

THE PROXIMATE COMPOSITIONS AND RUMEN DEGRADABILITIES OF SOME TROPICAL AND TEMPERATE LEGUMES

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(Received 18 June 1990; accepted 16 October, 1990)

ABSTRACT

The proximate compositions and degradabilities in the rumen of tropical legumes (peas and beans) and temperate peas were studied with the aim of comparatively evaluating their nutritive potential for ruminants. The mean crude fibre content of temperate peas (11.3%) was higher than for tropical peas and beans. The mean gross energy contents of tropical peas (18.2 MJ/kg) and beans (18.6 MJ/kg) were higher than for temperate peas (17.0 MJ/kg) despite a higher mean ash value for the tropical types. Other proximate components were very similar for both tropical and temperate legumes although lima bean had a higher crude protein content. Generally the individual compositions of both the temperate peas and were within the range of published values for tropical legumes. The degradabilities of the dry matter and crude protein in the rumen of hay-fed cows were comparable for both tropical and temperate type legumes.

Key words: legumes, tropical, temperate, rumen degradability, proximate composition

INTRODUCTION

There has been a considerable increase in the production of peas (*Pisum sativum*) in the countries of the European Economic Community to replace imported soya bean. Whilst some varieties of legumes, mainly peas and beans, are cultivated in the tropics, others grow wild amongst sparse vegetation and may be consumed by traditionally herded ruminants. Frequently, the nutritional values of feedstuffs obtained by both laboratory and animal experimentation in European countries may be utilised elsewhere without a proper appreciation of differences which may exist between different types and varieties of the particular crop which may be further complicated by difference in climate and soil properties.

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Legumes, particularly peas and beans, may be given to ruminants as a source of protein to supplement both cereals and roughages. Recent developments in the study of the protein requirements of ruminants (e.g. Agricultural Research Council (ARC), 1980) have emphasised the importance of the proportions of the crude protein (CP) which are degraded (RDP) or undegraded (UDP) in the rumen. Alawa, Fishwick, Parkins, Hemingway and Aitchison (1986) and Alawa and Hemingway (1986) have established that the voluntary intake and digestibility of straw by beef suckler cows are influenced by the intake of RDP rather than UDP. The only published data on the rumen degradability of peas is given by ARC (1980) which indicates that about 0.51 - 0.70 is degraded *in sacco* in the rumen.

This paper gives a comparative evaluation of a range of native varieties of legumes some of which are cultivated in Nigeria with a selection of those grown in Great Britain.

MATERIALS AND METHODS

Five types of tropical legumes (two varieties of peas and three of beans) and seven types of temperate peas were obtained in approximately 2 kg quantities. The tropical peas consisted of cowpea (*Vigna unguiculata* Walp) and pigeon pea (*Cajanus cajan*, Linn) while the beans were Treculia, popularly called African breadfruit, (*Treculia africana*), Lima bean (*Phaseolus lunatus* L.) and African yam bean (also called cowpea of the humid forests (*Sphenostylis stenocarpa*). These were collected at maturity in the middle of the dry season at various locations in the south of Nigeria. The temperate types were supplied by the Processors and Growers Research Organisation (Thornhaugh, Peterborough, U.K.). One half of each sample was milled (0.8 mm screen) for proximate analyses using normal standard methods. The other half was crushed using a cereal bruiser commonly found on farms (E. H. Bentall and Co., Malden, Essex) for subsequent rumen degradation studies.)

TABLE 1. THE MEAN PROXIMATE COMPOSITIONS (%) GROSS ENERGY METABOLISABLE ENERGY (MJ/KG DM) AND DEGRADABLE PROTEIN VALUES OBTAINED IN PREVIOUS STUDIES WITH PEAS AND BEANS.

n.	IBAN MAFF IBAN MAFF MAFF				
	1936	1936	1936	1986	1986
	Peas	Peas	Beans	Spring	Winter
	15	6	34	8	3
Crude protein	21.3	26.1	24.0	34.2	27.5
Ether extract	2.2	1.4	1.3	1.3	1.4
Crude fibre	5.8	6.0	4.0	7.4	8.3
Ash	3.5	3.2	3.2	3.8	3.3
Gross energy	n.d.	18.5	n.d.	18.6	18.5
Metabolisable energy	n.d.	13.8	n.d.	13.6	13.3
Digestible crude protein (%)	n.d.	21.8	n.d.	n.d.	n.d.
Rumen degradable protein coeff.	n.d.	0.5-0.7	n.d.	0.3-0.5	0.3-0.5

n.d. = not determined.

To determine rumen degradability, three replicates of 10g each of the various samples of peas and beans were placed in bags made of polyester filament (mean pore size, 43 μ m) and incubated for 24 hours in the rumen of three hay-fed, rumen fistulated cows as described by Alawa and Hemmingway (1986). The cows had previously been fed straw diets supplemented with the various legumes used in this trial for about three weeks so that the rumen microbes had adjusted to diets containing legumes. The bruising of the legumes resulted in the production of variable proportions of very fine, powdery material which could, by observation, pass directly through the polyester bags. It was established that the maximum loss of both dry matter (DM) and nitrogen of such fine material took place during 6 hours of gentle agitation in water at 37°C. Accordingly, prior determination of the amounts of each constituent lost in such a manner were made and used to adjust the amounts lost from the bags after 24 hours in the rumen.

RESULTS AND DISCUSSION

Table 1 gives the proximate compositions (DM basis) of both the tropical and temperate legumes together with the coefficients of degradability of both the dry matter and crude

protein. For comparative purposes, two other sets of data (Table 2) are included viz: (a) British data obtained from *in vivo* digestibility trials (Ministry of Agriculture, Fisheries and Food, Department of Agriculture and Fisheries for Scotland, Department of Agriculture for Northern Ireland, (MAFF, 1986) and (b) values obtained for other tropical peas and beans (Imperial Bureau of Animal Nutrition (IBAN, 1936).

The crude protein (CP) content of one of the varieties of tropical beans (Lima bean) of 28.8% was considerably higher than for the other two varieties and for the general range of values (12.6 - 29.3%) recorded for beans by IBAN (1936). This value is also higher than that obtained in New Zealand for spring sown field beans (24.9%) by Hill, Horn and Porter (1977) but intermediate between the mean values of about 27.5% for winter beans and 34.2% for spring beans quoted by MAFF (1986). Apart from this one value of 28.8% for Lima bean, other tropical legumes used in this study were very uniform with about 21.7 - 23.5%. The CP content of the tropical and temperate peas were comparable with relatively uniform values ranging from 21.6 to 23.6% for both. This is in spite of the fact that the temperate peas were varieties produced as a result of selective plant breeding for characteris-

TABLE 2. PROXIMATE COMPOSITIONS (%) AND 24-HOUR RUMEN DEGRADABILITY COEFFICIENTS OF LEGUMES

	Crude protein	Crude fibre	Ether extract	Ash	N-free extract	Gross energy	Degradability	
							Dry matter	Crude protein
Tropical varieties								
Cowpea	23.7	9.4	1.2	3.9	62.1	18.3	0.61	0.59
Pigeon pea	21.7	8.4	1.1	4.5	64.6	18.1	0.61	0.58
Treculia	23.5	5.4	6.1	3.6	61.4	19.1	0.60	0.62
Lima bean	28.8	5.6	0.9	3.0	61.7	18.5	0.64	0.63
African yam bean	20.7	4.9	1.6	2.8	70.0	19.0	0.64	0.63
Mean (5)	23.6	6.7	2.2	3.6	64.0	18.6	0.62	0.61
S.dev. +	2.84	1.81	1.97	0.62	3.22	0.39	0.017	0.021
Temperate varieties								
Vedette	21.6	11.6	1.2	2.7	62.9	17.1	0.53	0.64
Finale	22.1	10.9	1.0	2.6	63.4	16.9	0.55	0.60
Birte	23.0	8.7	0.9	2.7	64.8	17.0	0.59	0.66
Consort	22.3	11.4	1.1	2.8	62.4	17.0	0.72	0.78
Progetta	21.0	9.8	0.9	2.4	65.9	17.0	0.53	0.45
Maro	23.1	13.8	1.0	2.8	60.1	17.1	0.59	0.62
Imposant	21.2	14.0	1.1	2.8	60.9	17.1	0.51	0.51
Mean (7)	22.3	11.3	1.0	2.7	62.9	17.0	0.57	0.61
S.dev. ±	0.77	1.67	0.1	0.14	1.88	0.07	0.066	0.099
IBAN (1936) Mean	21.3	5.8	2.2	3.5	56.8	n.d.	n.d.	n.d.
MAFF (15) (1984)	26.2	6.3	1.9	3.3	62.4	18.9	n.d.	n.d.
MAFF (1986) Mean	26.1	6.0	1.4	3.2	n.d.	18.5	n.d.	n.d.
S. dev. ±	1.6	0.2	3.0	0.3	-	0.1		

n.d. = not determined.

tics such as yield, straw quality, early maturity, etc.

The mean crude fibre (CF) content of the tropical peas was relatively higher than those quoted by IBAN (1936) and MAFF (1986). On the other hand, the mean CF value for the seven temperate peas was significantly ($P < 0.05$) higher at 11.3% than that for the tropical legumes. The high CF content of the temperate peas may result from a deliberate choice to select preferentially for a high CF content in the interests of human health (Department of Health and Social Security, 1979). This mean value is similar to that of 13.8% CF recorded by Fairweather-Tait and Wright (1975) for the leafless peas (*Pisum sativum*). The relatively low CF values for the tropical beans is similar to values

recorded by IBAN (1936) but lower than those for temperate types quoted by MAFF (1986).

The ash content of the tropical peas (4.2%) was significantly ($P < 0.05$) higher than those for the beans (3.1%) and the temperate peas (2.7%). The overall mean value for the tropical legumes was similar to the mean recorded by IBAN (1936). In spite of this, the mean gross energy content of tropical peas (18.2 MJ/kg DM) or peas and bean considered together (19.6 MJ/kg DM) was significantly higher ($P < 0.01$) than that for the temperate peas (17 MJ/kg DM) and was comparable to the values quoted by MAFF (1986).

One variety of tropical beans (*Treculia africana*) was noteworthy in having an ether extract (EE) content of 6.1% a value much higher

than that quoted by either IBAN (1936) or MAFF (1986). The EE contents of both tropical and temperate peas were quite uniform but the individual values for the temperate varieties were generally lower than the mean values quoted by IBAN (1936) and MAFF (1986).

The degradability coefficients of the DM and CP in the rumen were comparable for both the tropical peas and beans and also for the tropical and temperate peas. MAFF (1986) indicates that peas should be placed in the rumen degradability class for CP described by ARC (1980), i.e. 0.51-0.70 which is in accord with all the present individual values.

The determined *in vivo* digestibility values of six samples of peas quoted by MAFF (1986) are 90.2% digestible organic matter in the dry matter (DOMD), 13.8 MJ metabolisable energy (ME) and 21.8% digestible crude protein (DCP). Apart from the few exceptional values for proximate composition for the tropical varieties described earlier, the essential similarity of the proximate analyses and rumen degradabilities given in Table 2 would seem to indicate that similar values for DOMD, ME and DCP can be assumed for tropical peas.

Since these investigations were completed, Alawa, Fishwick, Parkins and Hemingway (1987) have established a significant relationship between the voluntary intake of barley straw and the rumen degradable protein (RDP) supplied by seven different combinations of concentrate feeds given to beef cows in early lactation. Peas, providing 588 g CP (including 369 g RDP) were inferior to combination of (a) barley and soya bean meal (573 g CP with 362 g RDP) and (b) barley and dried brewers grains (565 g CP with 451 g RDP) and resulted in reduced amounts of ME obtained from straw and significantly reduced milk yields. The variety of peas used by Alawa *et al.* (1987) (Birte) was selected from among the temperate peas used in the present study on the basis of its moderate degradability relative to other combinations of concentrate feeds used in previous studies. Williams, Pusztai, Macdearmid and Innes (1984/85) have also indicated that milk yield of cows given unprocessed legume were significantly less than those given wet brewers grains.

Whilst it would thus appear that the nutritional value of tropical legumes can be assumed to be equivalent to those of temperate legumes, caution should be exercised when legumes are to form an important part of the diet. Nevertheless, the high protein content of legumes and their high content of phosphorus (MAFF, 1986) suggests that their value may be appreciable to cattle grazing otherwise poor range vegetation. This should be confirmed by animal experimentation.

ACKNOWLEDGEMENTS

The authors thank Miss M. J. Young and her colleagues of the Department of Veterinary

Animal Husbandry, Glasgow University for chemical analyses.

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