The Editors of the Proceedings of the Nutrition Society *accept no responsibility for the abstracts of papers read at the Society's meetings for original communications.*

PROCEEDINGS OF THE NUTRITION SOCIETY

ABSTRACTS OF COMMUNICATIONS

The Three Hundred and Forty-second Meeting of the Nutrition Society (One Hundred and Thirty-fourth of the Scottish Group) was held at the West of Scotland Agricultural College, Auchincruive, Ayr on Thursday, 24 April, 1980 when the following papers were read:

The responses of hens to feeds with different proportions of their energy from fat, protein and carbohydrate and the choices that they make between these. By Y. Y. PITRIES,[1] P. DUN[1] and G. C. EMMANS[2] (Introduced by M. A. RAVEN), *West of Scotland Agricultural College*[1] *and East of Scotland College of Agriculture*[2]

There isoenergetic feeds were formulated with approximately 0·6 of the metabolizable energy (ME) coming from either fat (feed F), protein (feed P) or carbohydrate (feed C). Half of the remaining ME in each feed came from each of the other two components. Three other feeds were made by mixing equal parts of each pair to make FC, FP and PC.

156 brown egg-laying hens aged 41 weeks and in full lay were allocated to eighteen treatments. The treatments were to offer the six single feeds alone (ten birds/treatment) or twelve different pairs of feeds (eight birds/treatment). The experiment lasted for 10 weeks and initial and final carcase measurements were made for the single birds on the single feeds. The feed intake of the birds on the single feeds were regressed on body-weight 0·75, egg output and weight gain.

Feed intake and egg production were lower on feed F and where the feeds contained F than on the other diets. When given a choice the birds tried to select a diet where the proportions of ME coming from carbohydrate, fat and protein were 0·41, 0·31 and 0·28 respectively.

The results showed that hens have a preferred balance between the three sources of ME. The efficiencies with which the ME from protein as estimated by regression, was used by hens for maintenance, was 0·81 of that from fat and carbohydrate.

0029–6651/80/3902–343A $00.35

The use of whole blood for the protection of organic materials from degradation in the ruman. By. E. R. ØRSKOV, C. F. MILLS and J. J. ROBINSON, *The Rowett Research Institute, Bucksburn, Aberdeen AB2 9SB*

A recent study revealed extremely low coefficients for the degradability of the protein of blood meal in the rumen (Gonzalez *et al.* 1979). Nevertheless, the undegraded fraction had a high 'pepsin' solubility and appeared, on the basis of its ability to stimulate milk production in ewes, to be effectively digested postruminally. These observations prompted an investigation to use blood to treat feeds in order to prevent their breakdown in the rumen.

In the first experiment, 2 l of sheep blood was mixed with 1 kg of soya-bean meal, dried at 100° and incubated in nylon bags suspended in the rumen of sheep (Mehrez & Ørskov, 1977). After 6 h incubation 35·2 and 18·2% nitrogen had disappeared from the 'untreated' and 'blood treated' soya-bean meal respectively; after 24 h the values were 91·5 and 38·3% respectively.

In the second experiment the same techniques were used to investigate the effects of altering the amount of blood on the degradation of the protein of either soya-bean or groundnut meal. There was a rapid reduction in the extent of protein degradation up to an inclusion rate of 0·5 l blood/kg protein supplement (see Table), and the degree of protection was similar for both protein sources. For samples treated with 3 l blood/kg the pepsin solubilities of the residues that remained after 8 h incubation were 93·0 and 93·6% for groundnut and soya-bean meal respectively.

	N disappearance (%)			
	Soya-bean meal		Groundnut meal	
Level of inclusion of blood (l/kg)	4 h	8 h	4 h	8 h
0	56·5	65·0	64·0	78·0
0·25	35·5	48·2	37·6	49·6
0·50	23·9	31·5	22·6	28·3
1·00	24·4	28·5	16·3	22·5
1·50	19·9	26·4	11·9	16·5
3·00	11·2	14·5	8·9	13·6

Currently the method is being tested for the protection of lipids and other additives from hydrolysis or breakdown in the rumen.

Gonzalez, J. S., Robinson, J. J., McHattie, I. & Mehrez, A. Z. (1979). *Proc. Nutr. Soc.* **38**, 145.
Mehrez, A. Z. & Ørskov, E. R. (1977). *J. agric. Sci., Camb.* **88**, 645.

0029-6651/80/3902-343A $00.35 © The Nutrition Society

The effect of pre-treatment on the stability of alpha tocopherol in moist barley. By C. H. McMurray, W. J. Blanchflower and D. A. Rice, *Veterinary Research Laboratories, Stoney Road, Stormont, Belfast, Northern Ireland*

Alpha tocopherol (AT) appears to be as important as selenium in protecting against nutritional myopathy in calves. It is therefore necessary to define the conditions under which tocopherol insufficiency can arise. Allen *et al.* (1974) and Marsden *et al.* (1973) have observed destruction of tocopherol in propionic acid treated barley. Whether the destruction was due to moisture or propionic acid or both has not been unambiguously established. Recently barley has been treated with sodium hydroxide to increase its digestibility (Ørskov & Greenhalgh, 1977). It is not known whether AT is stable in the presence of NaOH and if the amount of moisture present influences the rate of AT destruction.

An experiment was designed to examine these effects (see Table). Before analysis the barley was dried at 60° for 24 h and saponified in the presence of pyrogallol. The AT content as determined by high performance liquid chromatography (McMurray & Blanchflower, 1979) was 7·5±0·2 mg/kg (mean ± SEM; five determinations).

Treatment . . .	Moist			Moist + sodium hydroxide*			Moist + propionic acid†		
Moisture content of barley (g/kg) . . .	180	250	350	180	250	350	180	250	350
Time (d)									
5	7·3	7·4	7·7	5·3	1·7	0·9	4·3	6·3	5·7
12	7·2	7·1	8·0	4·7	0·9	1·0	3·5	4·4	5·2
23	nd	nd	nd	1·9	0·7	0·6	3·1	4·1	4·6
41	7·0	7·1	6·1	1·5	1·2	0·9	3·5	4·3	4·4

nd, not determined.
*30 g/kg dried grain.
†Treatment as recommended by manufacturers of Propcorn (BP Nutrition Ltd. Witham, Essex, England).

Both the acid and alkali treatment resulted in substantial destruction of AT. At 250 and 350 g moisture/kg barley the loss of AT was substantial in the alkaline treatment but the rate of loss with the acid treatment was lower. There was some apparent effect of moisture on the alkaline treatment; the rate of loss being lower in the driest sample. The loss of AT in acid treatment was independent of moisture content. Moisture alone had little effect on AT. With increasing use of these treatments, adequate supplementation of tocopherol will be necessary.

Allen, W. M., Parr, W. H., Bradley, R., Swannack, K., Barton, C. R. Q. & Tyler, R. (1974). *Vet. Rec.* **94**, 373.
Marsden, A., Mortensen, H. P., Hjarde, W., Leerbeck, E. & Leth, T. (1973). *Acta Agric. Scand. Suppl.* **19**, 169.
McMurray, C. H. & Blanchflower, W. J. (1979). *J. Chromat.* **176**, 488.
Ørskov, E. R. & Greenhalgh, J. F. D. (1977). *J. Agric. Sci., Camb.* **89**, 253.

0029-6651/80/3902-343A $00.35 © The Nutrition Society

The effect of dietary inclusions of protein on milk secretion and nitrogen retention in cows given silage–barley diets. By N. C. KELLY, P. C. THOMAS and D. G. CHAMBERLAIN, *The Hannah Research Institute, Ayr KA6 5HL*

Feeding experiments have shown that in cows given barley and *ad lib.* grass silage, inclusion of groundnut meal in the diet increases milk yield by 7–11%. (See Thomas & Castle, 1978). This effect is associated with an increase in silage intake but it has brought into question the adequacy of protein in silage–barley diets, for even moderate-yielding dairy cows.

The effect of dietary protein inclusion on milk secretion and nitrogen retention was investigated in six Ayrshire cows in mid-lactation. The animals were given diets consisting of silage and one of three concentrate mixtures (60:40 on a dry matter basis); the concentrates consisted of mineralized barley, barley and soya-bean meal and barley and groundnut meal (19·3, 35·3 and 30·9 g N/kg DM respectively). The silage was made from wilted perennial ryegrass using formic acid (2·3 l/tonne) as additive and contained 219 g N/kg DM of which 0·56 was non-protein N. The experiment was of a duplicated 3×3 Latin Square design with 28 d periods; measurements were made during the last 9 d of each period. Diets were rationed to meet the animals' energy requirements at the start of the experiment and adjusted for a decline in yield of 2%/week after each period.

	Concentrate			
	Barley	Barley + soya-bean meal	Barley + groundnut meal	SED
Organic matter intake (kg/d)	12·18	12·12	12·19	0·02
Digestibility of organic matter	0·752	0·795	0·765	0·009*
Nitrogen intake (g/d)	273	362	340	1·96***
Faecal N (g/d)	91·7	86·3	88·6	3·2
Milk N (g/d)	71·4	78·2	76·4	2·04
N retention (g/d)	8·8	32·2	29·2	3·58**
Milk yield (kg/d)	13·89	14·72	14·70	0·44
Milk energy (MJ/d)†	49·2	49·3	49·6	

*$P<0·05$, **$P<0·01$, ***$P<0·001$.
†Calculated from milk composition.

N retention was low but positive in animals receiving the silage–barley diet. Inclusion of either protein source in the diet increased the digestibility of organic matter and N retention. There were associated increases in milk yield, of approximately 6%, but these reflected an increased secretion of protein and lactose and a reduced secretion of fat and the energy secreted in milk remained virtually constant.

Thomas, P. C. & Castle, M. E. (1978). The Hannah Research Institute Report, p.108.

0029–6651/80/3902–343A $00.35 © The Nutrition Society

Some preliminary observations on the absorbability of copper in fresh and conserved grass to sheep. By N. F. SUTTLE, *Moredun Research Institute, Edinburgh EH17 7JH*

The absorption of Cu (^{A}Cu) from semi-purified diets given to sheep is markedly lowered by increases in dietary Mo and S and the relationships between these three variables have been described by equations which account for 80–87% of the variation in ^{A}Cu between diets (Suttle, 1978). The prediction equations have been applied to herbage grazed by cattle (Givens & Hopkins, 1978) but such extrapolations may not be justified. The repletion technique used in the above studies has therefore been applied to the assessment of ^{A}Cu from grazed pasture, dried grass, hay and silage. In the grazing experiments, groups of five to six initially hypocupraemic ewes were grazed on the same uncut plots in June and September. Herbage intake was assessed from output of faecal organic matter (OM) and the in vitro digestibility of herbage OM. In the feeding experiments, similar groups of animals were given daily 0·6–0·7 kg DM of each of the conserved grass products of divers origin. ^{A}Cu was estimated from the responses in plasma Cu after 21 d (Suttle, 1974) and the results are compared with those predicted from the equation for semi-purified diets (see Table).

	Sample No.	Mineral content (/kg DM) Cu (mg)	Mo (mg)	S (g)	True absorption of Cu (%) By repletion	By prediction*
Fresh grass:	1	6·5	0·7	2·8	5·3	4·5
	2	6·2	3·8	2·6	1·1	3·1
	3	8·2	1·4	3·6	2·8	3·6
	4	8·9	6·1	3·8	0·5	1·6
Silage:	1	10·3	0·6	4·9	1·2	2·9
	2	13·0	1·3	3·0	1·9	4·7
	3	33·2	1·0	2·9	0·9	4·8
Dried grass:	1	5·4	0·4	2·7	3·1	3·0
	2	7·8	1·3	4·5	4·9	4·0
Hay:	1	8·7	0·4	3·9	5·8	3·8
	2	7·6	0·4	3·1	7·2	4·4
	3	8·0	2·8	3·2	5·2	3·1

*Log ^{A}Cu = −1·113—0·0714 S—0·0187 S×Mo, where S and Mo are dietary concentrations in g and mg/kg DM respectively (Suttle, 1978).

Cu in hay and dried grass was invariably more absorbable than that predicted whereas in fresh grass and silage it was, with one exception, less absorbable. Specific equations are, therefore, required for predicting the biological availability of Cu in fresh and conserved grass from information on Mo and S concentrations. The trend to conserve grass as silage rather than hay may have contributed to a general decline in the Cu status of ruminants in the UK.

Givens, D. I. & Hopkins, J. R. (1978). *J. agric. Sci., Camb.* **91**, 13.
Suttle, N. F. (1974). *Br. J. Nutr.* **32**, 395.
Suttle, N. F. (1978). *Proc. Symp. on Sulphur in Forages*, Wexford, Ireland. [J. C. Brogan, editor]. Dublin: An foran Taluntais.

0029-6651/80/3902-343A $00.35 © The Nutrition Society

Dietary manipulation of the composition of milk. By J. L. CLAPPERTON, W. BANKS and J. A. F. ROOK, *The Hannah Research Institute, Ayr KA6 5HL*

Clapperton *et al.* (1977) showed that, when dairy heifers were given a low-roughage diet containing equal amounts of dried grass cubes and flaked maize, the fat content of milk was reduced, the protein content increased and that there was an increase in the proportion of polyunsaturated fatty acids (FA) in the milk fat. When 180 g/d soya-bean oil protected by encapsulation in formaldehyde-treated casein (Cook *et al.* 1970) was added to this basal diet, there was no further increase in the polyunsaturated fatty acid content of the milk.

For 12 weeks, four Ayrshire heifers were given a low-roughage diet comprising ground dried grass cubes–flaked maize (80:20 w/w) fed either alone or with the addition of 500 g/d sunflower oil as free oil, crushed, unextracted sunflower seeds or a 2:1 mixture of oil and casein treated with formaldehyde. Before and after this period, the animals were fed on a high-roughage diet of long hay, molassed sugar-beet pulp and dairy concentrates.

	High-roughage		Low-roughage				
	Mean	SE	No additives	Free oil	Crushed seeds	Protected casein mixture	SE
Milk yield (kg/d)	16·3	0·93	15·8	16·0	16·6	17·0	0·64
Total solids (%)	12·70	0·30	12·09	11·88	11·73	12·92	0·37
Milk fat (%)	3·92	0·19	3·40	2·87	2·97	4·02	0·17*
Solids (not fat) (%)	8·78	0·15	8·70	8·76	8·82	8·91	0·12
Crude protein (%)	3·36	0·15	3·27	3·30	3·36	3·41	0·09
Fatty acids (% total FA):							
6:0–14:1	17·4	1·65	21·2	13·0	15·6	14·6	1·51*
16:0+16:1	29·5	0·94	25·2	16·8	18·3	14·9	0·56*
18:0	11·7	0·46	11·6	13·1	12·6	13·9	1·04
18:1	36·2	2·17	35·4	46·1	44·4	32·2	1·69*
18:2+18:3	5·2	0·25	6·6	10·9	9·2	24·4	0·84

*Differences are statistically significant.

The low-roughage diet alone slightly reduced the milk fat content and the addition of free oil reduced this further and reduced the proportion of all FA up to 16:1. The free oil substantially increased the proportion of 18:1 and slightly increased the polyunsaturated FA content. When the protected oil was added, the milk fat content and the polyunsaturated FA content were both markedly increased. The results are consistent with the suggestion that when the amount of the polyunsaturated FA absorbed is sufficient to saturate the blood cholesterol ester and phospholipid fractions the surplus enters the plasma free FA and triglycerides from which it is transferred into the milk (Christie, 1978).

Christie, W. W. (1978). *Prog. Lipid Res.* **17**, 111.
Clapperton, J. L., Kelly, M. E. & Rook, J. A. F. (1977). *Proc. Nutr. Soc.* **37**, 8A.
Cook, L. J., Scott, T. W., Ferguson, K. A. & McDonald, I. W. (1970). *Nature, Lond.* **288**, 178.

0029-6651/80/3902-343A $00.35 © The Nutrition Society

Changes in plasma levels of linoleic and linolenic acids in calves recently introduced to spring pasture. By C. H. McMurray, D. A. Rice and W. J. Blanchflower, *Veterinary Research Laboratories, Stoney Road, Stormont, Belfast, Northern Ireland*

Nutritional degenerative myopathy can occur in young cattle deficient in vitamin E and selenium when they are challenged by a myopathic agent, thought to be the free radicles formed by the breakdown of polyunsaturated fatty acids in tissues. Most outbreaks occur when calves are turned out to pasture in spring. Although unaccustomed exercise and rapid growth may be predisposing factors, the main factor relating to this high incidence is the high level of polyunsaturated fatty acids in young grass (McMurray & McEldowney, 1977). These acids may be hydrogenated in the rumen (Noble *et al.* 1974) and thus be incapable of producing the hydroperoxides and free radicles in animal tissues through in vivo oxidation mechanisms. Should these dietary acids lead to increased levels in tissues, then this disease would be better understood. We have measured the levels of linoleic and linolenic acids in plasma of calves before and after introduction to spring pasture.

Six Friesian calves, 8–9 months old previously fed on hay and a proprietary concentrate containing 0·2 ppm selenium, were maintained on a diet of hay and rolled barley from early February. The mean glutathione peroxidase (Gpx) level of the calves, at the time of turn-out was 71·5 IU/g Hb and alpha tocopherol concentration in plasma 0·9 μg/ml. Calves were turned out into a permanent rygrass sward on 4 June, and blood sampled according to the schedule shown in the Table. The plasma was analysed for linoleic and linolenic acids by a high performance liquid chromatographic method (Borch, 1975) after saponification using potassium hydroxide.

Time from turn-out (h)	0	24	48	72	96	120
Linolenic acid (μg/ml)	$76 \pm 6{\cdot}8^{a}$	$107 \pm 6{\cdot}2^{b}$	$151 \pm 9{\cdot}2^{c}$	$209 \pm 25{\cdot}9^{d}$	$226 \pm 22{\cdot}4^{d}$	$263 \pm 30{\cdot}8^{d}$
Linoleic acid (μg/ml)	$381 \pm 28{\cdot}9^{a}$	$376 \pm 23{\cdot}8^{a}$	$318 \pm 22{\cdot}2^{ab}$	$298{\cdot}2 \pm 26{\cdot}9^{b}$	$275 \pm 21{\cdot}3^{b}$	$293 \pm 25{\cdot}5^{b}$

a, b, c, d, Results with different superscripts are significantly different ($P<0{\cdot}05$).

A twofold increase in the linolenic acid in plasma occurred within 48 h of turn-out and a threefold increase within 72 h. Over the same period there was a decrease in levels of linoleic acid with no significant change occurring after 48 h. No disease occurred in these animals since the Gpx levels were kept high. This shows, however, that animals are subjected to a considerable change in linolenic acid status and this, under certain circumstances, could be the trigger factor for nutritional degenerative myopathy.

Borch, R. F. (1975). *Analyt. Chem.* **47**, 2437.
McMurray, C. H. & McEldowney, P. K. (1977). *Br. Vet. J.* **133**, 535.
Noble, R. C., Moore, J. H. & Harfoot, C. G. (1974). *Br. J. Nutr.* **31**, 99.

0029-6651/80/3902-343A $00.35 © The Nutrition Society

Nutrient supply from fresh grass and clover fed to housed cattle. By

D. E. BEEVER, M. J. ULYATT, D. J. THOMSON, S. B. CAMMELL, A. R. AUSTIN and M. C. SPOONER, *Grassland Research Institute, Hurley, Maidenhead, Berkshire*

Whilst the nutritional superiority of legumes over grasses is well documented (Butler *et al.* 1978), few attempts have been made to elucidate the mechanisms involved (MacRae & Ulyatt, 1974; Ulyatt & MacRae, 1974). This study was conducted to measure the nutrient supply of growing calves fed on perennial rygrass and white clover indoors.

Twelve 5-month-old calves each fitted with simple cannulas into the reticulo-rumen and proximal duodenum were used to measure duodenal flow, with ruthenium phenanthroline and chromium EDTA as markers. A further nine calves were used to measure diet digestibility and a further six calves were used to measure methane production using open-circuit calorimetry. Five diets, R1, comprising rygrass as primary growth (mean date 12–5–79); R2, trimmed primary growth (3–6–79); R3, regrowth (25–6–79); W1, white clover as primary growth (16–7–79); W2, regrowth (16–8–79), were fed at 18·0, 22·0 and 26·0 g/kg body-weight for the digestion and digestibility measurements. The CH_4 and nitrogen balance measurements were restricted to the middle level only.

Despite large differences in the chemical and agronomic characteristics of R1, R2 and R3, organic matter (OM) digestibility was similar (mean 81·7%), whilst OM digestion in the rumen amounted to 71% of total OM digestion. Although the N content of the dietary OM declined from 37·3 (R1) to 26·3 (R2) and 24·4 (R3) g/kg diet, the flow of non-ammonia N (NAN) to the duodenum remained constant (32 g/kg). Digestibility of OM in diet W1 was approximately 7 units lower than in diet W2 (80·6) but the digestion characteristics of W1 and W2 were similar. In marked contrast to the grass diets, only 55 and 50% of the digestible OM was digested in the rumen. Furthermore, NAN flow per unit digestible OM intake (DOMI) were 43·7 and 44·8 g/kg, a 40% improvement compared with the grasses.

Despite changes in the sites of OM digestion, CH_4 production (mol/kg DOMI) was constant for all diets (mean 2·23) except R1 which was significantly lower (1·87) and in consequence metabolizable energy content/MJ digestible energy varied only slightly from 0·78 to 0·81. From this data it may be concluded that even though all diets, except R3, showed a net loss of N across the rumen, the higher N intake achieved with white clover sustains a higher duodenal flow of NAN, and with the shift in the site of OM digestion, may explain some of the improvements in voluntary food intake and net energy content of legume diets.

Butler, G. W., Rae, A. L. & Bailey, R. W. (1968). *N.Z. Agric. Sci.* **3**, 8.
MacRae, J. C. & Ulyatt, M. J. (1974). *J. Agric. Sci., Camb.* **82**, 309.
Ulyatt, M. J. & MacRae, J. C. (1974). *J. Agric. Sci., Camb.* **82**, 295.

0029-6651/80/3902-343A $00.35 © The Nutrition Society

Measurement of nutrient supply at pasture. By M. J. Ulyatt, D. E. Beever, D. J. Thomson, R. T. Evans and M. J. Haines, *Grassland Research Institute, Hurley, Maidenhead, Berkshire*

Using rygrass and white clover swards similar to those described earlier (Beever *et al.* 1980) measurements were made of the flow of nutrients to the proximal duodenum in twelve calves maintained entirely at pasture. All calves had been fitted with simple cannulas into the rumen and the proximal duodenum.

To facilitate the continuous intraruminal infusion of ruthenium phenanthroline and chromium EDTA as digesta markers (Faichney, 1975), miniaturized portable peristaltic pumps were constructed, capable of constant pump rates of 5–20 ml/h. Collection of duodenal contents was achieved by the development of a fully automatic portable sampler comprising a switching valve mechanism, timer and rigid PVC container to retain the sample. Sampling frequency could be varied between 100 and 900 sec with sampling durations of 1 to 6 sec. Both devices were powered by nickel/cadmium rechargeable batteries and the total apparatus weighed 7·5 kg.

During each grazing period the animals were allocated fresh pasture at 09·00 and 17·00 hours, designed to provide 5·6 kg dry matter (DM) per 100 kg live weight (LW). A back fence was used to restrict animal access to the previous day's grazing. All animals were sampled at the duodenum for two separate 24 h periods, 5 d after the start of the infusion of markers. Sampling from all animals covered a total of 6 d for each period and 87% of planned collections were successful.

It can be seen from the Table that NAN flow/kg live weight was highest on R1, and declined to 0·67 on the two regrowths, whilst W1 and W2 gave intermediate values. Similarly, OM flow/kg live weight was highest on diets R1, W1 and W2.

For the clover diets NAN content of duodenal OM was identical to values observed by Beever *et al.* (1980) with housed cattle, whilst the values recorded on the grass diets were on average 8% lower. Assuming the same partition of OM digestion as was observed indoors in the previous study, it can be calculated that NAN flow/kg digestible OM intake (DOMI) averaged 34·7 g on the grasses and 48·5 g on the clover, values very similar to those recorded by Beever *et al.* (1980).

Diet	Non-ammonia nitrogen flow (g/kg live weight)	Organic matter flow (g/kg live weight)	Non-ammonia nitrogen flow/digestible organic matter intake (g/kg)
R1	0·93	13·0	33·7
R2	0·69	10·2	32·7
R3	0·65	9·9	37·8
W1	0·75	13·3	48·2
W2	0·80	13·1	48·8

Beever, D. E., Ulyatt, M. J., Thomson, D. J., Cammell, S. B., Austin, A. R. & Spooner, M. C. (1980). *Proc. Nutr. Soc.* (In the Press).

Faichney, G. J. (1975). In *Digestion and Metabolism in the Ruminant*, p. 277. [I. W. McDonald and A. C. I. Warner, editors]. Armidale: University of New England Press.

0029-6651/80/3902-343A $00.35 © The Nutrition Society

The rate of digestion of the dry matter of forage material conserved in different ways. By E. JILL SMITH, J. L. CLAPPERTON and J. A. F. ROOK, *The Hannah Research Institute, Ayr KA6 5HL*

The voluntary intake of dry matter (DM) in silage of high digestibility by dairy cows is low and appears to be regulated by a physical mechanism (Thomas *et al.* 1976). In the experiment reported here, the extent of ruminal degradation of forage materials conserved in different ways was determined by incubating the materials in Dacron bags (Mehrez & Ørskov, 1977).

On two occasions during the spring of 1979, when the D-value was expected to be about 70 and 60, a crop of S23 Perennial Rygrass was cut and conserved either by ensiling, freezing, drying or as hay.

Disappearance of DM (g/kg)

Incubation time (h)...		3	6	12	24	48
Cut 1	Silage	188	215	272	444	626
	Frozen	191	206	276	499	685
	Dried	169	205	286	474	642
	Hay	149	185	277	448	634
Cut 2	Silage	227	233	316	444	626
	Frozen	198	220	314	460	570
	Dried	143	160	240	374	587
	Hay	108	130	187	303	535

LSD 40.

The results (see Table) show that there were no significant differences between the different conservation methods in Cut 1. In Cut 2, the dry materials (dried grass and hay) were digested more slowly than the wet materials (silage and frozen grass). It is concluded that these results do not explain the observed differences in food intake between the different methods of conservation.

Mehrez, A. S. & Ørskov, E. R. (1977). *J. Agric. Sci.* **88**, 645.
Thomas, P. C., Kelly, N. C. & Wait, M. K. (1976). *J. Br. Grassld Soc.* **31**, 123.

0029-6651/80/3902-343A $00.35

Seasonal live-weight gain of cattle at a range of stocking rates. By M. J. Watson*, P. R. Bird and J. W. D. Cayley, *Pastoral Research Institute, Hamilton, Victoria, Australia*

Animal production systems based on grazed pastures involve a compromise between a high level of animal performance and high efficiency of utilization of pastures.

A grazing experiment was conducted at the Pastoral Research Institute between 1974 and 1978. The mean annual rainfall is 740 mm and the climate is Mediterranean with a growing season extending on average from mid-April to mid-December. The soils are derived from basalt, and pastures predominantly perennial rygrass (*Lolium perenne*, cv. Victorian) and subterranean clover (*Trifolium subterranean*, cv. Mt. Barker) fertilized with superphosphate–potash (5:1; 24 kg/ha) each autumn. Each year, commencing in mid-February, weaner Hereford steers (approximately 240 kg fasted live weight) were allocated to five stocking rates (SR; steers/ha) each SR being replicated twice. The relationship between SR and seasonal live-weight gains, (LWG) for individual years are shown in the Table.

	Autumn–winter					Spring–early summer				
SR...	1·2	1·8	2·4	3·0	3·3	1·2	1·8	2·4	3·0	3·3
Year										
1975*	60	36	7	−13	−5	89	85	107	111	65
1976	73	47	13	−4	−12	124	117	125	131	123
1977	86	60	10	−7	−22	119	125	137	142	117
1978†	78	77	25	15	−9	117	124	144	152	143
Mean	74	55	14	−2	−12	112	113	128	134	112

*Values are the mean of 20 animals.
†In 1978 the SR were 1·1, 1·6, 2·2, 2·7 and 3·3 steers/ha.

In autumn–winter (early March to late August) the dry residues from the previous spring have been depleted and low availability of green pasture limits LWG with the degree of restriction depending on SR. In spring–early summer (September to mid-January) LWG is less dependent on SR and if the highest SR is ignored then the trend is for increased LWG as SR rises. It was not possible to account for this trend solely in terms of either pasture effects or previous nutrition of the steers, because both factors were confounded.

In the years 1975–1978 the mean percentage compensation in weight differences present in early spring of steers at the second highest SR when compared with the two lowest SR was 31%, however, this compensation was variable, ranging from 3 to 50%. Experiments examining these questions are currently in progress.

*Present address: Department of Animal Science, University of Ife, Nigeria.

0029-6651/80/3902-343A $00.35

Hemicellulosic contamination of acid-detergent residues and their replacement by cellulose residues in cell wall analysis. By I. M. MORRISON (*introduced by* P. C. THOMAS), *The Hannah Research Institute, Ayr KA6 5HL*

The importance of fibre measurements in diets has been recognized for many years but since the chemical constituents of fibre interact with each other, a measure of these individual constituents would have even greater importance in both human and animal nutrition. Methods are available but are too time-consuming to be used on a routine basis (e.g. Southgate, 1969). The introduction of detergent-fibre methods led to suggestions for the use of these methods in more rapid analyses of cell wall components (Van Soest, 1963). Van Soest (1966) claimed that neutral-detergent residues (NDR) contained cellulose, hemicelluloses and lignin, while acid-detergent residues (ADR) contained cellulose and lignin so, if lignin itself was determined, cellulose and hemicelluloses could be determined by difference.

Acid-detergent residues have been prepared from twenty-six plant samples, covering fruits, vegetables, legumes, forages and woods. The carbohydrate compositions of these residues were determined by acidic hydrolysis and gas–liquid chromatography of the aldononitrile acetates of the neutral sugar residues. Up to 15·4% of the sugar residues present were neutral sugars other than D-glucose and which were derived from hemicelluloses.

At the same time, residues were prepared from the twenty-six samples by a modification of the acetic–nitric acid method (Crampton & Maynard, 1938). On determination of the neutral sugar composition of these residues, up to 9·6% of the sugar residues present were neutral sugars other than D-glucose. The percentage of non-D-glucose residues present in these preparations was always higher in the acid-detergent residues.

The amount of contamination appeared to be related to the lignin–phenolic acid content of the plant material but the relationship was not a linear one for all species. It may be directly correlated within a family, for example in the grasses. The contamination had little effect on the cellulose content of plant materials with very low lignin contents, but was important in plants with a high percentage of cell wall. As a typical example, the cellulose content of mature timothy stem was overestimated by 4·2%.

Crampton, E. W. & Maynard, L. A. (1938). *J. Nutr.* **15**, 383.
Southgate, D. T. A. (1969). *J. Sci. Fd Agric.* **20**, 331.
Van Soest, P. J. (1963). *J. Assoc. Off. Agric. Chem.* **46**, 825.
Van Soest, P. J. (1966). *J. Assoc. Off. Anal. Chem.* **49**, 546.

0029-6651/80/3902-343A $00.35

Effect of hay particle size on retention time, dry matter digestibility and rumen pH in sheep. By B. F. M. Dafaalla and R. N. B. Kay, *Rowett Research Institute, Bucksburn, Aberdeen AB2 9SB*

A timothy-ryegrass hay was given as two meals totalling 800 g/d to each of four Suffolk-Blackface wethers fitted with rumen cannulas and weighing 40–44 kg. The hay was either ground or chopped and was given according to a 4×4 Latin Square design.

A dose of ^{103}Ru-phenanthroline in 90 ml of water was mixed with about 30 g of the hay, dried to 40° and put into the rumen. Faeces were collected for 8 d for determination of ^{103}Ru retention time (MRT) and dry matter (DM) digestibility. At the end of each period the pH of rumen contents was determined just before, and 1 h after the morning feed.

	Particle size (mm)				LSD	
	2	5	20	Chopped	5%	1%
MRT (h)	38·9	41·1	43·4	45·3	3·28	5·32
DM digestibility	0·463	0·504	0·541	0·551	0·025	0·038
Fall in pH	0·48	0·43	0·25	0·19	0·21	0·32

There were significant effects of particle size on MRT, DM digestibility and fall in pH from a prefeeding value of 6·7 (see Table). These results are in agreement with previous reports, e.g. Alwash & Thomas (1974), in showing a decrease in MRT and DM digestibility when a hay diet is finely ground.

Partition of MRT between rumen and caecum plus proximal colon by the method of Grovum & Williams (1973) showed only a slight tendency for the fine hay to have a shorter rumen MRT than coarser hays, but retention of the fine hay in the caecum-colon was substantially shorter. The reduced DM digestibility of the finely ground hay may have been due more to curtailed fermentation in the hind gut than in the rumen.

When the hay was incubated in nylon bags in a water bath the loss of DM after 1 h incubation was 21, 14, 13 and 9% from the 2 mm, 5 mm, 20 mm and chopped material respectively. Only 2–4% of this loss was particulate matter retained on filter paper; the rest was soluble which perhaps explains the sharp fall in pH after feeding.

Alwash, A. H. & Thomas, P. C. (1974). *J. Sci. Fd Agric.* **25**, 139.
Grovum, W. L. & Williams, V. J. (1973). *Br. J. Nutr.* **30**, 313.

0029-6651/80/3902-343A $00.35

Prolonged periods of unstable fermentation in the rumen contents of sheep. By J. W. CZERKAWSKI, *Hannah Research Institute, Ayr KA6 5HL*

After several years work with artificial rumen, about 10 years ago, prolonged periods were observed, when incubation of rumen contents of sheep resulted in an unstable fermentation. During those periods the addition of a readily fermented substrate (glucose or sucrose) decreased the production of methane and resulted in accumulation of hydrogen gas, but did not change the production of carbon dioxide. The instability was detected using the short-term artificial rumen techniques (large and small scale Czerkawski & Breckenridge, 1969 and 1970 respectively) or the rumen simulation technique (Rusitec; Czerkawski & Breckenridge, 1977).

Our work in the biochemistry of the microbial system of the rumen in general and the mechanism of production and inhibition of methane in particular, required frequent incubations of rumen contents in vitro (two or more incubations/month) and these determinations covered most of the period 1966–1980.

There were three periods of instability in 1968–1970 and two recent episodes in 1978 and 1979. An examination of our records during 1966–1980 showed that during 1971–1977 there were no periods of instability. The instability lasted 6–8 weeks, it seemed to affect all the donor sheep and it did not depend on the diet. The periods of instability were not seasonal. The recovery was usually rapid (a few days) and on one occasion, occurred at about the same time in the donor sheep and in Rusitec, which was kept in the laboratory far removed from the donor animals.

It is hoped that this report will induce ruminologists to re-examine their amassed data. A more general survey of similar phenomena may help in their elucidation. If the periods of instability are widespread, they may explain some of the variability in long-term experiments with animals.

Czerkawski, J. W. & Breckenridge, G. (1969). *Br. J. Nutr.* **23**, 51.
Czerkawski, J. W. & Breckenridge, G. (1970). *Lab. Pract.* **19**, 717.
Czerkawski, J. W. & Breckenridge, G. (1977). *Br. J. Nutr.* **38**, 371.

0029-6651/80/3902-343A $00.35