

A STUDY OF THE WATER-SOLUBLE PHOSPHATE CONCENTRATION
OF THE RUMINAL CONTENTS IN NORMAL AND
PHOSPHORUS DEFICIENT ANIMALS.

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INTRODUCTION.

Following their work on "Wasting Disease" (Skravelsjuka), Hoflund and Hedsrom (1948), postulated that the presence of water-soluble phosphate in the ruminal ingesta was essential for the maintenance of a normal flora. They further stated that, on a phosphorus deficient diet, it was necessary to supplement with water-soluble phosphate in order to maintain ruminal digestion. Their theory was, therefore, that non-water-soluble phosphates could be given for the benefit of the animal but water-soluble phosphate must also be given for the maintenance of the ruminal flora.

On the other hand, Brunnich and Winks (1931) had shown that the phosphorus concentration in the rumen of sheep was three times as great as could be accounted for by the amount in the food ingested. Watson (1933) also reported that large amounts of water-soluble phosphate were secreted in the saliva of sheep. This was later confirmed by McDougall (1948), who found that the concentration of inorganic phosphorus in sheep's saliva was, on the average, fifteen times as great as in the serum.

It, therefore, appeared that in the sheep at least, the salivary glands excreted water-soluble phosphate with the apparent function of maintaining a high phosphorus content of the rumen irrespective of the diet.

The possibility of impaired ruminal function due to a deficiency of water-soluble phosphates appeared to be of great importance in all phosphorus deficient areas. In view of the absence of any data from cattle, it was decided to investigate the matter further.

THE PHOSPHORUS CONTENT OF THE SALIVA OF DIFFERENT SPECIES.

In order to determine whether the secretion of phosphorus in the saliva was a characteristic of ruminants, simultaneous samples of blood and saliva were taken from several species and their phosphorus content determined. The results are summarised in Table 1.

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TABLE 1.
Phosphorus Content of Blood and Saliva of Different Species.

Species.....	—	Goats.	Sheep.	Cattle.	Horse.	Dog.
No. of Individuals.....	—	3	4	6	2	3
Blood: Inorganic P (mg./100 c.c.)	Range... Average.	4.2-4.9 4.6	3.1-4.5 3.7	4.3-4.5 4.4	2.3-2.2 2.5	1.8-2.6 2.2
Saliva: Inorganic P (mg./100 c.c.)	Range... Average.	7.4-9.7 8.5	41-98 68.5	7.6-33 19.6	2.7-2.9 2.8	.03-.07 .05
Ratio, Saliva P..... Blood P	Average.	1.8	18.5	4.5	1.1	.02

From the above table it will be seen that of the species selected, only the ruminants actively secreted phosphorus in their saliva.

THE EFFECT OF A PHOSPHORUS DEFICIENT DIET ON THE PHOSPHORUS CONTENT OF THE SALIVA AND RUMINAL INGESTA.

(a) *Sheep.*

Simultaneous samples of blood, saliva and ruminal contents were taken from sheep on a normal diet and from others which had been on a phosphorus deficient diet for three months. The results are shown in Table 2.

TABLE 2.
Phosphorus Content of Blood, Saliva and Ruminal Contents of Sheep (mg. per 100 c.c.).

NORMAL.			PHOS. DEFICIENT.		
Blood. Inorg. P.	Saliva. Total P.	Rumen. Total P.	Blood. Inorg. P.	Saliva. Total P.	Rumen. Total P.
3.7	98	34	2.3	16	35*
3.6	41	26	2.9	32	34
3.1	46	32	2.6	52	65
4.5	89	31	—	—	—
3.7	68.5	30.8	2.6	33.3	44.7

* Sheep died of aphosphorosis the following day

Probably owing to the small number of animals used, statistical analysis showed no significant difference between the blood phosphorus figure of the two groups. It is, however, obvious that there is no correlation between the blood phosphorus figures and the phosphorus content of the rumen. In the case of the one sheep the latter remained within the normal limits at least till the day before death from acute aphosphorosis.

(b) *Cattle.*

The grazing on the experimental farm Armoedsvlakte near Vryburg is notoriously low in phosphorus. In long-term experiments on the farm cattle of different breeds are maintained, some of which receive adequate bone meal, while others are kept as controls. Samples of blood, saliva and ruminal ingesta were taken from these two groups. An equal number of Frieslands and Afrikanders were selected from each group but as no breed differences were subsequently found the figures were amalgamated in Table 3.

TABLE 3.
Phosphorus Content of Blood, Saliva and Ruminal Ingesta of Phosphorus Deficient and Normal Cattle.

Controls.			Bone Meal Fed.		
Blood.	Saliva.	Rumen.	Blood.	Saliva.	Rumen.
2·9	5·1	39	4·3	7·6	35
3·7	6·5	31	4·3	10·7	39
3·1	13·2	23	4·5	16·0	33
3·1	14·3	40	4·5	23·9	51
2·6	13·4	35	4·3	26·0	44
3·1	7·4	35	4·4	24·0	35
Av.... 3·1	10·0	34	4·4	18·0	40

All figures mg. per 100 c.c. Blood inorganic P, Saliva and Rumen watersoluble P.

Statistical analysis of the above figures revealed significant differences between the blood and saliva of the two groups but no difference in the ruminal contents. It can, therefore, be stated that the water-soluble phosphorus content of the ruminal ingesta is maintained in aphosphorosis in cattle as has already been shown to be the case in sheep.

THE CONCENTRATION OF PHOSPHORUS AT DIFFERENT LEVELS OF THE ALIMENTARY TRACT.

In order to determine the site of reabsorption of salivary phosphate, samples of ingesta were taken at different levels of the alimentary tract of boviness after slaughter. These animals had not received any bone meal for at least a week prior to slaughter. The results are given in Table 4.

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TABLE 4.
Percentage Concentration of Total Phosphorus at Different Levels of the Bovine Alimentary Tract (Dry Basis).

Level of Tract.	Cow No.				
	1.	2.	3.	4.	Av.
Rumen.....	1.08	0.87	1.01	0.65	0.90
Duodenum.....	1.08	0.55	1.11	0.40	0.79
Ileum.....	0.62	0.37	0.36	0.34	0.42
Caecum.....	0.39	0.38	0.30	0.41	0.37
Rectum.....	0.41	0.39	0.29	0.49	0.37

As will be seen the main portion of the phosphorus disappeared from the ingesta between the upper duodenum and the lower ileum, i.e. in the small intestine.

DISCUSSION.

It has been established that in ruminants there is a circulation of water-soluble phosphorus from the blood, through the saliva into the rumen and back via the small intestine. A high water-soluble phosphorus concentration of the ruminal ingesta is thus maintained irrespective of the diet or the phosphorus level of the blood. There is, therefore, no indication that the supplementation of a phosphorus deficient diet with water-soluble phosphate will have any effect on ruminal function.

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