NUTRITION OF GRAZING CATTLE

3. Estimation of Protein, Phosphorus and Calcium in Mixed Diets

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SUMMARY

Regressions developed to relate dietary and faecal composition in terms of protein, phosphorus and calcium are applied to estimate the percentages of protein, phosphorus and calcium in diets comprising two or more feeds differing widely in chemical composition.

The regressions for phosphorus and calcium give satisfactory results when applied over a wide range of dietary phosphorus and calcium levels in a variety of feedstuffs.

The regression for estimating protein percentage is unsatisfactory, giving a marked under-estimate of the protein level in most mixed diets.

When the diet consists of two feeds which differ in phosphorus or calcium content, analysis of each feed together with the regression estimates of phosphorus and calcium permits an assessment of the relative proportion of each feed in the diet. From this proportion the protein content in the mixed diet may be calculated.

I. INTRODUCTION

Regressions were developed previously (Moir 1961*a*, 1960*b*) to relate dietary and faecal composition in terms of protein, phosphorus and calcium. These regressions were developed on data from relatively uniform diets.

The object of the investigation reported in the present paper is to determine whether these regressions could be applied to diets comprising two or more feeds differing widely in chemical composition.

II. METHODS

The procedure of Moir (1960*a*) was used for sampling pastures and faeces. The pasture sampling technique was also used for sampling grazed crops.

The analytical procedures described by Moir (1960*a*, 1960*b*) were used.

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III. EXPERIMENTAL AND RESULTS

Samples of feeds and faeces were collected from 11 dairy farms. In Table 1 are recorded:—

(1) Feeding practices at the time of sampling.

(2) Percentages of protein, phosphorus and calcium from analysis of feeds and faeces.

(3) Percentages of protein, phosphorus and calcium derived by applying the regression equations to the percentages of these constituents in organic-matter faeces.

These equations are:—

$$y = 3{\cdot}34\ (x - 5{\cdot}5)^{0{\cdot}60}$$

where $y =$ *per cent.* protein in dry-matter pasture.

$x =$ *per cent.* protein in organic-matter faeces.

$$y = 0{\cdot}057 + 0{\cdot}364\ x$$

where $y =$ *per cent.* P in dry-matter pasture.

$x =$ *per cent.* P in organic-matter faeces.

$$y = 0{\cdot}019 + 0{\cdot}405\ x$$

where $y =$ *per cent.* Ca in a diet.

$x =$ *per cent.* Ca in organic-matter faeces.

IV. DISCUSSION

In Herd 1, percentages of phosphorus and calcium derived from regression are of the order of magnitude of the percentages determined by analysis of the feed. Protein estimated from regression is considerably less than protein from analysis of the feed.

In Herd 2, percentages of protein, phosphorus and calcium in the whole diet must lie between the levels in the two feeds comprising the diet. Phosphorus and calcium derived from regression both lie about midway between the percentages in the two feeds. Protein derived from regression is considerably less than protein in the two feeds.

For Herd 3, if the two components of the diet, forest grass and irrigated clover, are eaten in the proportion of 2 to 1, then the mixed diet contains 16·3 per cent. protein, 0·23 per cent. phosphorus and 0·55 per cent. calcium. This ratio gives satisfactory agreement with the regression estimates for phosphorus and calcium but the estimate for protein is low and obviously incorrect.

TABLE 1

Feeding Practices, Analysed Percentages of Protein, Phosphorus and Calcium in Feeds on a Dry-matter Basis and in Faeces on an Organic-matter Basis, and Percentages of these Constituents derived from Regression

Herd No.	Feeding Practice	Analyses of Feeds and Faeces				Regression Estimates		
		Feeds and Faeces	Protein (%)	P (%)	Ca (%)	Protein (%)	P (%)	Ca (%)
1	Grazing irrigated pasture only	Faeces	18·2	0·96	2·54	15·2	0·41	1·05
		Irrigated pasture	26·8	0·43	1·27	..	..	..
2	Grazing irrigated pasture and lucerne only	Faeces	21·1	1·01	4·16	17·2	0·42	1·70
		Irrigated pasture	30·1	0·47	1·92	..	..	..
		Lucerne ..	28·8	0·37	1·53	..	..	..
3	Grazing irrigated clover and native forest grass	Faeces	13·7	0·45	1·38	11·7	0·22	0·58
		Irrigated clover	30·6	0·37	1·24	..	..	..
		Forest grass ..	9·2	0·16	0·21	..	..	..
4	Grazing irrigated clover and native forest grass	Faeces	17·1	0·49	1·62	14·4	0·24	0·68
		Irrigated clover	27·1	0·28	1·23	..	..	..
		Forest grass ..	9·2	0·16	0·16	..	..	..
5	Grazing irrigated pasture and paspalum	Faeces	14·3	0·65	1·48	12·2	0·29	0·61
		Irrigated pasture	23·6	0·48	0·84	..	..	..
		Paspalum ..	11·2	0·26	0·46	..	..	..
6	Grazing irrigated clover and paspalum	Faeces	18·6	0·75	1·80	15·5	0·33	0·75
		Irrigated clover	27·1	0·38	1·33	..	..	..
		Paspalum ..	13·7	0·32	0·40	..	..	..
7	Grazing lucerne, oats and paspalum	Faeces	14·6	0·69	2·42	12·4	0·31	1·00
		Lucerne ..	25·2	0·38	1·99	..	..	..
		Oats	16·4	0·73	0·48	..	..	..
		Paspalum ..	12·2	0·25	0·29	..	..	..
8	Grazing kikuyu grass and supplemented with 5 lb concentrate	Faeces	15·2	1·25	1·76	12·9	0·51	0·73
		Kikuyu grass ..	11·4	0·26	0·88	..	..	..
		Concentrate ..	19·5	1·19	1·09	..	..	..
9	Entirely hand-fed lucerne hay and concentrates	Faeces	19·2	1·16	1·64	15·9	0·48	0·68
		Composite feed sample	17·2	0·47	0·54	..	..	..
10	Grazing forest grass and paspalum supplemented with 5 lb (dry matter) of maize and concentrate	Faeces	14·2	0·74	1·33	12·1	0·33	0·56
		Grass	10·0	0·26	0·32	..	..	..
		Supplement ..	14·7	0·47	0·72	..	..	..
11	Entirely hand-fed lucerne hay and concentrates, supplemented with bonemeal	Faeces	22·2	..	..	17·9	..	..
		Composite feed sample	19·4	..	..	..	..	..

For Herd 4, if the ratio of forest grass to irrigated clover is 1 to 1, then the diet contains 18·1 per cent. protein, 0·22 per cent. phosphorus and 0·69 per cent. calcium. As in Herd 3 there is satisfactory agreement with the regression estimates of phosphorus and calcium but the estimate for protein is low.

For Herd 5, if the ratio of paspalum grass to irrigated clover is 2 to 1, then the diet contains 15·3 per cent. protein, 0·33 per cent. phosphorus and 0·59 per cent. calcium. The levels of phosphorus and calcium are of the same order of magnitude as the estimates from regression. The regression estimate for protein is low.

For Herd 6, if the ratio of paspalum grass to irrigated clover is 2 to 1, then the diet contains 18·1 per cent. protein, 0·34 per cent. phosphorus and 0·71 per cent. calcium. This ratio gives satisfactory agreement with the regression estimates for phosphorus and calcium but the estimate for protein is low.

In Herd 7 the regression estimate of 1·00 per cent. calcium suggests a large amount of lucerne in the diet, as this is the only constituent of the diet of very high calcium content. The regression estimate for protein is obviously much less than the actual protein content of the diet.

In Herd 8, if a 30 lb dry-matter intake is assumed, the ratio of grass to concentrate in the diet is 5 to 1. Thus the diet would contain 12·7 per cent. protein, 0·41 per cent. phosphorus and 0·91 per cent. calcium. These levels are of the same order of magnitude as the estimates from regression.

In Herd 9, the difference between protein derived from regression and protein determined by analysis of the feed is less than the standard error of estimate of 1·4 per cent. protein in the regression of protein in pasture and in faeces.

In Herd 10, a dry-matter intake of 30 lb would mean a ratio of 5 parts pasture to 1 part concentrate. Thus the diet would contain 10·8 per cent. protein, 0·30 per cent. phosphorus and 0·39 per cent. calcium. At the time of sampling the season was a particularly dry one and milk production had fallen to a low level. A low feed intake was highly probable. At an intake of 15 lb dry matter the ratio is 2 to 1 and the diet would contain 11·6 per cent. protein, 0·33 per cent. phosphorus and 0·46 per cent. calcium. These levels approximate more closely to the estimates from regression.

In Herd 11 the difference between protein determined by analyses of the feed and protein derived from regression is just outside the standard error of estimate of 1·4 per cent. protein.

It is evident that at high protein levels in diets of irrigated pasture, irrigated clover and lucerne, the regressions markedly under-estimate the protein content

of the diet. From published digestibility data, the protein content of faeces derived from lucerne is much less than that derived from grass of the same protein content. Thus an under-estimate would be expected. However, for clover and grass of high protein content the lower estimate from regression can be explained only in terms of a higher apparent protein digestibility and/or a lower dry-matter digestibility than those shown in the literature for similar feeds.

V. CONCLUSIONS

The regressions for phosphorus and calcium developed on data from relatively uniform diets may be used to estimate the percentages of these elements in diets comprising feeds differing widely in chemical composition.

The percentages of phosphorus and calcium in feeds and faeces may be used to estimate the approximate proportions of two feeds comprising a diet. A limitation is that these feeds must have sufficiently wide differences in phosphorus or calcium content. From this proportion the protein content in a mixed diet may be calculated when the protein content of each feed in the diet is known. Reasonable deductions may be made also with regard to the total dry-matter intake when a supplement of known composition is fed in known amounts.

REFERENCES

MOIR, K. W. (1960*a*).—*Qd J. Agric. Sci.* 17 : 361.

MOIR, K. W. (1960*b*).—*Qd J. Agric. Sci.* 17 : 373.

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