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THE USE OF FAECAL ANALYSES TO ESTIMATE THE PHOSPHORUS INTAKE BY GRAZING SHEEP. II. THE REPEATABILITY OF THE TECHNIQUE AND THE INFLUENCE OF VARYING THE PHOSPHORUS INTAKE

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ABSTRACT

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Fifty sheep received a pelleted ration containing between 0,31 and 0,38% phosphorus. Pooled faecal samples, composed of 3 faecal pellets from 30 randomly selected sheep, were taken on 15 occasions during 23 days. The faecal phosphorus levels of the 15 pooled samples were remarkably constant with a mean of 0,94% and a coefficient of variation of 6,38%. However, when the animals received either more or less phosphorus, there was a corresponding respective increase or decrease in the faecal phosphorus levels above and below the limits set in the repeatability trial. There was also a rise in faecal phosphorus when the total food intake was halved. The faecal samples were also analysed for calcium and magnesium.

Résumé

L'UTILISATION D'ANALYSES FAECALES POUR ESTIMER L'ABSORPTION EN PHOSPHORE DE MOUTONS EN PÂTURE. II. LA RÉPÉTABILITÉ DE LA TECHNIQUE ET L'INFLUENCE DE LA VARIATION D'ABSORPTION DE PHOSPHORE

Cinquante moutons reçurent une ration granulée contenant entre 0,31 et 0,38% de phosphore. Des échantillons de déjections faecales rassemblées et composées en 3 crottes originaires de 30 moutons choisis au hazard furent pris à 15 occasions pendant 23 jours. Les niveaux de phosphore faecal des 15 échantillons de masse commune furent remarquablement constants avec une moyenne de 0,94% et un coéfficient de variation de 6,38%. Cependant, quand les animaux avaient reçu soit plus ou soit moins de phosphore, il y avait un accroissement ou une diminution respectif correspondant dans les niveaux de phosphore faecal au dessus et en dessous du jeu de limites dans les essais de répétabilité. Il y eut aussi une augmentation dans le phosphore faecal quand la consommation totalee d'aliment était réduite de moitié. Les échantillons faecaux furent également analysés en ce qui concerne le calcium et le magnesium.

INTRODUCTION

The level of phosphorus in the faeces of sheep appears to be an indication of the level of phosphorus in their diet (Belonje, 1978). Our previous work (Belonje & Van den Berg, 1980) has shown that a pooled faecal analysis for phosphorus does not differ significantly from the arithmetic mean of the analyses of the individual samples which were used to make the pool. This meant that by pooling we could determine the mean faecal phosphorus in a flock and at the same time considerably reduce the laboratory work entailed.

In the present experiments we wanted to establish how constant pooled faecal phosphorus levels remained when sheep had a relatively constant intake of phosphorus, and also to observe the changes which occurred in faecal levels if intake was changed. Calcium and magnesium are intimately related to phosphorus, so their analyses were included.

MATERIALS AND METHODS

Animals

The same 50 healthy, non-pregnant, non-lactating Merino ewes were used in both experiments. They were randomly and equally divided into groups of 10 sheep which were placed in separate floored camps with a roof cover and open runway. All the animals were treated against internal parasites (Valbazen, Smith Kline) before the experiments began.

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Experiment 1—The reproducibility of faecal analyses (Days 1–23)

Feeding

Each group of 10 animals received per day a 10 kg ration of a pelleted diet (Diet A) containing c. 0,3% phosphorus (P). The sheep received the ration for at least 2 weeks before the commencement of the experiment. Water was freely available.

Sampling feed and faeces

A handful of the ration was taken daily for 5 days to make a pool sample for analyses. This was repeated on Days 1–5; 8–12 and 15–19 inclusive.

Rectal faeces were removed manually from 6 sheep selected at random from the 10 sheep in each camp. Three faecal pellets from each of these 30 sheep were pooled for analyses (Belonje & Van den Berg, 1980). Sampling was done daily for 5 days and repeated on Days 5–9; 12–16 and 19–23 inclusive. The faecal sampling was staggered after the feed sampling so that the faeces produced would represent more closely the feed consumed.

Experiment 2—Influence of change in dietary intake on faecal analyses (Days 33–65)

The 50 animals were fed in groups of 10, each group receiving a 10 kg ration of the Diet A used in Experiment 1. This ration was fed for 10 days before the start of the experiment, and thereafter for 43 days.

On Days 34, 35 and 36 each sheep was also dosed *per os* with 40 mℓ of a solution containing 3 g of phosphorus (754,8 g $NaH_2PO_4.2H_2O$ up to 2 ℓ in water).

From the morning of Day 44 to the morning of Day 46, the ration of Diet A fed to each group of sheep was reduced to 5 kg. From the morning of Day. 47 the ration was again increased to 10 kg.

On the morning of Day 53, Diet A was replaced by a pelleted high phosphate diet (Diet B) containing 0,5% P, which was fed at the rate of 1 kg/sheep/day.

On the morning of Day 57, Diet B was replaced by a pelleted low phosphate diet (Diet C) containing 0,2% P, which was fed at the same level of intake (1 kg/sheep/day) until the final Day 65. Water was available at all times.

Sampling feed and faeces

Grab samples of feed were taken daily to make pool samples as follows: from Diet A (0,3% P) pools of 7 days (Days 33–39 inclusive), 4 days (Days 40–43 inclusive) and 9 days (Days 44–52 inclusive); from Diet B (0,5% P) a 4-day pool (Days 53–56 inclusive), and from Diet C (0,2% P) a 9-day pool (Days 57–65 inclusive).

A daily pool of rectal faeces was made throughout the experiment in the manner described for Experiment 1.

Analytical methods

Feed and faeces: These were processed as described before (Belonje, 1978) and analysed for phosphorus (Hanson, 1950). Calcium and magnesium concentrations were determined by atomic absorption using a nitrous oxide-acetylene flame and potassium as an ionization suppressor (Varian Techtron Manual, 1972).

Results and Discussion

Experiment 1—Reproducibility of faecal analyses

Feed and faeces

Variation was expected in the faecal analyses (Table 1), but in none of the 3 elements (P, Ca, Mg) was there a great variation. In the faecal phosphorus the coefficient of variation was only 6,38%, in calcium 4,42%, and in magnesium 4,11%. Although only 3 feed analyses were done, it is interesting to note that the coëfficient of variation for feed was always slightly higher than for faeces, i.e. phosphorus the highest (11,43%) followed by calcium (5,36%) and magnesium (5,41%).

In view of the above, we arrived at the conclusion that when a flock of sheep are consuming a fairly constant amount of phosphorus, calcium and magnesium, pooled faecal analyses for these minerals will show little variation. Furthermore, we suggest that if an analysis of a pooled faecal sample from any other flock falls outside the 2 standard deviation limits shown in Fig. 1, then that flock was eating a diet with a different mineral composition.

Experiment 2—Influence of change in dietary intake on faecal analyses

Feed and faeces

The oral administration of the phosphorus in the form of NaH_2PO_4 had a marked effect on faecal phosphorus which rose above the 2 standard deviation limits (set in Experiment 1) within 24 hours (Table 2). Furthermore, 24 hours after the 3rd and final administration, it started falling back to the original level and remained within the range until the next stage of the experiment. This result is pleasing as it means that a supplementation of phosphorus in this soluble form can be monitored by faecal phosphorus levels. It is also interesting to note that this additional phosphorus did not influence the levels of faecal calcium or magnesium.

In the second phase of the experiment the sheep received only half of their normal ration. Once again faecal phosphorus rose above the upper limit (Fig. 2). This rise in the concentration of phosphorus can be attributed to a decrease in the volume of faeces which was not accompanied by a concomitant decrease in loss of endogenous phosphorus. This is an important point to remember under field conditions, and animals should not be starved before specimens are taken, as artificially high levels of faecal phosphorus may cloud the diagnosis. Calcium and magnesium also rose at about the same time, but calcium changed rather erratically while magnesium first dropped and then rose.

TABLE 1 The phosphorus, calcium and magnesium levels in the pooled faecal samples from 30 out of the 50 sheep in the repeatability trial and analyses of the feed being consumed

Faeces				Feed			
Days	Phosphorus %	Calcium %	Magnesium %	Days	Phosphorus %	Calcium %	Magnesium %
—				1–5	0,36	1,78	0,36
5	0,87	3,60	0,70				
6	0,90	3,56	0,77				
7	0,87	3,63	0,77				
8	0,87	3,81	0,80				
9	0,83	3,86	0,75				
—				8–12	0,31	1,59	0,36
12	0,89	3,90	0,70				
13	1,01	4,15	0,72				
14	1,00	4,10	0,72				
15	1,02	3,98	0,75				
16	0,95	3,83	0,75				
—				15–19	0,38	1,67	0,39
19	0,91	3,86	0,69				
20	0,95	3,85	0,69				
21	1,03	3,85	0,74				
22	0,99	3,79	0,73				
23	0,97	4,03	0,73				
Mean	0,94	3,85	0,73		0,35	1,68	0,37
S.D.	0,06	0,17	0,03		0,04	0,09	0,02

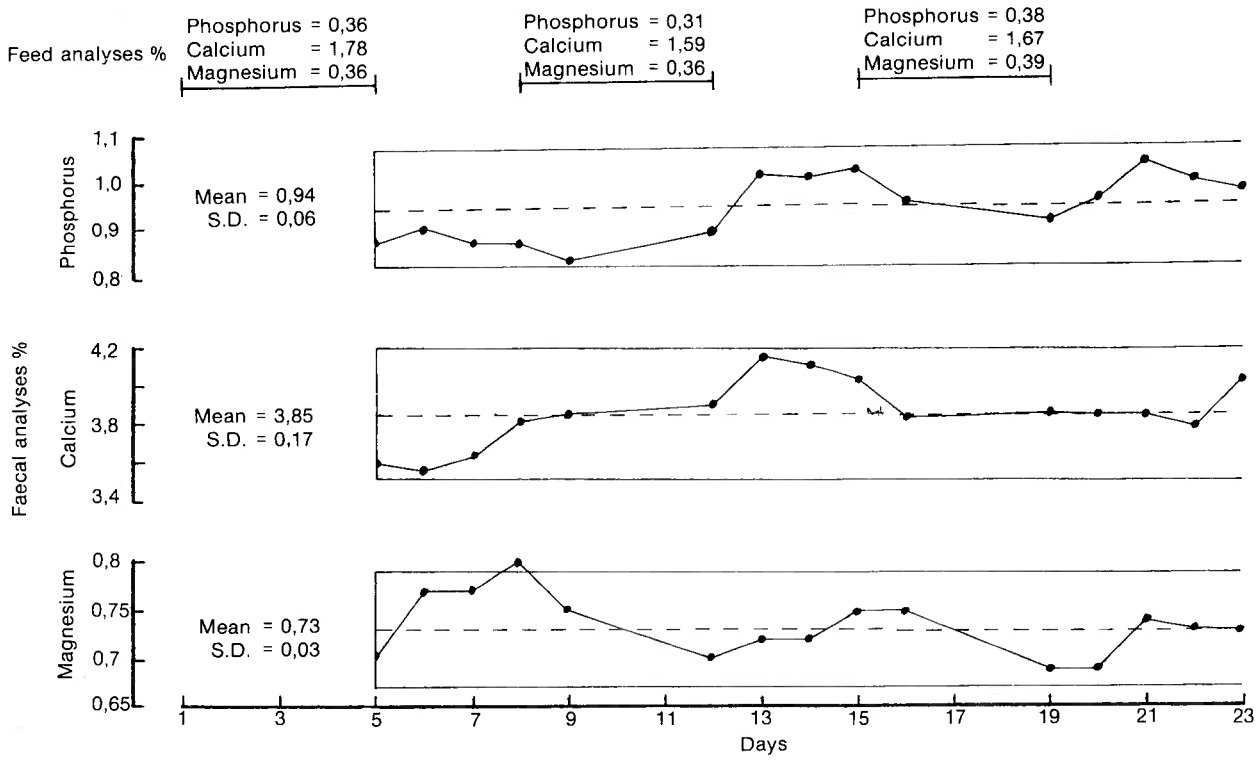

FIG. 1 The phosphorus, calcium and magnesium levels in the pooled faecal samples from 30 of the 50 sheep in the repeatability trial, and the analyses of the feed being consumed

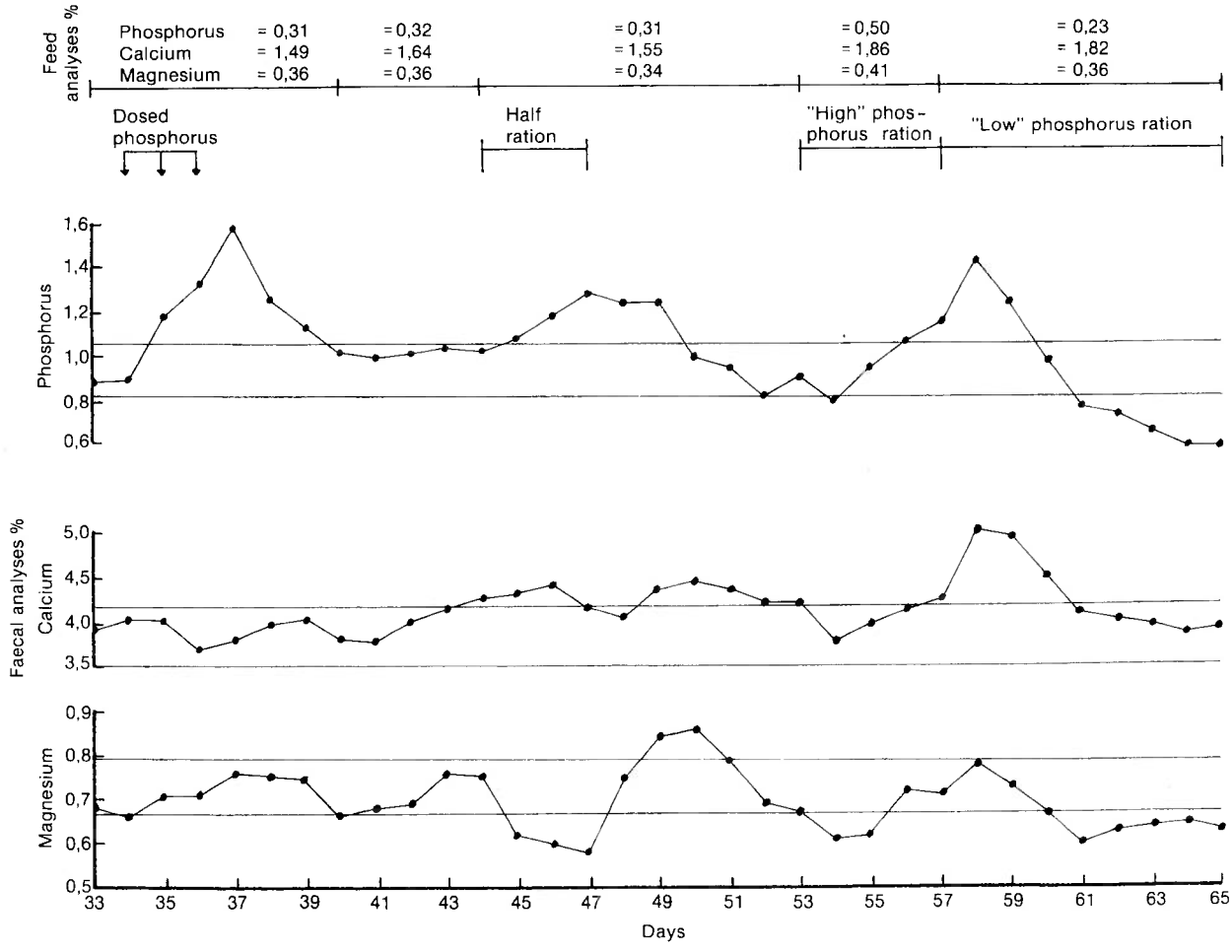

FIG. 2 The phosphorus, calcium and magnesium levels in the pooled faecal samples from 30 out of the 50 sheep whose intake of phosphorus was periodically changed, and the analyses of the feed being consumed

TABLE 2 The phosphorus, calcium and magnesium levels in the pooled faecal samples from 30 of the 50 sheep whose intake of phosphorus was periodically changed and analyses of the feed being consumed

Faeces				Intake			
Days	Phosphorus %	Calcium %	Magnesium %	Days	Phosphorus %	Calcium %	Magnesium %
33	0,88	3,90	0,68	33–40	0,31	1,49	0,36
34	0,89	4,04	0,66	34	Additional 3 g P/sheep/day		
35	1,18	4,02	0,71	35	Additional 3 g P/sheep/day		
36	1,32	3,70	0,71	36	Additional 3 g P/sheep/day		
37	1,59	3,80	0,76				
38	1,26	3,99	0,75				
39	1,13	4,02	0,74				
40	1,01	3,80	0,66	40–43	0,32	1,64	0,36
41	0,99	3,79	0,68				
42	1,01	4,00	0,69				
43	1,04	4,16	0,76				
44	1,02	4,28	0,75	44–52	0,31	1,55	0,34
45	1,08	4,32	0,62	45	Half ration days 44; 45; 46		
46	1,18	4,41	0,60	46			
47	1,28	4,17	0,58				
48	1,24	4,03	0,75				
49	1,24	4,36	0,84				
50	0,99	4,46	0,86				
51	0,95	4,37	0,79				
52	0,81	4,21	0,69				
53	0,90	4,23	0,67	53–56	0,50	1,86	0,41
54	0,79	3,79	0,61				
55	0,95	3,99	0,62				
56	1,07	4,16	0,72				
57	1,15	4,24	0,71	57–65	0,23	1,82	0,36
58	1,42	5,05	0,78				
59	1,24	4,96	0,73				
60	0,97	4,51	0,67				
61	0,77	4,10	0,60				
62	0,74	4,00	0,63				
63	0,66	3,96	0,64				
64	0,59	3,86	0,65				
65	0,59	3,92	0,63				

In the 3rd phase of the experiment a sudden change was made to a high phosphorus (0,5%) ration. In this case a few days elapsed before faecal phosphorus rose (Fig. 2). This is very different from the 1st phase when soluble phosphorus was dosed to the animals. It would appear then that the soluble phosphorus either passed down the digestive tract very quickly or was absorbed into the blood stream and then excreted in the colon. Note also the concomitant rise in faecal calcium. Some of the rise in calcium may be attributed to higher calcium content of the high phosphorus diet, but there might have been the production of insoluble or unabsorbable calcium phosphate compounds. Magnesium showed a similar trend although the values remained within the limits.

In the final phase of the experiment, in which a "low" phosphorus diet was given, there was a gratifying drop in the level of faecal phosphorus even below the lowest level for 0,3% P during this period. The drop appeared to flatten out at a new level during the last 2 days of the experiment (Fig. 2). Calcium once again remained within limits set for about 1,7% intake (Experiment 1). Magnesium on the other hand dropped below the lower line. This low faecal magnesium when dietary phosphorus is low has also been documented before (Belonje, 1978) and must be kept in mind when faecal analyses are used for assessing pasture content.

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