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PROCEEDINGS OF THE NUTRITION SOCIETY

ABSTRACTS OF COMMUNICATIONS

The Three Hundred and Eighth Meeting of the Nutrition Society was held in the Ground Floor Lecture Theatre, Atkins Building, Queen Elizabeth College, Campden Hill, London W8 7AH on Tuesday, 13 *September,* 1977, *when the following papers were read:*

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Ephedrine, a thermogenic and potential slimming drug. By M. MASSOUDI and D. S. MILLER, *Department of Nutrition, Queen Elizabeth College, London W8 7AH*

The thermogenic activity of ephedrine (E) was compared with that of triiodothyronine (T_3) by incorporating both drugs into the diets (T_3, 400 μg/kg; E, 1 g/kg diet) fed to groups of four adult laboratory animals for 5 weeks (mice) and 8 weeks (rats). The animals used were normal lean mice (CBA strain), mice made obese with gold thioglucose (GTG) (Djazayery & Miller, 1973) and with monosodium glutamate (MSG) (Bunyan *et al.* 1976), mice and rats (Hooded) made obese by diet (HPHF) (Miller & Parsonage, 1971), and genetically obese mice (obob) and rats (Zucker). Food intake and body-weight were monitored throughout, and 24 h oxygen consumption measurements (Boroumand & Miller, 1976) were made at least once during the experimental period. Finally the animals were killed and their carcasses analysed.

		Food intake		Oxygen consumption		Body-weight		Carcass protein		Carcass fat	
		T_3	E	T_3	E	T_3	E	T_3	E	T_3	E
Mice:	obob	•	0·79	•	1·16	•	0·80	•	0·86	•	0·72
	GTG	1·53	0·66	1·88	1·13	0·78	0·64	0·85	0·83	0·43	0·29
	MSG	1·33	0·82	1·43	1·22	0·96	0·69	1·08	0·91	0·78	0·43
	HPHF	1·57	1·02	1·44	1·22	1·00	0·82	1·10	0·98	0·69	0·32
	Lean	1·49	1·00	1·85	1·22	1·00	0·95	1·13	0·94	0·83	0·71
Rats:	Zucker	•	0·55	•	1·25	•	0·59	•	0·88	•	0·34
	HPHF	1·13	0·72	1·48	1·08	0·77	0·81	0·78	0·84	0·24	0·37

•Animals died.

The results are shown in the table. Generally, T_3 increased oxygen consumption but also increased food intake; it killed the genetically obese animals, but reduced body-weight and fat in GTG and HPHF animals. On the other hand, the animals treated with E lost body-weight and body fat without increasing food intake, and had elevated oxygen consumptions.

This experiment not only demonstrated marked differences between the various laboratory animal models of obesity, but also that E is a potential slimming agent. It is relatively safe and has been used by us to obtain successful breeding using the genetically obese male animals which are normally sterile.

Boroumand, N. & Miller, D. S. (1976). *Proc. Nutr. Soc.* **36**, 12A.
Bunyan, J., Murrell, A. E. & Shah, P. P. (1976). *Br. J. Nutr.* **35**, 25.
Djazayery, A. & Miller, D. S. (1973). *Proc. Nutr. Soc.* **32**, 30A.
Miller, D. S. & Parsonage, S. R. (1971). *Proc. Nutr. Soc.* **31**, 31A.

The effect of ephedrine on the oxygen consumption of fed and fasted subjects. By ELIZABETH EVANS and D. S. MILLER, *Queen Elizabeth College, London W8 7AH*

As a result of the previous study by Massoudi & Miller (1977) evidence of thermogenic activity of ephedrine was looked for in man. This paper reports on the effect of ephedrine on the oxygen consumption of fed and fasted subjects.

Ephedrine has been widely used as a decongestant for asthmatic sufferers, and many patent preparations containing this compound are freely available over the counter. Accordingly, one brand containing 22 mg ephedrine per tablet was used in this trial. Nine healthy volunteers (one male, eight female) were given on three occasions, either 44 mg ephedrine (2 tablets), or 1·26 MJ (300 kcal) of a liquid meal (Complan), or ephedrine plus the liquid meal. Oxygen consumption was measured using the Benedict Roth spirometer. The subjects were asked to come in fasting in the morning and rested for at least 30 min before measurements were made. Four readings were then taken preprandially and six serial readings were taken over 135 min postprandially.

A summary of the results for the nine subjects is shown in the table:

	Mean oxygen consumption (ml/min $\dot{V}_{O_2} \pm$ SE)		
	Ephedrine	Meal (1·26 MJ)	Ephedrine+meal
Preprandial	207±10·5	209±8·7	205±11·2
Postprandial	236± 8·6	237±9·7	247±12·4
$\Delta \dot{V}_{O_2}$	29± 1·4	27±4·2	41± 4·2

Ephedrine had a marked effect on oxygen consumption equivalent to that obtained with the 1·26 MJ (300 kcal) meal. When ephedrine was combined with the meal a greater increase in oxygen consumption was observed than with the ephedrine or the meal alone.

Clearly ephedrine produces a thermic effect in man when given as a single dose. Further investigations are required to determine the effect of exercise and prolonged administration. The value of ephedrine in promoting loss of body fat in the refractory obese is being assessed.

Massoudi, M. & Miller, D. S. (1977). *Proc. Nutr. Soc.* **36**, 135A.

The effect of fasting and refeeding on whole-body protein synthesis in the rat. By C. C. Lo and D. J. Millward, *Department of Human Nutrition, London School of Hygiene & Tropical Medicine, Hospital for Tropical Diseases, 4 St Pancras Way, London NW1 2PE*

During a constant intravenous infusion of a labelled amino acid, the rate of whole-body protein synthesis can be estimated by comparing the plateau value of the specific radioactivity (SR) of the labelled amino acid in the plasma with the rate of infusion. This gives the amino acid flux (Waterlow & Stephen, 1967). Because the plasma SR is always higher than the intracellular SR the flux will probably be underestimated. As an alternative the fractional rate of protein synthesis (FSR) can be determined by measuring the mean SR of the protein-bound and free amino acid in the whole body at the end of the infusion. The FSR can then be calculated in the same way as individual tissues (Garlick *et al.* 1973). We have now done this to examine the effects of fasting and refeeding on the whole-body FSR in the rat.

Male Wistar rats (100 g) were infused via the tail vein with a total of 2·5 μCi [^{14}C]tyrosine for 6 h. After this they were decapitated, bled and the whole body minus the blood frozen in liquid nitrogen. It was then homogenized in cold 5% trichloroacetic acid and the SR of the free and protein-bound tyrosine determined as well as the protein and RNA content. The FSR was calculated (with the 'muscle' formula) as previously described by Garlick *et al.* 1973).

Whole-body RNA concentration and rate of protein synthesis in rats during fasting and refeeding

(Mean values and standard deviations)

	RNA/protein $\times 10^3$	Fractional protein synthesis rate (%/d)	RNA activity (g protein synthesis/ g RNA per d)
Initial well-fed	29·7±0·8	27·4±2·2	9·5±0·9
1 d fasted	25·3±2·3	19·3±3·5	7·7±1·5
3 d fasted	19·0±2·0	17·1±4·6	8·9±2·2
1 d refed	23·7±1·8	29·1±4·0	12·5±1·0
5 d refed	38·8±3·9	30·7±3·8	7·9±1·0

Fasting induced a 37% fall in the FSR but 1 d refeeding completely restored the control value. These changes involved primarily alterations in total body RNA concentrations, but in addition the RNA activity appeared to be somewhat increased after 1 d refeeding. These values for the FSR ought to be more reliable than previous estimates derived from the amino acid flux.

Garlick, P. J., Millward, D. J. & James, W. P. T. (1973). *Biochem. J.* **136**, 935.
Waterlow, J. C. & Stephen, J. M. L. (1967). *Clin. Sci.* **33**, 489.

The unreliability of urinary 3-methylhistidine excretion as a measure of muscle protein degradation in sheep. By C. I. HARRIS and G. MILNE (Introduced by G. E. LOBLEY), *Rowett Research Institute, Bucksburn, Aberdeen AB2 9SB*

3-Methylhistidine excretion in urine has been established as a valid index of muscle protein degradation in the rat, man and the adult rabbit (Harris *et al.* 1977). Such an index of protein degradation would be invaluable for the main farm species and could be a useful guide in the genetic selection of animals for maximum efficiency of protein deposition. The use of urinary 3-methylhistidine excretion to quantitate muscle protein degradation rests on certain assumptions: an absence of dietary 3-methylhistidine, that actin and myosin are degraded at similar rates and that 3-methylhistidine released from protein is rapidly and quantitatively eliminated in urine. The kinetics of urinary excretion were studied after intravenous administration of 3-[^{14}C-Me]methylhistidine. Recoveries in animals over a range of ages were incomplete after 7 d (highest recovery obtained 78% in 6 year old blackface ewe) although tissue pools of free 3-methylhistidine appear relatively low (15–30 nmol/g muscle, 10–30 nmol/ml blood).

It was found that the concentration of free 3-methylhistidine substantially increased (up to ten times) after acid hydrolysis of perchloric acid extracts of muscle while similar extracts of blood showed much smaller increases (total non-protein-bound 3-methylhistidine of 100–500 nmol/g muscle, 15–40 nmol/ml blood). Deproteinized extracts of muscle from an animal injected intravenously with 3-[^{14}C-Me]methylhistidine 4 h before death showed two radioactive components on ion-exchange chromatography, one apparently identical with free 3-methylhistidine. The identity of the other 3-methylhistidine-containing component is under investigation but does not appear to be *N*-acetyl-3-methylhistidine. The wide range of values for total non-protein bound 3-methylhistidine in muscle reflects variations in both absolute concentration and relative proportions of the two components and may be age related i.e. the body-pool size may not be constant.

The daily urinary excretion of 3-methylhistidine in a 60 kg sheep is in the range 5–15% of the total muscle pool of non-protein bound 3-methylhistidine (approx. 200 nmol/g muscle). Small fluctuations in muscle pool size thus dramatically alter apparent excretion rates. Since the control of pool size and its fluctuations with time are unknown, the use of urinary 3-methylhistidine excretion in sheep is not a reliable measure of muscle protein degradation.

Harris, C. I., Milne, G., Lobley, G. E. & Nicholas, G. A. (1977). *Biochem. Soc. Trans.* (In the Press.)

The effect of increasing the dietary lysine concentration on food intake and growth in the Zucker rat. By J. D. RADCLIFFE, *Department of Human Nutrition, The State Agricultural University, De Dreijen* 11, *Wageningen, The Netherlands*

The rates of food intake and growth of normal rats, given gluten-containing diets which do not support the maximal rate of growth, can be improved by increasing the dietary lysine concentration. However, if this increase is too great, both rates are depressed (e.g. Muramatsu *et al.* 1973). The following experiment was done to see if the same would be true for the Zucker fatty rat and also to try to gain an understanding of the regulation of the food intake of both phenotypes (fatty and lean) of Zucker rat having sub-maximal rates of protein deposition, a regulation which is not well-understood (Radcliffe & Webster, 1976; Radcliffe, 1977).

Four 34-d-old female rats of each phenotype were given, *ad lib.*, one of four iso-nitrogenous, iso-energetic, semi-synthetic diets until slaughter, at 66 d of age. The basal diet (diet A) contained 100 g gluten/kg. In the other three diets gluten was replaced by L-lysine hydrochloride at levels of 10, 20 or 50 g/kg diet (diets B, C and D respectively). Collections of urine and faeces were made to determine the metabolizable energy (ME) in the diets. Animals were analysed individually for total body protein and lipid. Body energy was calculated therefrom. Retentions of protein, lipid and energy were calculated by the comparative slaughter procedure.

The results were:

Phenotype	Diet	ME intake (MJ)	W increase (g)		Protein retention (g)		Lipid retention (g)		Energy* retention (MJ)
			Mean	SE	Mean	SE	Mean	SE	
Fatty	A	6·61	58·2	2·8	2·55	0·17	42·2	2·0	1·7
	B	8·22	122	2·7	8·32	0·32	57·2	2·3	2·4
	C	8·56	126	2·3	8·10	0·33	64·0	2·4	2·6
	D	5·24	25·1	1·4	−1·12	0·11	5·13	0·19	0·17
Lean	A	4·70	1·8	0·16	1·37	0·15	6·50	0·31	0·28
	B	5·70	21·7	1·3	6·30	0·16	9·31	0·48	0·50
	C	4·91	1·92	0·11	1·45	0·09	5·10	0·13	0·23
	D	3·50	−20·0	1·8	−1·93	0·14	−1·52	0·17	−0·10

*Assuming the heats of combustion of body lipid and body protein to be 38 and 23 MJ/kg respectively.

By increasing the dietary lysine concentration it was possible to influence the rate of food intake and growth in the fatty as well as in the lean rats, although the effect of the increase was slightly different for the two phenotypes. Whilst the animals of both phenotypes given diet B, and the fatties given diet C, had higher rates of protein deposition than the corresponding animals given diet A, they did not achieve the maximal rate attainable during this period (0·78 g/d). The results will be discussed further.

Muramatsu, K., Takeuchi, H. & Sakuari, K. (1973). *J. Nutr. Sci. Vitaminol.* **19**, 277.
Radcliffe, J. D. (1977). The regulation of food intake during growth in obese (fatty) and lean rats of Zucker strain. PhD Thesis, University of Aberdeen.
Radcliffe, J. D. & Webster, A. J. F. (1976). *Br. J. Nutr.* **36**, 457.

Intravenous glucose tolerance and insulin secretion in growing offspring of congenitally malnourished rabbits. By M. R. TURNER, J. S. BRYANT and J. C. CARTER, *School of Biochemical and Physiological Sciences, The University, Southampton SO9 3TU*

Glucose tolerance is poor in the young animal but increases progressively with age until the adult level is attained. This pattern of development can be modified by protein-energy malnutrition (PEM) which eventually results in impairment of glucose tolerance, normally accompanied by poor insulin secretion and hypoglycemia. These diet-induced changes are substantially reversed by nutritional therapy.

New Zealand white rabbits were given from mating diets containing (g/kg dry weight) either 180 protein from soya bean (Promine D + methionine) and wheat bran with 80 sucrose and 316 corn starch (P18S8 diet) or 120 protein with 80 sucrose and 381 maize starch (P12S8 diet). Both diets contained 160 g/kg corn oil, plus bran, cellulose, minerals and vitamins. The offspring were weaned onto a diet high in protein (P18) and sucrose (S32 i.e. 320 g/kg) intended to simulate in general terms the diet typical in the UK which is rich in fat, sucrose and protein. A further group of animals was maintained throughout on the stock diet (RAG; Christopher Hill Ltd, Poole, UK).

The increase in glucose tolerance during growth described previously for dogs, pigs, rats and humans is confirmed in rabbits. Tolerance in the offspring of mothers given the P18S8 diet was slightly but not significantly depressed both at weaning and subsequently whilst being maintained on the P18S32 diet. In the offspring of mothers given the P12S8 diet and weaned onto the P18S32 diet, however, glucose tolerance was significantly impaired.

	i.v. glucose tolerance (K)		
Maternal diet	Stock	P18S8	P12S8
postweaning diet	Stock	P18S32	P18S32
	(n=6)	(n=10)	(n=10)
6 weeks (weaning)	1·8±0·2	1·4±0·3	$^{\bullet}$0·9±0·2
12 weeks	2·4±0·1	2·2±0·3	$^{\bullet\bullet}$1·6±0·2
18 weeks	2·6±0·1	2·2±0·2	$^{\bullet\bullet\bullet}$1·9±0·1

Significance of difference from stock group (Student's t): $^{\bullet}P<0·02$; $^{\bullet\bullet}P<0·01$; $^{\bullet\bullet\bullet}P<0·001$.

There were major differences in insulin secretion in the three groups. The maximal serum insulin concentration (μU/ml) after intravenous glucose ranged from 40 at 6 weeks to 70 at 18 weeks in the stock group, from 4 at 6 weeks to 20 at 18 weeks in the P18S8 group and from 6 at 6 weeks to 10 at 18 weeks of age in the P12S8 group. Even though glucose tolerance is impaired and insulin secretion is poor in PEM, the fasting serum glucose is rarely elevated and is usually reduced. In these experiments, however, the fasting glucose concentration was significantly elevated by about 30% at all ages between 6 and 18 weeks in both of the experimental groups, relative to animals given the stock diet.

Water supplies and nutritional status in rural Northern Nigeria. By A. M. TOMKINS, *Department of Human Nutrition* and B. S. DRASAR, *Department of Microbiology, London School of Hygiene and Tropical Medicine* and A. K. BRADLEY and A. WILLIAMSON, *Liverpool School of Hygiene and Tropical Medicine Team, Ahmadu Bello University, Malumfashi, Nigeria*

The importance of gastroenteritis in the genesis of malnutrition is recognized, but the precise factors responsible for intestinal disease are not clear. Bacterial colonization of the upper intestine in children (Mata *et al.* 1972) and adults (Tomkins *et al.* 1975) appears important but environmental factors, in particular water supply, require elaboration.

Nutritional indices of preschool children were measured by an anthropometric study of a randomized subsample from the enumerated population of Gamzago, a village of population 11 000 in the Guinea Savanna region of N. Nigeria, an area in which water-related diseases are the commonest cause of visits to mobile clinics or hospitals (21%). Measurements at the end of the dry season, April–May 1977, showed that 'stunting' (<90% ht/age (Jelliffe, 1966)) occurred in increasing incidence from 5·8% in year 1 to 57·2% in year 4 of life, whereas 'wasting' (<80% wt/ht (Jelliffe, 1966)) occurred predominantly in the 2nd and 3rd years of life (35·1% and 13·5% respectively) falling to less than 11% by year 4. 'Wasting', in many cases associated with gastroenteritis, occurred more commonly (37·6%) among families using unprotected water (uncovered wells or ponds) than among those using protected sites (covered wells) (10·9% $P<0·01$). Stunting occurred in similar proportions in each group. Bacterial culture of water from unprotected sites showed greater colonization by coliforms ($4·3\pm0·3$ $\log_{10}$ bacteria/ml) than in protected water ($1·98\pm0·5$ $\log_{10}$ bacteria/ml, $P<0·05$) but overnight storage in earthenware storage vessels permitted counts to fall. Samples of Guinea maize pap made with this water were all coliform free but solid food sources (beans, beancakes) were grossly contaminated (up to 4·9 $\log_{10}$ bacteria/g).

The implication is that water purity may be unimportant in the poor hygiene–gastroenteritis complex in malnutrition and suggests that other aspects of water supply such as volumes available and patterns of utilization require investigation.

Jelliffe, D. B. (editor) (1966). *Harvard Standard Tables in Assessment of the Nutritional Status of the Community*. Geneva: World Health Organization.

Mata, L. J., Jiminez, F., Cordon, M., Rosales, R., Prera, E., Schneider, R. E. & Viteri, F. (1972). *Am. J. clin. Nutr.* **25**, 1118.

Tomkins, A. M., Drasar, B. S. & James, W. P. T. (1975). *Lancet* i, 59.

Acid and pepsin secretion in young pigs reared solely by the sow or supplemented with solid food and weaned at 21 d. By P. D. CRANWELL, *School of Agriculture, La Trobe University, Bundoora, Victoria* 3083, *Australia*

Gastric secretion of HCl and pepsin was measured in young pigs at intervals from 9 to 38 d of age. One group (milk-fed) was reared solely by the sow, whereas the other group (creep-fed) was reared by the sow for 21 d, but was allowed access to solid food (21% crude protein) at 12 d and was entirely dependent on solid food after 21 d.

Pigs were anaesthetized, the stomach was perfused at a constant rate with Ringers solution and gastric secretion was stimulated by intravenous infusion of betazoline hydrochloride (Histalog; Eli Lilly, Indianapolis, Indiana, USA) at 3 mg/kg per h for 2 h. HCl and pepsin were measured in the perfusate which was collected at 15 min intervals. The results are summarized in the table:

Age (d)		9–12	18–21	27–32	34–38
No. of pigs per treatment		4	6	5	5
Live weight (kg)	Milk-fed	3·4±0·3	**6·3±0·3	**9·3±0·6	**12·1± 0·2
	Creep-fed	§2·9±0·2	**5·8±0·3	**†7·9±0·6	**†10·1±0·4
Stomach weight (g)	Milk-fed	20·0±2·3	*29·5±1·4	**47·9±3·7	**66·9± 3·7
	Creep-fed	§17·5±0·6	*29·8±1·5	**53·6±3·3	**71·8± 4·6
Acid secretion (mmol H^+/2 h)	Milk-fed	5·2±1·2	5·6±1·3	9·1±2·4	9·0± 2·5
	Creep-fed	§4·0±0·6	8·0±0·6	*†15·0±2·6	13·0± 2·0
Pepsin secretion (kunits/2 h)	Milk-fed	3·1±0·4	7·6±2·4	23·5±2·4	44·3±14·6
	Creep-fed	§1·8±0·4	16·9±2·2	**†50·7±8·7	†70·7± 8·2

Results expressed as mean ± SEM.
Significance of differences between age within treatments: $^{*}P<0.05$, $^{**}P<0.01$.
Significance of differences between treatments within age: †$P<0.05$.
§Received only sow's milk during this period.

For each treatment acid secretion increased with age only up to 4 weeks, whereas pepsin secretion increased with age throughout the period of the experiment. The amount of stomach tissue per animal and per unit live weight was greater in the creep-fed pigs in the two oldest age groups, whereas HCl and pepsin secretion were greater in these pigs from an earlier age, i.e. at 18–21 d. In addition their acid and pepsin secretory outputs per unit stomach tissue were also greater than in the milk-fed pigs.

Earlier experiments in pigs with separated Heidenhain fundic pouches lacking vagal innervation (Cranwell & Titchen, 1974, 1976) indicate that hormonal influences may be important in the development of the secretory capacities of the stomach. Gastrin has a trophic effect on the gastric mucosa in adult rodents and dogs (Johnson, 1977) and it could have a similar action on the development of parietal and peptic cells in the young pig. In these experiments an increase in stomach weight and gastric secretion was induced by the intake of solid food but, it remains to be determined whether gastrin mediates these trophic effects.

Cranwell, P. D. & Titchen, D. A. (1974). *Res. vet. Sci.* **16**, 105.
Cranwell, P. D. & Titchen, D. A. (1976). *Proc. Nutr. Soc.* **35**, 28A.
Johnson, L. R. (1977). *Gastroenterology* **72**, 788.

The effect of by-passing the jejunum of 9–14 day old pigs on the activities of three enzymes in it later in life. By R. A. McCance, A. W. Wilkinson and C. A. Artavanis, *Sidney Sussex College, Cambridge, and The Institute of Child Health, Guilford Street, London*

The operation procedures and the effect of by-passing the jejunum of pigs on its length and mass were briefly described by McCance & Wilkinson (1977). When the animals were 7·5 to 24 months old each one was killed at the slaughterhouse with a litter mate or sized-matched control. The jejuna of both animals were divided into three equal parts, chilled and processed for storage as described by Widdowson *et al.* (1976). The enzymes studied were acid phosphatase (orthophosphoric monoester phosphohydrolase, *EC* 3.1.3.2), amylase (α-1,4-glucan glucohydrolase, *EC* 3.2.1.3) and lactase (neutral β-galactohydrolase, *EC* 3.2.1.23). The activity of the amylase was determined by the method of Schlegel-Haueter *et al.* (1972) using a standard obtained from Merck, that of the acid phosphatase and of the lactase as given by Widdowson *et al.* (1976). The two former were stable on storage for 100 d, but the lactase lost about 20% of its activity on storage for this time, so the activity in each by-passed jejunum was determined as soon as possible and always at the same time as that of its control. Twelve normal and fifteen experimental animals have been used.

Per g mucosal protein the mean activity of the amylase in the normal jejuna did not differ significantly from that found in the by-passed organs: nor was the activity affected by the distance from the pylorus. The findings for acid phosphatase were similar. The mean activity of the lactase, however, was always significantly higher in the by-passed jejuna than in the normal ones ($P=0·005$, $P<0·025$ and $P<0·01$) in the upper, middle and lower thirds respectively. The activity, moreover, was highest in the proximal third and fell progressively to the distal third ($P<0·001$) (Manners & Stevens, 1972).

Since the by-passed segments were thinner and lighter than the normal ones and contained less mucosal protein/mm gut, the activities of all three enzymes appeared materially lower in the by-passed intestines when expressed per cm of length than per g mucosal protein.

McCance, R. A. & Wilkinson, A. W. (1977). *Proc. Physiol. Soc.* (In the Press.)
Manners, M. J. & Stevens, J. A. (1972). *Br. J. Nutr.* **28**, 113.
Schlegel-Haueter, S., Hore, P., Kerry, K. R. & Semanza, G. (1972). *Biochim. biophys. Acta* **258**, 506.
Widdowson, E. M., Colombo, V. E. & Artavanis, C. A. (1976). *Biol. Neonat.* **28**, 272.

The digestibility of wheat starch and maize starch by the pre-ruminant calf. By D. G. EDWARDS, *The Lord Rank Research Centre, Lincoln Road, High Wycombe, Bucks.* and P. BARRE, *Union des Cooperatives Agricoles d'Alimentation du Betail, Chateau Thierry, France*

Prompted by the current escalation in the energy cost of feed ingredients, three samples of wheat starch and, for comparison, one of maize starch, were fed to calves in milk replacer formulations in order to measure their digestibilities as potential alternative energy sources. The wheat starch samples (Tenstar Products Ltd, Ashford, Kent) were: a normally processed mixed starch (low damage, LD), a mixed starch which had been subjected to a more severe physical process such that damage was inflicted on the starch grains (high damage, HD), and a further low damage sample consisting mostly of A starch grains. The maize starch was a commercially available product (Snowflake; CPC (UK) Ltd).

Fifteen male Friesian calves were received at 1 week of age and, after 10 d acclimatization, each of the 5 experimental diets was fed to 3 calves. The control diet contained (g/kg) 480 dried skimmed milk, 220 fat, 40 cerelose, 240 whey and 20 vitamin and mineral supplement. The starch diets contained (g/kg) 560 dried skimmed milk, 220 fat, 200 of the appropriate starch sample and 20 supplement. Digestibilities were determined over two 10 d periods, at 4–5 weeks and 9–10 weeks of age.

The control diet gave apparent digestibility indices in periods 1 and 2 respectively of 93·9 and 96·6 dry matter, 94·5 and 97·0 organic matter, 98·8 and 99·5 carbohydrate, and 94·4 and 96·4 energy. The results for the starch diets are summarized below.

	Apparent digestibility indices of starch diets (%)			
Period 1	Maize	Wheat (LD)	Wheat (HD)	Wheat (A)
Dry matter	86·1	88·9	86·1	88·8
Organic matter	86·1	89·1	80·7	85·5
Carbohydrate	81·9	88·0	86·2	88·8
Energy	88·3	90·2	88·1	89·8
Period 2				
Dry matter	89·0	91·0	91·7	92·2
Organic matter	89·0	91·1	91·9	92·3
Carbohydrate	85·7	89·4	92·8	92·4
Energy	91·1	92·6	92·9	93·4

From the results the digestibilities of starch per se, adjusted to dry matter were 53·5 and 62·6 maize starch, 70·7 and 71·1 low damage wheat starch, 51·7 and 80·1 high damage wheat starch, and 62·7 and 79·2 A starch, in periods 1 and 2 respectively.

From this we conclude that starch can form a useful energy source for calves. Wheat starch is at least as digestible as maize starch, and in most instances the indices were higher. All starches were more highly digestible in the older calf, but even in the young animal they were rather more digestible than might have been expected. The large difference between periods 1 and 2 for the high damage wheat starch is not easily explained.

Long-term effects of level of intake and diet composition on the performance of lactating dairy cows. 1. Milk yield and live weight change. By W. H. BROSTER, J. D. SUTTON, J. A. BINES, T. SMITH, J. W. SIVITER and V. J. BROSTER, *National Institute for Research in Dairying, Shinfield, Reading, Berks.*

An experiment extending over a whole lactation was conducted with 75 first calf cows, 36 second calf, and 36 older Friesian cows, all individually fed. The nine treatments consisted of a factorial arrangement of three levels of digestible energy intake/d (125, 156 MJ and *ad lib.* for first calf cows; 156, 187 MJ and *ad lib.* for other parities) and three ratios, concentrates:hay in the diet (60:40, 75:25, 90:10 on air dry basis.

Considerable agreement in effects was observed for first calf and older cows (full results for second calf cows are not yet available). Mean values for the milk yield and live weight change for first calf cows are shown in the table.

Period of lactation (weeks)		1–18			19–36		
No. of animals . . .		76			67		
Level of intake . . .		Moderate	High	*Ad lib.*	Moderate	High	*Ad lib.*
Milk	60:40*	15·4	16·9	18·7	12·0	13·7	16·7
yield	75:25*	17·3	20·0	22·1	13·0	15·9	18·5
(kg/d)	90:10*	19·1	22·8	22·2	14·9	18·5	16·9
Light-weight	60:40*	−0·44	−0·15	−0·11	+0·21	+0·30	+0·29
change	75:25*	−0·54	−0·25	−0·01	+0·19	+0·27	+0·44
(kg/d)	90:10*	−0·28	−0·07	+0·18	+0·35	+0·43	+0·54

*Ratio of concentrates to hay in the diet (air dry basis).

Peak yield and general level of milk production throughout the lactation but not rate of fall of yield after peak were improved by more generous feeding and by a greater proportion of concentrates in the diet. Thus peak yield becomes the determinant of lactation performance. All treatments were associated with some live weight loss in early lactation, the fall being less precipitous and the subsequent recovery earlier and more rapid with increasing level of intake and greater proportion of concentrates in the diet. On the lowest level of intake the initial post calving live weight had not been recovered by the end of lactation. During the period 2–4 months of lactation the 90:10–*ad lib.* dietary combination was associated with a more than average incidence of loss of appetite and fall in milk yield.

Bines *et al.* (1977) will discuss voluntary food intake and ration digestibility. Milk composition will be discussed by Sutton *et al.* (1977) together with rumen fermentation.

Bines, J. A., Napper, D. J. & Johnson, V. W. (1977). *Proc. Nutr. Soc.* **36**, 146A.
Sutton, J. D., Broster, W. H., Smith, T., Schuller, E. & Napper, D. J. (1977). *Proc. Nutr. Soc.* **36**, 147A.

Long-term effects of level of intake and diet composition on the performance of lactating dairy cows. 2. Voluntary intake and ration digestibility in heifers. By J. A. BINES, D. J. NAPPER and V. W. JOHNSON, *National Institute for Research in Dairying, Shinfield, Reading RG2 9AT*

A general outline of the experiment has been presented previously (Broster *et al.* 1977). When feeding *ad lib.*, it was generally necessary to feed one constituent of the ration at a level to give about a 5% refusal, and to feed the other constituent at a controlled level to give the correct ratio, hay:concentrate.

Digestibility trials of 10 d duration and based on total faeces collection were usually conducted twice on each animal, between days 30–60 and 150–180 of lactation.

Mean daily voluntary intakes of dry matter (DM) and digestible energy (DE) were:

	Concentrates:roughage		
	60:40	75:25	90:10
Weeks 1–18 (n=27)			
DM intake (kg/d)	13·7	13·2	13·7
DE intake (MJ/d)	171·0	171·1	183·6
Weeks 19–36 (n=23)			
DM intake (kg/d)	15·1	14·5	13·9
DE intake (MJ/d)	188·4	187·9	186·3

The mean intake values shown for weeks 1–18 conceal a trend towards earlier and higher peak intakes as the level of concentrates in the ration increased.

Compared to heifers control-fed at the high level, DM intakes for the three diets were respectively 12, 12 and 20% higher during weeks 1–18 and 22–23% higher during weeks 19–36 in heifers fed *ad lib.* Intakes of the three diets by older cows (not reported in detail here) were about 33, 27 and 7% higher respectively in weeks 1–18, and 9–18% higher in weeks 19–36, compared to heifers fed *ad lib.*

For years 1–4, intake by heifers during weeks 1–18 of lactation was given by:

$I = 0{\cdot}160M + 2{\cdot}450\Delta W + 0{\cdot}0113W + 4{\cdot}25$, I is dry matter intake (kg), M is milk yield (kg/d), ΔW is live weight change (kg/d), W is initial live weight (post-calving) (kg).

Coefficients of digestibility of the DM of rations containing 75 or 90% concentrates were approximately 0·71 and 0·74 and were not affected by the level of feeding. Digestibility of the diet containing 60% concentrates was reduced from 0·70 to 0·68 by *ad lib.* feeding.

Broster, W. H., Sutton, J. D., Bines, J. A., Smith, T., Siviter, J. W. & Broster, V. J. (1977). *Proc. Nutr. Soc.* 37, 145A.

Long-term effect of level of intake and diet composition on the performance of lactating dairy cows. 3. Milk composition and rumen fermentation. By J. D. SUTTON, W. H. BROSTER, E. SCHULLER, T. SMITH and D. J. NAPPER, *National Institute for Research in Dairying, Shinfield, Reading RG2 9AT*

Milk samples were taken from all the cows in the experiment described by Broster *et al.* (1977) on four consecutive milkings at weekly intervals throughout lactation. Samples of rumen contents were taken by stomach tube about 3 and 8 h after the morning feed from 43 of the 76 first-calf cows, 2, 4 and 6 weeks after calving and at 4-week intervals thereafter throughout lactation.

The main treatment effects on fat and solids-not-fat (SNF) in the milk and rumen volatile fatty acid (VFA) proportions for weeks 1–18 of lactation are summarized in the table.

	Milk				Rumen VFA		
	Fat (g/kg)	Fat (kg/d)	SNF (g/kg)	SNF (kg/d)	Acetic (mol/100 mol total VFA)	Propionic	Butyric
Ratio of concentrates to hay							
60:40	40·6	0·70	88·2	1·50	62	18	15
75:25	35·2	0·69	88·7	1·78	55	25	13
90:10	28·8	0·61	87·6	1·87	53	29	12
Level of intake							
Moderate	38·6	0·66	87·9	1·51	60	21	14
High	33·6	0·66	88·0	1·76	55	25	13
Ad lib.	32·7	0·67	88·7	1·86	55	26	13

Milk fat content was decreased by increases in the ratio of concentrates to hay at each level of intake and by an increase in level of intake from moderate to high at each ratio. However an additional increase in intake to *ad lib.* caused no further decline in milk fat content except at the ratio, 75:25. Milk fat yield was relatively constant for all treatments except for a decline with increasing ratio of concentrates to hay in the *ad lib.* group. Increases in level of intake increased SNF yield at each ratio of concentrates to hay except 90:10 when yield in the *ad lib.* group was less than that of the high group.

The ratio of acetic acid to propionic acid in the rumen fell with an increase in the ratio of concentrates to hay at all levels and also with an increase in intake from moderate to high but only in the second half of lactation did a further fall accompany the increase in intake to *ad lib.* Although all cows except those on *ad lib.* intake were consuming their full ration from 16 d after calving the ratio of acetic to propionic acid increased over the first 10 weeks of lactation.

Broster, W. H., Sutton, J. D., Bines, J. A., Smith, T., Siviter, J. W. & Broster, V. J. (1977). *Proc. Nutr. Soc.* **36**, 145A.

The effect of added tallow on the rumen digestion rate and microbial populations of sheep fed dried grass. By C. HENDERSON, C. S. STEWART and R. S.HINE (Introduced by E. R. ØRSKOV), *Rowett Research Institute, Bucksburn, Aberdeen AB2 9SB*

Kowalczyk *et al.* (1977) posed the question as to whether the low rumen ammonia levels, associated with feeding a high-fat supplement to lambs given dried grass *ad lib.*, were the cause of the accompanying decreases in digestion rate. To examine this possibility six Finn×Dorset wethers were given dried grass, dried grass plus 5 or 10% tallow, dried grass plus 1·5% urea or dried grass plus 1·5% urea plus 5 or 10% tallow in a 6×6 Latin square design experiment. The six animals each received, in turn, the six diets for a period of 14 d. Ruminal dry matter (DM) digestion rate, cotton thread digestion rate, concentrations of volatile fatty acids (VFA), long-chain fatty acids and ammonia and numbers of cellulolytic, lipolytic and total bacteria and numbers of protozoa were determined.

Addition of 10% tallow to the diet reduced DM digestion rate, cotton thread digestion rate, rumen ammonia concentration and numbers of protozoa in the rumen. Addition of 5% tallow reduced cotton thread digestion rate but no other significant changes were observed. No significant changes in the numbers of cellulolytic, lipolytic or total bacteria were noted in the presence of added tallow. When urea was added to increase the rumen ammonia levels no significant changes in DM digestion rate, cotton thread digestion rate or protozoal numbers were found (see table).

Diet	NH_3 (mg/100 ml) A	NH_3 (mg/100 ml) B	DM digestion* (%/24 h)	Cotton thread digestion (%/24 h)	Total bacteria ($\times 10^8$)	Total protozoa ($\times 10^5$)
DG	26·43	18·45	68·85	28·2	6·4	4·88
DG+5 T	25·93	15·91	68·61	16·8	4·6	3·64
DG+10 T	17·43	9·72	63·19	10·1	5·4	1·45
DGU	43·51	23·82	70·27	29·6	4·3	3·57
DGU+5 T	44·40	19·56	69·72	17·2	9·4	3·99
DGU+10 T	37·12	17·62	65·38	7·2	10·6	1·34
Standard error of means	1·68	1·50	1·03	2·36	4·5	0·51

DG, dried grass: U, 1·5% urea; 5 T, 10 T, 5 or 10% tallow. A, 1 h post-feeding; B, 7 h post-feeding.
*% disappearance of dried grass following rumen incubation using the Dacron bag technique (Kowalczyk *et al.* 1977).

On the basis of this work the depression of ammonia levels cannot account for the depressed fibre digestion in the rumen but is presumably a related effect. The coating of the feed by fat is likely to restrict colonization of the fibre by cellulolytic and proteolytic bacteria and the depression of ammonia levels may result from decreased proteolysis. The rate of cellulolysis on dried grass diets probably does not provide energy at a rate sufficient for the micro-organisms to respond to the elevated ammonia levels present on the urea-supplemented diets.

Kowalczyk, J., Ørskov, E. R., Robinson, J. J. & Stewart, C. S. (1977). *Br. J. Nutr.* 37, 251.

Absorption of volatile fatty acids in different compartments of the ruminant stomach. By B. M. EDRISE and R. H. SMITH, *National Institute for Research in Dairying, Shinfield, Reading RG2 9AT*

It is known that volatile fatty acids (VFA) are absorbed from the omasum as well as the reticulo-rumen of the ruminant but the relative amounts absorbed at these sites are not known for the bovine.

Digesta samples were obtained from the reticulum and from a flexible sleeve sutured at the omasal–abomasal orifice of bull calves (20–37 weeks of age) given diets twice/d at 09.00 and 17.00 hours consisting mainly of (A) 60% dried grass, 40% flaked maize or (B) 33% dried grass, 67% flaked maize. Diets were supplemented with minerals and vitamins with polyethylene glycol (PEG) as a marker. Estimates of VFA production in the rumen were made, assuming that 62% of the digestible organic matter consumed was digested in the rumen and that 80% of this was converted to VFA (J. D. Sutton, personal communication).

Flows of VFA at the different sites were estimated from VFA:PEG ratios in the appropriate digesta samples. Average values for such ratios based upon samples taken before a morning feed and at 2, 4 and 6 h after it, were assumed to be reasonably representative of the ratio for the total flow. Thus VFA flow/24 h was calculated as (PEG intake/24 h)×(VFA:PEG). The table shows mean values with their standard errors for estimates of amounts of VFA (mol/d) produced and passing different sites and of proportions absorbed between these sites for four experiments for each of the diets.

	Produced in rumen		Entering omasum		Leaving omasum		Proportion of production absorbed		
	Mean	SE	Mean	SE	Mean	SE	In rumen	In omasum	Below* omasum
Diet A Acetate	6·99	0·17	1·46	0·10	0·57	0·02	0·79	0·13	0·08
Propionate	2·16	0·04	0·43	0·03	0·16	0·01	0·80	0·13	0·07
n-Butyrate	1·28	0·09	0·25	0·03	0·07	0·01	0·81	0·14	0·06
other VFA	0·24	0·03	0·02	0·00	0·01	0·00	0·92	0·05	0·03
Diet B Acetate	6·96	0·03	1·04	0·02	0·45	0·02	0·85	0·09	0·07
Propionate	1·80	0·11	0·28	0·02	0·13	0·01	0·84	0·09	0·07
n-Butyrate	1·90	0·14	0·27	0·01	0·10	0·01	0·86	0·09	0·05
other VFA	0·56	0·06	0·02	0·00	0·01	0·00	0·95	0·03	0·02

*Amount leaving omasum and presumed to be absorbed in abomasum or small intestine. Similar results were obtained for another calf.

The reason for the apparent differences between diets in proportions of VFA absorbed at the different sites is not clear but may have been associated with a greater volume of digesta/h flowing out of the rumen and through the omasum as observed with diet A. It appears that the contribution of the omasum to VFA absorption may be appreciable. Our calculated values for this contribution take no account of synthesis of VFA in the omasum and are therefore probably underestimates.

The effect of level of feeding on the extent of digestion and mean retention time of alkali-treated straw given as part of a complete diet to sheep.

By I. L. JOHNSON, T. C. HOLFORD and E. L. MILLER, *Department of Applied Biology, University of Cambridge, Pembroke Street, Cambridge CB2 3DX*

Alkali treatment of straw has been shown to increase its digestibility. However, reduction in particle size during commercial processing and pelleting and again when the treated material is reground for incorporation into pelleted diets or compounds may adversely affect digestibility especially at high rates of feeding. A preliminary experiment was designed to investigate the effect of incorporating ground alkali-treated straw (ATS) in pelleted complete diets for sheep.

The ATS was prepared on a pilot-scale plant by spraying 300 kg ground barley straw with 37·5 l of NaOH (400 g/l) to give 50 g NaOH/kg straw. The mixture was pelleted through a 10 mm die.

Two shearling sheep were given a pelleted (12·5 mm) diet (D1) (g/kg dry matter (DM) basis) of sugar beet pulp 350, wheat middlings 490, groundnut meal 150 and trace element–vitamin premix 10, to supply in turn either 430 or 860 g DM/d, approximately equal to maintenance (M) or twice maintenance (2M) in two equal feeds/d. Two further sheep were given in turn a pelleted diet (D2) (g/kg DM basis) of reground ATS 400, sugar beet pulp 206, wheat middlings 294, groundnut meal 90 and trace element–vitamin premix 10, at the same M and 2M levels of feeding.

The sheep were accustomed to each diet and each level of feeding for 10 d, followed by a 6 d period during which digestibility by total collection, and for D2, rate of excretion of ATS stained with safranine dye was determined. Mean retention time was calculated by the method of Castle (1956).

Diet	D1		D2		SEM
Level of feeding	M	2M	M	2M	
Apparent digestibility of DM	0·825	0·780	0·732	0·689	0·0041
Apparent digestibility of energy	0·784	0·761	0·706	0·654	0·0031
Mean retention time (h)	—	—	40·5	28·0	2·78

Assuming no associative effects, the apparent digestibility of energy of ATS was calculated to be 0·589 at M and 0·494 at 2M. The gross energy of the ATS was 17·3 MJ/kg DM and therefore the digestible energy was 10·2 MJ/kg DM at M and 8·6 MJ/kg DM at 2M.

Increasing the level of feeding decreased retention time and digestibility of ATS. The extent of the depression in digestibility was greater than that predicted from the equation of Blaxter (1969) for both diets and for ATS alone.

Blaxter, K. L. (1969). In *Energy Metabolism of Farm Animals*. EAAP No. 12 [K. L. Blaxter, J. Kielanowski and G. Thorbeck, editors]. p. 22.
Castle, E. J. (1956). *Br. J. Nutr.* 10, 145.

The metabolizable energy value of high-lysine barleys. By I. L. JOHNSON and K. J. CARPENTER, *Department of Applied Biology, University of Cambridge, Pembroke Street, Cambridge CB2 3DX*

Considerable work is in progress to improve the nutritive value of the seed proteins of barley which is mainly limited by lysine. This has resulted in the breeding of several experimental high-lysine varieties of barley (e.g. Doll *et al.* 1974; Rhodes & Jenkins, 1977). Little attention has been paid to the metabolizable energy (ME) value of such barleys.

The ME content of normal and high-lysine barleys (provided by A. P. Rhodes and G. Jenkins of the Plant Breeding Institute, Trumpington) was determined in three experiments with chicks as described by Carpenter & Clegg (1956). The test barley replaced 400 g glucose/kg in a balanced diet with the following results (calculated ME content expressed as MJ/kg dry matter):

Type of barley	Standard	High-lysine					Mean difference between high-lysine and Maris Mink
Variety	Maris Mink*	Risø 1508	HL1†	HL2†	HL3‡	SEM	
Expt 1	13·39	12·26	—	—	—	0·071	−1·13
Expt 2	(13·39)	—	11·55	11·42	—	0·117	−1·91
Expt 3	(13·39)	12·34	—	—	12·25	0·093	−1·10

*The ME value was determined in Expt 1 and then assumed and used as the reference value in Expts 2 and 3.

†High-lysine selections from the cross between Risø 1508 and Lofa Abed.

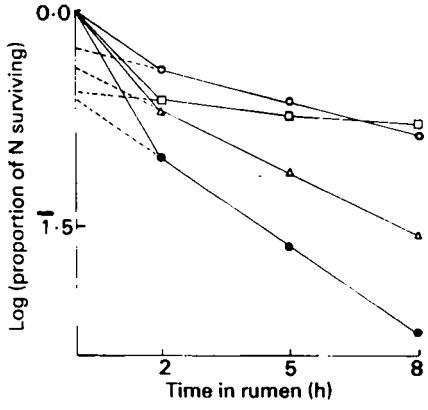
‡High-lysine selection from the cross between Risø 1508 and Julia.

The high-lysine samples appear to have approximately 8–15% less ME than the Maris Mink samples which is an economically important difference (cf. Carpenter, 1970). It appears to be largely explained by a lower content of 'available carbohydrate' (starch+sugars, expressed as starch) i.e. 59·8% in the dry matter of the high-lysine samples, compared with 68·5% for the Maris Mink samples. This difference was to be expected since the high-lysine grains were not so well filled.

Carpenter, K. J. (1970). *Proc. Nutr. Soc.* **29**, 3.
Carpenter, K. J. & Clegg, K. M. (1956). *J. Sci. Fd. Agric.* **7**, 45.
Doll, H., Køie, B. & Eggum, B. O. (1974). *Radiat. Bot.* **14**, 73.
Rhodes, A. P. & Jenkins, G. (1977). In *Plant Proteins*. [G. Norton, editor]. London: Butterworths. (In the Press.)

Measurement of protein degradation in the rumen. By O. E. MOHAMED and R. H. SMITH, *National Institute for Research in Dairying, Shinfield, Reading RG2 9AT*

Degradabilities of dietary proteins in the rumen have been studied by measuring the amounts disappearing from polyester bags suspended in the rumen of the sheep (e.g. Ørskov & Mehrez, 1977). Results are determined partly by physical loss and partly by microbial degradation. We have made similar measurements but have plotted logarithms of proportions surviving in the bag *v.* time; examples are shown in the figure for unheated soya-bean meal (US) (●), heated soya-bean meal (HS) (○), groundnut meal (GN) (△) and fish meal (FM) (□) all ground to a particle size of <2·5 mm and suspended in the rumen of a sheep receiving dried lucerne as a background diet.



The slope of the linear curve from 2–8 h may be used to calculate the proportion of protein disappearing/h, due presumably to microbial degradation (A value), while one minus the antilog. of the value shown by projecting the curve back to zero gives an estimate of the proportion of the protein simply washed out of the bag (B value).

Three similar experiments were made with each protein source in the rumens of each of two steers. Over-all means (6 experiments) with their standard errors were 0·152±0·004, 0·059±0·004, 0·134±0·004 and 0·013±0·001 for 'A values' and 0·383±0·020, 0·115±0·011, 0·285±0·012 and 0·366±0·004 for 'B values' for US, HS, GN and FM respectively. When the steers were given a different background diet (85% flaked maize, 15% dried lucerne) 'B values' were little affected but 'A values' were reduced about threefold. Supplementing such a diet with FM for 2 weeks before an experiment led to a threefold increase in the 'A value' for this protein. Samples of US, HS and GN with different particle sizes disappeared at different rates; A and B values increased progressively as particle size decreased from 1·2–2·5 mm to <0·125 mm by factors of about 3 and 2 respectively.

It appeared that estimates of protein degradability were very sensitive to conditions of measurement.

Ørskov, E. R. & Mehrez, A. Z. (1977). *Proc. Nutr. Soc.* **36**, 78A.

Effect of degradation in the rumen on dietary protein entering the ruminant duodenum. By R. H. SMITH and O. E. MOHAMED, *National Institute for Research in Dairying, Shinfield, Reading RG2 9AT*

The high-producing ruminant frequently needs a supply of undegraded dietary protein at the duodenum to help meet its amino acid requirements. The amount supplied by a particular diet will presumably be affected by the rate at which dietary protein is degraded in the rumen, but estimates of this rate are very sensitive to conditions of measurement (Mohamed & Smith, 1978) and the effects of other factors such as residence time of the protein in the rumen must also be considered. In comparative experiments, estimates of protein in dietary unheated soya-bean meal (US), heated soya-bean meal (HS), groundnut meal (GN) and fish meal (FM) surviving to the duodenum of the young steer (Smith *et al.*, 1978) did not closely reflect differences in protein degradabilities for the same samples measured as amounts disappearing from a polyester bag in the rumen (Mohamed & Smith, 1977). On the other hand Mathers *et al.* (1977) reported such a correlation in similar comparative experiments with sheep. Whatever the reliability of predicting the amount of protein survival to the duodenum by measuring its disappearance from a polyester bag, it must also be recognized that the value of surviving protein to the host depends on its quality as well as its quantity. This is generally assumed to be similar to that of the protein eaten but little is known of the effect of the rumen processes upon it.

Samples of US and HS in polyester bags were suspended for varying periods in the rumen of a sheep receiving dried lucerne. Samples of FM were similarly treated but in the rumen of a steer receiving flaked maize, lucerne and FM. Total and available methionine (g/16 g N) and relative nutritive value (RNV) of the samples were determined microbiologically using *Streptococcus zymogenes* as test organism (Ford, 1962). Some mean results for duplicate experiments were:

	HS			FM		
	Methionine		RNV	Methionine		RNV
Period in rumen (h)	Total	Available		Total	Available	
0	1·43	1·43	80	2·51	2·23	80
2	1·34	1·13	60	2·55	1·85	68
5	1·38	1·06	56	2·55	1·39	59
7	1·38	1·00	51	2·51	1·21	55

Values for US were similar to those for HS.

From these microbiological assessments it appeared that residual proteins left in the bags were markedly different from those eaten, indicating the possible need to take a further factor into account in assessing the value of a dietary protein to the host.

Ford, J. E. (1962). *Br. J. Nutr.* **16**, 409.
Mathers, J. C., Horton, C. M. & Miller, E. L. (1977). *Proc. Nutr. Soc.* **36**, 37A.
Mohamed, O. E. & Smith, R. H. (1977). *Proc. Nutr. Soc.* **36**, 152A.
Smith, R. H., McAllan, A. B., Hewitt, D. & Lewis, P. E. (1978). *J. agric. Sci., Camb.* (In the Press.)