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ABSTRACTS OF COMMUNICATIONS

The One Hundred and Seventy-Seventh Meeting of The Nutrition Society was held in the Department of Physiology and Biochemistry, Queen's College, Dundee, on Saturday, 26 February 1966, at 1.45 pm, when the following papers were read:

The low nutritive value of dried beef tendon. By J. ATKINSON and K. J. CARPENTER, *School of Agriculture, University of Cambridge*

Ferrando, Henry & Vaiman (1962*a*,*b*) found that rats fed beef tendon and connective tissue, dried at 90°, as the sole source of protein (13% in the diet) lost weight and died from the 16th day onwards. They hypothesized that toxic factors formed during oven-drying.

We have dissected suspensory ligament and extensor and flexor tendons, retaining the adhering mucopolysaccharide-rich fluid. These were frozen and chopped, then vacuum freeze-dried for 72 h or oven-dried at 90° for 44 h. Each was included to provide 12·7% crude protein in a basal diet of arachis oil 9·6, potato starch 9·6, mineral mix 3·8, vitamins (including choline chloride 0·2) and sucrose *ad* 100. In addition diets A to C included 13·6% casein (Glaxo 'vitamin-free') plus five amino acids. The diets were fed to 26-day-old rats, of mean starting weights 45 g for Expt 1 and 42 g for Expt 2, for 24 days.

	Expt 1 (eight rats/treatment)			Expt 2 (twelve rats/treatment)	
Diet	A	B	C	D	E
Casein*	+	+	+	0	0
Tendon + ligament	0	Freeze-dried	Oven-dried	Freeze-dried	Oven-dried
Weight change (g/head): 0–18 days	+65	+62†	+82	−3	−5
0–24 days	+78	+82†	+100	—	—
Deaths between 18th and 24th day	0	0	0	4/12	3/12

*Plus L-histidine 0·03, L-lysine 0·08, DL-tryptophan 0·03, DL-methionine 0·32, L-threonine 0·005% of the diet.

†Diet B was reground on the 11th day of experiment in an attempt to counteract spillage; thereafter three rats lost weight for some days.

Neither experiment gave evidence that the oven-drying had produced toxic material. The weight loss and mortality on both diets D and E may be explained by their low tryptophan content. We found 0·13 g tryptophan/16 g N in each tendon preparation using a chemical procedure (E. L. Miller, private communication); Ferrando, Henry & Fourlon (1963) found even less. Rats fed from weaning on a low-tryptophan diet based on acid-hydrolysed casein all died after 21–28 days (Bavetta, Bernick & Ershoff, 1956).

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A technique for quantitative measurement of hydrogenation of long-chain fatty acids in the fore-stomachs of the sheep. By M. J. ULYATT, J. W. CZERKAWSKI and K. L. BLAXTER*, *Hannah Dairy Research Institute, Ayr*

Cubes of dried grass were given to sheep with permanent cannulas in both the rumen and at the level of the pylorus at constant rate using the moving belt apparatus of Murray, Reid & Sutherland (1962). An aqueous solution of polyethylene glycol (PEG) was infused at constant rate into the rumen. Analysis of samples of ruminal and abomasal contents withdrawn at 4 h intervals for lignin and PEG by the methods of Czerkawski (1965) and Hydén (1961) respectively showed, in agreement with the observations of Portugal (1963), that steady-state conditions of flow of digesta through the rumen and abomasum were achieved.

Solid and liquid phases of the digesta pass through the rumen at different rates (Weller, Pilgrim & Gray, 1962). Digesta were sampled at the pylorus, the solid and liquid phases were separated by centrifugation, and their rates of flow were estimated by dividing the rate of adminstration of marker by its concentration in each phase.

The technique was used to determine the extent of hydrogenation of unsaturated fatty acids in the rumen. The amounts of individual fatty acids given in 24 h were determined and, from the concentrations of fatty acids in the liquid and solid digesta at the pylorus and the rates of passage of these phases determined as above, the amounts leaving the abomasum were estimated. The results of two experiments, one in which dried grass alone supplied fatty acids and the other in which additional fatty acids from linseed oil were given, are shown in Table 1. The results support

Table 1. *Hydrogenation of linseed oil fatty acids in the fore-stomachs of the sheep*

Source	Amount of fatty acids (g/24 h) Total	Stearic	Oleic	Linoleic	Linolenic
In diet A of grass	14·2	0·23	0·40	1·89	9·11
In diet B of grass +linseed oil fatty acids	46·2	1·35	5·71	6·52	28·80
In abomasum when diet A given = A^1	10·9	5·28	2·53	0·44	0·40
In abomasum when diet B given = B^1	42·7	24·93	10·20	2·39	1·77
Given as linseed fatty acids (B – A)	32·0	1·12	5·31	4·63	19·69
Recovered in abomasum from linseed fatty acids ($B^1 - A^1$)	31·8	19·65	7·67	1·95	0·37

the qualitative work of Shorland, Weenink, Johns & McDonald (1957) in showing that hydrogenation occurs. They further show that most of the long-chain fatty acid

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given is recovered in the abomasum and that 85% of the double bonds of the unsaturated acids given were hydrogenated before reaching the pylorus.

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Partition of nitrogen in the urine of African sheep given low-protein diets.

By J. H. TOPPS*, *Department of Agriculture, University College of Rhodesia and Nyasaland, Salisbury, Rhodesia*, and R. C. ELLIOTT, *Henderson Research Station, Mazoe, Rhodesia*

Sixteen Blackhead Persian wether sheep, weighing between 20 and 50 kg, were given a total of sixteen diets. There were four main groups of diets of the following types: equal parts of roughage and concentrate (group A), six parts of roughage with one part of concentrate (group B), all roughage (group C), and dried veldt grass (group D). Within each group the four diets had different contents of crude protein ranging from 2·6 to 10%. Each group of diets was offered *ad lib.* to four sheep for 28 days in a Latin square trial, 3 weeks of preliminary feeding being followed by the collection period.

Table 1. *Mean intakes of digestible nitrogen and values for urinary nitrogen excretion and distribution*

Diet	Approximate crude protein in diet (%)	Intake of digestible N (g/24h)	Urinary N loss (g/24h)	Distribution of N in urine (% of total)						
				Ammonia	Urea	Creatinine	Creatine	Uric acid	Hippuric acid	Allantoin
A	4	0·67	1·21	15·2	26·5	21·7	0·6	3·8	15·8	16·5
	6	3·85	1·66	3·0	29·2	15·9	1·3	3·6	20·0	21·9
	8	9·70	5·09	2·8	58·4	6·0	1·9	1·7	8·3	14·3
	10	13·84	8·52	3·6	63·5	3·8	1·3	0·9	6·0	8·0
B	4	0·04	1·39	23·1	30·8	15·6	0·3	2·5	14·7	15·5
	6	2·88	2·15	13·0	44·6	10·4	0·2	1·9	12·9	13·9
	8	5·03	4·16	11·6	59·2	5·8	0·3	1·0	8·8	6·7
	10	7·68	6·99	7·8	69·3	3·7	0·1	0·6	6·2	4·8
C	4	−0·28	1·44	27·1	24·3	13·7	1·9	2·4	17·2	10·4
	6	1·96	2·69	6·6	51·7	7·5	2·3	1·7	11·0	10·2
	8	2·34	2·99	4·5	58·3	6·9	1·4	1·6	9·6	7·1
	10	5·71	5·44	1·9	71·1	4·8	1·0	1·2	6·5	6·5
D	2·6	−0·40	1·49	16·4	27·0	15·4	5·2	1·5	21·9	7·0
	3·5	−0·60	1·40	3·9	27·8	18·2	4·5	2·0	31·4	11·3
	5·5	1·47	1·39	3·9	14·2	17·4	4·0	2·7	26·2	17·4
	8·2	2·91	2·48	3·6	28·2	11·1	2·8	1·9	32·2	14·8

Within each group of diets, urinary nitrogen excretion decreased with digestible N intake. For all diets there was a highly significant ($P<0·01$) positive correlation

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between digestible N intake and excretion of urea and of allantoin, and for diets in groups A, B and C, between digestible N intake and hippuric acid excretion. Urea excretion was also positively correlated ($P<0.05$) with N retention. The proportion of urinary N excreted as urea was closely related ($r=0.757$, $P<0.01$) to digestible N intake. The amount of creatinine excreted daily was directly related to body-weight of the sheep and showed little variation with diet.

It is suggested that either the absolute or relative amount of urea excreted, or the ratio of urea to creatinine in the urine, may be a useful index of digestible N intake of low-protein diets by sheep. Since digestible energy and digestible N intakes of such diets are closely related (Elliott & Topps, 1964), the same parameters may provide some measure of energy intake.

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Effect of water intake on the metabolism of magnesium in the sheep.

By N. F. SUTTLE and A. C. FIELD, *Moredun Institute, Edinburgh*

At the onset of grazing in spring the change from dry winter foodstuffs to lush pasture leads to an increase of up to fourfold in total water intake. Since hypomagnesaemia occurs widely among ruminants at 'turn out' (Butler *et al.* 1963) it seemed desirable to investigate the effects of high water intakes on magnesium metabolism.

Water intake of fistulated Scottish Blackface wethers was raised from 2 to 10 l./day by infusing water continuously into the rumen. Mg balance studies were carried out for 7–10 day periods both before and during the infusion. The experiment was repeated three times using three diets which provided a wide range of Mg, potassium and protein intakes. Faeces were not collected in Expt 3. The nature of the diets and experimental results are given in Table 1.

Table 1. *The influence of water infusion and ration composition on Mg retention and excretion*

		Expt 1		Expt 2		Expt 3	
No. of sheep*		6		4		4	
Daily ration		Concentrates (600 g), chopped hay (200 g)		Spring grass nuts (800 g)		Mg-rich concentrates (200 g), Chopped hay (300 g),	
		Before infusion	During infusion	Before infusion	During infusion	Before infusion	During infusion
Mg (g/day)	In food	1·80		1·03		2·94	
	In urine	0·44	0·57	0·15	0·24	0·70	1·10
	In faeces	1·12	0·95	1·01	0·71	—	—
	Retained	0·24	0·28	−0·13	0·09	—	—
Apparent availability of dietary Mg(%)		38	47	2	32	24†	37†

*Results below are means from the given number of animals.

†In absence of full balance data, calculated as $\frac{\text{urinary Mg}}{\text{dietary Mg}} \times 100$ (Rook & Campling, 1962).

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Raising the water intake caused a significant increase ($P<0.05$) in the urinary excretion of Mg in each experiment and significantly decreased ($P<0.001$) the faecal Mg excretion when the data from Expts 1 and 2 were pooled. These effects were probably produced by an increase in the true absorption of dietary Mg during the infusion. The effects were greatest in Expt 2 when the apparent availability of Mg before infusion was very low.

It appears that high water intakes are probably not responsible for the low availability of Mg in lush spring herbage reported by Rook & Balch (1958).

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The zinc requirement of Friesian calves fed on an artificial diet. By C. F. Mills, A. C. Dalgarno, R. B. Williams and J. Quarterman, *Rowett Research Institute, Bucksburn, Aberdeen*

Fourteen Friesian bull calves, 4–6 days of age, were fed whole milk in plastic buckets. Initially 6 pints of milk were offered/head daily but after 35 days the quantity was progressively reduced until the animals were weaned 6 days later. Calves were offered a solid basal diet of low zinc content (1·0–1·5 mg/kg) (Mills, Quarterman, Williams & Dalgarno, 1965) after milk had been fed for 2 weeks. Twelve of the calves were randomized according to weight into three groups which received oral doses of a solution of $ZnSO_4.7H_2O$ to provide the following quantities of Zn: group A, 0·7; group B, 0·2; group C, 0·05 mg/kg live weight day. Zn-deficient diet and deionized water were available at all times. Two calves not included above received no Zn supplement (group O).

After 14 days the calves of groups B and C and O showed marked declines in plasma Zn concentration from the normal level of approximately 1 μg/ml to mean levels of 0·4 (group B) and 0·2 μg/ml (groups C and O). A decrease in the rate of growth of the calves of groups C and O (but not those of group B) was noted after 14 days. Lesions of Zn deficiency developed in group O after 16 days and in group C after 21 days, in the following order: excessive salivation; loss of hair around eyes and mouth; parakeratosis of skin of neck, heel of mandible and inside legs; 'stepping' motion of legs and enlargement of hocks. No lesions developed in groups A or B.

That the calf has only a limited ability to store Zn became apparent when Zn supplementation of group A was discontinued after 51 days. The mean plasma Zn concentration fell from the previous level of 1·1 μg/ml to 0·3 μg/ml within 5 days; lesions of Zn deficiency developed 11 days later. At this time the Zn intakes of groups B and C were increased to 0·3 mg/kg live weight whereupon plasma Zn

concentrations returned to normal levels in six of the eight animals within 21 days; the two other animals in these groups showed a slower rate of recovery.

It is concluded that, on this ration based on egg albumen, urea, starch and cellulose, a Zn intake of 0·2 mg/kg live weight met the Zn requirement of the calf for growth but this quantity was insufficient to maintain the plasma Zn pool for which an intake of 0·3 mg/kg live weight was probably required. This intake corresponds to a dietary concentration of approximately 12·5 mg Zn/kg dry ration. Zn deficiency has been reported in grazing cattle where the pasture has contained between 22 and 112 mg Zn/kg dry matter (Legg & Sears, 1960; Grashuis, 1963).

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The energy cost of standing in sheep. By A. J. F. WEBSTER and DOROTHY VALKS, *Nutrition Department, Hannah Dairy Research Institute, Ayr*

Indirect estimates of the energy cost of standing in sheep vary from 1·7 kcal/kg 24 h (Blaxter & Joyce, 1963) to 8·2 kcal/kg 24 h (Graham, 1964). These values represent increases of 6% and 40% respectively in the heat production of sheep fed a maintenance ration. Direct measurements of the heat losses of sheep obtained in a gradient layer calorimeter have regularly given increased heat losses when the sheep stood up of 50–70% which persisted throughout the period that the sheep remained standing. The major source of this increased heat loss was due to evaporation of water from the respiratory tract (Brockway & Pullar, 1963; Brockway, 1965).

The present experiment was made to determine directly the energy cost of standing in four well-trained sheep fed a maintenance ration of dried grass. The heat production of the sheep was determined from measurements of respiratory exchange using a ventilated mask technique (Webster, 1966). The mean heat production of the sheep when standing was 61·3 kcal/h and when lying was 54·2 kcal/h. The increase in heat production due to standing was about 13%. The heat production of the sheep recorded when standing was always greater than that recorded when they were lying. The increase varied in individual experiments between 0·10 and 6·25 kcal/kg 24 h, the mean increase in heat production being 2·82 kcal/kg 24 h. This increase was very highly significant statistically ($P<0·001$). J. D. Pullar (personal communication) reports that the respiration rate of the sheep in his experiments increased by as much as 100% when the sheep stood up. In the present experiment no significant difference was found in the respiration rate of the sheep between periods of standing and lying.

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Strain differences in the response of Blackface sheep to injections of sodium selenate. By J. QUARTERMAN, C. F. MILLS and A. C. DALGARNO, *Rowett Research Institute, Bucksburn, Aberdeen*

Forty Blackface ewes on a hill farm on soil derived from parent material of a type earlier shown to be associated with farms on which the live-weight gains of sheep were increased by selenium administration (Blaxter, 1960) were given subcutaneous injections of Se, 3 mg as Na_2SeO_4, every 2–3 months for 3 years. Forty uninjected ewes served as controls. Each group contained sheep of Lanark, Newton-Stewart, Lewis and Perth strains. There was a significant ($P<0.05$) seasonal effect of Se on weight gain. The summer body-weight gain was increased by +5·6, +0·9, +4·0 and +2·3 lb for the four strains respectively. The net weight loss over winter (including that associated with lambing) was increased by +5·2, −0·2 (i.e. a net gain), +0·5 and +0·4 lb when Se was administered. There was no effect of Se on lambing percentage or lamb birth weight or on ewe weight gain over the whole year. Se injections increased the wool yield significantly ($P<0.01$) by 0·23 lb and there was a suggestion ($0.05<P<0.10$) of strain differences in response, the increase in yield from Se being +0·73, −0·05, −0·17 and +0·40 lb for the four strains respectively. Differences in grazing behaviour also occur between these strains.

Weight gains in sheep in response to Se have been observed in many parts of the world including Scotland (Blaxter, 1960) but these results differ from those of Blaxter (1960) with non-pregnant sheep in showing a weight loss due to Se during the winter period. During preliminary trials it was observed that subcutaneous injections of 15 mg of Se were severely toxic when given in winter to pregnant ewes. It seems possible that even 3 mg may adversely affect the pregnant ewe during periods of cold stress.

The increases in fleece weight were about the same as those observed by Slen, Demiruren & Smith (1961). The effect of these Se injections on wool structure as revealed by its percentage contraction in saturated LiBr solution was similar to that reported by Demiruren & Slen (1963): 49·8% with Se injections, 55·1% in control sheep.

We are very grateful for the help of the staff at the HFRO Experimental Farm, Glensaugh, Kincardineshire, for all the recording and to Dr J. Doney for wool samples.

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A method for determining the body composition of sheep based on dissolution of the carcass in nitric acid. By A. C. FIELD and N. F. SUTTLE, *Moredun Institute, Gilmerton, Edinburgh*

The present lack of information on the mineral composition of sheep is due in part to the difficulty of obtaining a sample representative of both bone and soft tissue from a minced carcass. This difficulty can be overcome by dissolving, but not digesting, the whole or minced carcass in concentrated nitric acid.

The apparatus consisted in essence of a heated Pyrex glass reaction vessel (50 l.) and a scrubbing tower for the removal of nitrous fumes. It was necessary to separate large sheep (>40 kg) into two fractions, the skeleton and soft tissues, which were dissolved separately. The fleece and skin were not included. Dissolution of the tissues was completed within 6 h, once the reaction had become exothermic, and fat floated to the surface. The two layers were separated whilst hot, the acid mixture was weighed and sampled and its mineral composition was determined without further oxidation. The fat layer was allowed to solidify, sampled and the percentage of ether-extractable fat determined. The mineral content of the fat layer was negligible.

Water content of the whole mince was calculated from the relationship water (kg)=0·72 × fat-free mince weight (kg) and bone content from the Ca content and the concentration of Ca in bone (26%).

Results obtained in this way for twenty-three minced half carcasses of sheep were compared with those obtained by conventional chemical analyses of two 15 g samples from each mince. There was no significant difference between the two methods in the concentration of calcium, phosphorus, magnesium and sodium found in the fresh mince. The sampling method, however, gave 7% less potassium than the bulk method ($P<0·01$).

The sampling errors, expressed as the coefficients of variation, were 10·5% for Ca, 8·6% for P, 8·9% for Mg, 6·7% for Na and 4·8% for K. There was a significant correlation ($r=0·81$, $P<0·01$) between the concentrations of Ca and P in the individual subsamples of the same mince, which indicated that differences in the proportion of bone in the subsamples were largely responsible for the sampling error. The smallest sampling error was for K which is confined largely to the soft tissues.

There was no difference between the mean percentage of ether-extractable fat in the dissolved mince and that determined in samples of fresh mince, the figures being 17·5 and 16·5 ± 0·66% respectively; the values ranged from 7·1 to 31·5%. The mean percentages of water in the minces, calculated and determined by drying, were 58·1 and 60·1 ± 0·7 ($P<0·01$) respectively.

We wish to thank Mr A. J. F. Russel, Hill Farming Research Organization, Edinburgh for supplying the minced carcasses and data on their fat and moisture content.

The influence of dietary additions of starch and casein in the later stages of pregnancy upon the nitrogen retention of pregnant gilts. By F. W. H. ELSLEY, D. M. ANDERSON and R. M. MACPHERSON, *Rowett Research Institute, Bucksburn, Aberdeen*

Five groups of four litter-sister gilts were reared under standard conditions and were mated when they weighed approximately 130 kg. During the first 50 days after mating they received a basal ration of 1·35 kg/day of a diet with 14·1% crude protein and 4100 cal/g dry matter. From the 50th to the 110th day of pregnancy animals were given (1) the basal ration of 1·35 kg; (2) the basal ration plus 0·95 kg maize starch daily; (3) the basal ration plus 0·15 kg casein daily or (4) the basal ration plus 0·95 kg starch and 0·15 kg casein. Nitrogen retention was increased by 25% with the addition of starch, by 69% with the addition of casein and by approximately 92% when starch and casein were both added. No relationship was found between N retention during pregnancy and the intrauterine deposition of N.

Circadian rhythm of rumination. By J. G. GORDON, *Rowett Research Institute, Bucksburn, Aberdeen*

The effect of light in determining the pattern of incidence of rumination was discussed.

The One Hundred and Eightieth Meeting of The Nutrition Society was held in the Sir John Atkins Laboratories, Queen Elizabeth College, Campden Hill, London, W 8, on Saturday, 21 May 1966, at 10 am, when the following papers were read:

Comparison of two simple measures of activity in old women. By MOLLY M. DISSELDUFF and EDNA MURPHY, *Ministry of Health, London, SE 1*

Comparisons were made, on ten women aged 75–95, all senile to the point where institutionalization was imminent, between the reading of a pedometer attached to their day clothes for 24 h, and their activity as indicated by the relationship between their basal metabolic rates and their total caloric intake measured by 7-day dietary records prepared under close and repeated supervision. No attempt was made to measure the distances walked; the pedometer record simply related to the number of movements made in the day of sufficient magnitude to register on the pedometer.

The relationship found was sufficiently close to justify the conclusion that the two methods of assessment were in effect measuring the same thing, albeit in different ways, viz, the amount of movement made. Indeed it was unexpectedly close, partly it is thought because, compared with younger subjects, these old women lived very uniform lives with little variation from week to week either in the food they ate or the activity which they took. They may thus have avoided the short-term discrepancies between caloric expenditure and consumption often reported in