14 m-equiv./l., than that of the cows.
4. Significant differences were not detected for any constituent in the plasma of lactating compared with dry cows or of pregnant compared with non-pregnant cows, with the exception of magnesium, for which a highly significant difference was found between the concentration in the plasma of pregnant lactating cows and in that of non-pregnant lactating cows.

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