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 Sixteenth Meeting of the Nutrition Society (One Hundred and Twenty-fifth of the Scottish Group) was held at the Hannah Research Institute, Ayr on Friday, 21 *April* 1978, *when the following papers were read:*

https://doi.org/10.1079/PNS19780047 Published online by Cambridge University Press

The estimation of body water and fat in pregnant ewes using deuterium oxide. By R. A. HOUSEMAN, J. J. ROBINSON and C. FRASER, *Rowett Research Institute, Bucksburn, Aberdeen AB2 9SB*

Deuterium oxide (D_2O) space was used to estimate total body water (W_{TB}) in 38 Finnish Landrace × Dorset Horn ewes at about 90 d and about 140 d of gestation. D_2O was injected into the jugular vein of each ewe and blood samples were taken at hourly intervals between 3 and 7 h after injection. Their analysis indicated that equilibration of D_2O in plasma had occurred within 4–7 h. The D_2O space (D) was calculated from the plasma concentration at 6–7 h. After slaughter the following day the fleece-free empty body, including the gravid uterus, was minced and chemically analysed to obtain estimates of empty-body fat (F) and W_{TB}.

For the twelve ewes killed at about 90 d and the twenty-six ewes killed at about 140 d, the mean live weights (L) were respectively 73·4 and 79·3 kg, the mean values of D were 46·0 and 56·0 kg, those of W_{TB} were 43·5 and 53·4 kg, and those of F were 17·2 and 11·0 kg respectively. Relationships among these variables could not be satisfactorily described by single equations: although the regression coefficients were combinable the means were not. The equations presented in Table 1 indicate that even with this separation there was substantial variation in the relationship of W_{TB} to D and also in the relationship of F to L and W_{TB}. Thus the resultant regression of F on L and D was also very variable and would be of doubtful value for prediction.

Table 1. *Regression equations relating total body water (W_{TB},kg) to D_2O space (D,kg), body fat (F,kg) to W_{TB} and F to D*

Equation		RSD
(1) W_{TB}=0·73 D	+ 9·9 (90 d) + 12·4 (140 d)	2·20
(2) F (kg) =0·92 L* −1·01 W_{TB}	− 6·5 (90 d) − 8·0 (140 d)	1·47
(3) F (kg) =1·01 L* −0·80 D	− 20·7 (90 d) − 24·7 (140 d)	2·56

*Live weight (kg) at time of D_2O sampling

https://doi.org/10.1079/PNS19780047 Published online by Cambridge University Press

Biohydrogenation of protected soya-bean oil in sheep fed a low-fibre diet.

By J. L. CLAPPERTON, *Hannah Research Institute, Ayr KA6 5HL*

Clapperton *et al.* (1978) found that, when cows were given a low-fibre diet of dried grass cubes and flaked maize instead of a normal diet of hay and concentrates, the proportion of 18:2 fatty acid in milk was increased from 3 to 10% but that the addition of a formaldehyde-protected mixture of casein and soya-bean oil did not cause any further increase in the level of polyunsaturated acid. This lack of response may have been due to inadequate protection of the fatty acid and the present experiment was designed to assess the degree of protection.

Three sheep each fitted with a permanent duodenal T-piece cannula were given a basal ration of equal parts by weight of dried grass and flaked maize at about 1·2 times maintenance in 24 approximately equal meals daily. The animals were also given a 1 g pellet of chromic oxide twice daily. In addition in one period the sheep were given a supplement of 45 g/d of spray-dried mixture of 2 parts of soya-bean oil and 1 part of casein, in a second period they were given the same amount of the casein–soya-bean oil mixture after it had been treated with formaldehyde and in a third period, no supplement was given. Each period lasted for 3 weeks. Samples of duodenal content were withdrawn on 2 d at the end of each experimental period.

Table 1. *The amount (g/d) of fatty acids entering the duodenum*

Fatty acid	Unprotected Casein–soya-bean oil	Protected Casein–soya-bean oil	No supplement	SE
16:0	5·2	5·8	2·8	0·67
18:0	27·3	18·2	10·0	3·62
18:1	6·7	7·8	3·0	0·99
18:2+18:3	2·5	13·0	1·7	1·03

Treating the mixture with formaldehyde significantly reduced the amount of 18:0 and increased the amount of 18:2+18:3 fatty acid flowing into the duodenum. Of the 18:2+18:3 fatty acid added in the casein–soya-bean oil mixture, 4% entered the duodenum when the mixture was not protected with formaldehyde; when protection was given the corresponding figure was 60%.

Clapperton, J. L., Kelly M. E. & Rook, J. A. F. (1978). *Proc. Nutr. Soc.* **37**, 8A.

The energy value to sheep of mixed diets containing alkali-treated straw and ground field beans. By J. S. SMITH, F. W. WAINMAN and P. J. S. DEWEY, *Rowett Research Institute, Bucksburn, Aberdeen AB2 9SB*

Although the quantity of alkali-treated straw fed to livestock in the UK is increasing annually there are no reports in the literature of complete energy balances on ruminants fed on such material. Likewise there is little information on the energy value of field beans (*Vicia faba*), potentially a valuable source of home-grown protein. The present work examined the energy balances of rations consisting of different ratios of these two feedstuffs.

Alkali-treated straw was prepared by spraying a 16% solution of NaOH on to chopped barley straw in a mixer trailer (Greenhalgh, 1976). The beans were milled through an 0·125 inch screen. Sheep were fed three ratios of straw to beans, 65:35, 50:50 and 35:65 by weight on a dry matter (DM) basis. Each ration was fed to the same four sheep at two planes of nutrition, approximately maintenance (M) and 2× M. The fasting metabolism of each sheep was determined before and after the experimental feeding periods.

Ration beans/straw	Digestibility (%)		DOMD % ('D' Value)	ME
	DM	Energy		
65:35	81·0	78·6	75·7	11·2
50:50	76·5	72·9	68·9	10·4
35:65	74·0	68·2	64·2	9·4

The digestibilities of DM and energy, together with the digestible organic matter in the DM (DOMD) and the values for metabolizable energy (ME) obtained with each ration fed at maintenance are shown in the table. Extrapolation to 100% of each constituent gives ME values of 7·40 MJ/kg DM for the alkali-treated straw and 13·3 MJ/kg DM for the milled field beans.

Greenhalgh, J. F. D. (1976). *ARC Review* Vol. 2, no. 3.

Utilization of volatile fatty acids by young sheep. By E. R. ØRSKOV, D. A. GRUBB, A. J. F. WEBSTER* and J. S. SMITH, *Rowett Research Institute, Bucksburn, Aberdeen AB2 9SB*

The utilization of volatile fatty acids (VFA), the main source of energy absorbed by ruminants, has been studied by various techniques. Below the maintenance energy level, utilization has been measured of VFA infused intraruminally as the main source of energy (Armstrong & Blaxter, 1957*a*; Tao & Asplund, 1975). Above maintenance, VFA have been given either as salts incorporated in a diet (Ørskov & Allen, 1966) or infused as a supplement to a basal diet (Armstrong & Blaxter, 1957*b*). These techniques may give equivocal results owing to interference of the supplement with metabolism of the basal feed. Recently we have developed a technique to sustain ruminants for long periods with normal live weight gain entirely by the infusion of VFA into the rumen and protein into the abomasum (Ørskov, E. R., Grubb, D. A., Wenham, G. & Corrigal, W., unpublished).

Thirty lambs, prepared with rumen cannulas and abomasal catheters, were used to determine heat production, in closed circuit respiration chambers, when different mixtures of VFA were infused either approximately at maintenance or twice their maintenance energy need (450 and 900 kJ/kg$^{0.75}$ per d, respectively). The results were analysed by regression analysis using equations of the form $y = k_f (x - m)$ where y = energy retention/live weight$^{0.75}$ and x = energy intake/live weight$^{0.75}$.

The maintenance energy needs did not differ between the various treatments, the mean value being 430 ± 0·020 kJ/kg$^{0.75}$ per d. The efficiency of energy utilization above maintenance is given below.

	Acid proportions (mmol/mol)			Efficiency of energy utilization (k_f)
	Acetic	Propionic	Butyric	
(1)	350	550	100	0·75 ± 0·05
(2)	450	450	100	0·65 ± 0·04
(3)	550	350	100	0·58 ± 0·04
(4)	650	250	100	0·61 ± 0·04
(5)	750	150	100	0·60 ± 0·04
(6)†	850	50	100	0·60 ± 0·10

†Studied at 1 and 1·5 times maintenance only

The only significant difference was between the lowest acetic acid mixture (1) and the other treatments ($P<0·05$). This suggests that for practical diets for which VFA proportions are not generally outside the range of mixtures 2 to 5, differences in utilization of metabolizable energy cannot be explained by differences in the efficiency of utilization of VFA.

Armstrong, D. G. & Blaxter, K. L. (1975*a*). *Br. J. Nutr.* 11, 247.
Armstrong, D. G. & Blaxter, K. L. (1957*b*). *Br. J. Nutr.* 11, 413.
Ørskov, E. R. & Allen, D. M. (1966). *Br. J. Nutr.* 20, 519.
Tao, R. C. & Asplund, J. M. (1975). *J. Anim. Sci.* 41, 1653.

*Present address: Department of Animal Husbandry, University of Bristol, Langford House, Langford.

A demonstration of marked recycling of molybdenum via the gastrointestinal tract of sheep at low sulphur intakes. By N. F. SUTTLE and N. D. GRACE, *Moredun Research Institute, 408 Gilmerton Road, Edinburgh EH17 7JH*

Previous studies of the S × Mo interaction in ruminant nutrition have concentrated mainly on its effect on Cu metabolism. To obtain information on Mo metabolism *per se*, 16 ewes were given intakes of 0·3 or 3·5 mg Mo and 0·98, 1·33, 1·73 or 3·23 g S/d in a 2×4 factorial experiment lasting 35 d. The basal diet provided 6 mg Cu, 0·3 mg Mo and 0·98 g S/d and was fed at hourly intervals: higher intakes of Mo and S were achieved by giving continuous intraruminal infusions of ammonium molybdate or sodium sulphate. For the last 14 d, ^{99}Mo was administered continuously by intravenous infusion. Secretion of Mo into the rumen (SR) was calculated on each of the last 3 d of the experiment from the specific activities (SA, % daily dose/mg Mo) of rumen contents (R) and urine (U), where SR (mg/d) = [daily Mo intake × R. SA] ÷ [U. SA − R. SA]. Other details of methodology and results were reported by Grace & Suttle (1977).

Table 1. *Effects of sulphur and molybdenum intake on the mean secretion of Mo into the rumen (SR, mg/d) and related changes in Mo concentrations in rumen contents (mg/l) of ewes*

Mo intake (mg/d)	0·3				3·5			
S intake (g/d)	0·98	1·33	1·73	3·23	0·98	1·33	1·73	3·23
SR	0·045	0·025	0·010	0·008± 0·004	2·363•	0·109	0·036	0·009± 0·004
	(17·6)†	(13·8)	(6·1)	(6·0)	(89·3)	(8·9)	(3·4)	(0·9)
Rumen Mo	0·17	0·11	0·11	0·12± 0·01	1·14	0·82	0·77	0·83± 0·20

• The mean for this group had a SE of ± 0·272 and was excluded from the pooled analysis
† Values in brackets are SR as percentage of absorbed Mo

Evidence for Mo recycling is presented in Table 1. When S intake was low and Mo intake high, 2·4 mg Mo/d (i.e. 89% of the absorbed dietary Mo) was secreted into the rumen. The coefficients of absorption for dietary and dietary + secreted Mo were of the same high order on this treatment (0·75), indicating that secreted Mo was extensively reabsorbed. However, the first increment in S intake markedly reduced SR ($P<0·001$) both in absolute terms and as a proportion of the absorbed Mo: this explains concomitant fall in rumen Mo concentrations under stead-state conditions. It was concluded that S reduced the amount of Mo recycled via the saliva by reducing the amount of Mo available for secretion and the secretability of circulating Mo. The extent of Mo recycling in ruminants under natural dietary conditions merits further investigation.

Grace, N. D. & Suttle, N. F. (1977). *Proc. Third Int. Symposium on Trace Element Metabolism in Man and Animals, Munich.* (In the Press).

Effect of tallow and whey powder on fermentation of hay and barley, using the Rumen Simulation Technique (Rusitec). By J. W. CZERKAWSKI and GRACE BRECKENRIDGE, *The Hannah Research Institute, Ayr KA6 5HL*

The intake of energy by ruminants can be increased by supplementing the basal rations with concentrates. One such additive consists of whey and tallow (50:50 by weight, Volac Ltd). This compound and the constituents were tested in Rusitec (Czerkawski & Breckenridge, 1977) using a basal ration of hay, barley and soya-bean meal (20, 2 and 1 g/d respectively).

After achievement of steady fermentation with basal rations, the rations were supplemented with tallow (1·5 g/d), whey powder (1·5 g/d), both additives (1·5 g/d of each) or the tallow–whey compound (3·0 g/d). The treatment of 10 d was followed by another control period.

Tallow depressed the production of methane and volatile fatty acids by 23 and 17% respectively. This was partly due to the depression in the digestion of dry matter (15%). Addition of whey resulted in an increase in the rate of fermentation. The increases were confined to CO_2, CH_4, acetic and butyric acids (12·5, 5·6, 3·2 and 2·7 mol/g whey powder digested respectively). When both whey and tallow, were added, the detrimental effect of tallow was compensated for by the increase due to whey. When the compound of whey and tallow was used, the results were almost as if whey had been added alone.

The results indicated that the tallow in the compound was 'protected', probably by a coat of whey. When this compound and a compound of whey and tallow prepared by mixing the components at low temperature, were extracted with hexane, only 46% of the lipid could be extracted from the former compound (used here) and over 90% of the lipid in the latter.

The analysis of the lipid content of the effluent and the undigested residue showed that with tallow or whey added together or separately to the same vessel, 71% of the recovered lipid was in the undigested residue. When the tallow–whey compound was used, nearly 70% of the recovered lipid emerged from the vessel in the effluent.

It is concluded that in the tallow–whey compound, the tallow is coated with whey, that the coat is available for microbial attack and that, at least temporarily, the 'coat' reduces the detrimental effect of tallow on fermentation.

Czerkawski, J. W. & Breckenridge, G. (1977). *Br. J. Nutr.* **38**, 371.

Use of the Rumen Simulation Technique (Rusitec) to study the distribution of microbial matter in the solid and liquid phases of the reaction mixture; sequestration of micro-organisms. By J. W. CZERKAWSKI and GRACE BRECKENRIDGE, *The Hannah Research Institute, Ayr KA6 5HL*

It is possible, using Rusitec, to maintain normal rumen fermentation, over prolonged periods of time, under strictly controlled conditions (Czerkawski & Breckenridge, 1977). The reaction mixture in this apparatus contains both solid and liquid digesta, but the heterogeneity can be controlled. The particulate matter of the liquid phase is microbial and the undigested solid which is partly removed every day, before addition of new food, contains 10–13% microbial matter. The results of 5 long-term experiments, using a variety of foods, showed that the dry weight ratio, protozoa: (bacteria + protozoa) was greater in the undigested residue (0·40–0·45) than in the effluent (0·25–0·30).

In the experiment reported here, hay and barley were placed as a mixture in a single nylon gauze bag or in separate bags (same vessel). After 11 d the feeding procedures were interchanged. The output of end-products of fermentation and digestibility of dry matter were greater when the feed components were incubated in separate bags.

As in other experiments, the protozoal matter accounted for 28% of microbial matter in the effluent and for 45% in the undigested residue. The concentrations of protozoa and bacteria in the liquid phase, in the liquid that was loosely associated with the solid, and in the liquid space that was closely associated with the solid, were estimated either by counting or with microbial markers. The mean concentration of bacteria and protozoa in liquid space of drained semi-solid digesta was respectively about 4 and 16 times greater than in the effluent. The concentration of bacteria and protozoa in the washed residue was estimated from the DAP and AEP content (Czerkawski, 1974) and from the water content of the wet material. The concentrations of bacteria and protozoa in this liquid space were respectively 13 and 26 times greater than in the effluent.

It appears that the specific removal rates of bacteria and protozoa (0·55 and 0·40/d respectively) are smaller than the dilution rate (0·70/d), that both microbial groups are sequestrated (cf Weller & Pilgrim, 1974), and that protozoa are sequestrated to a greater extent than bacteria.

Czerkawski, J. W. (1974). *J. Sci. Fd Agric.* **25**, 45.
Czerkawski, J. W. & Breckenridge, G. (1977). *Br. J. Nutr.* **38**, 371.
Weller, R. A. & Pilgrim, A. F. (1974). *Br. J. Nutr.* **32**, 341.

An effect of physiological state on digestion in the ewe. By JANE L. THOMPSON, J. J. ROBINSON and I. MCHATTIE, *Rowett Research Institute, Bucksburn, Aberdeen AB2 9SB*

Three Finnish Landrace × Dorset Horn ewes, each with two foetuses, were fitted with simple cannulas in the rumen and abomasum during the 13th week of gestation. The ewes were kept in individual pens and given daily 2·2 kg of a complete diet containing hay (milled through a 35 mm screen), rolled barley, fish meal and molasses in the proportions 0·50, 0·33, 0·09 and 0·08 respectively. The ration was given in two equal portions at 08.00 and 20.00 hours. Chromic oxide was used as a marker. Samples of rumen and abomasal fluid were taken at 2 h intervals over a 48 h period in the penultimate week of pregnancy, during the first month of lactation and immediately after weaning at 1 month. Indices of digestion for each ewe for the three physiological states are given in Table 1.

Table 1. *Daily nutrient intakes and some indices of digestion in ewes during late pregnancy (P), early lactation (L) or immediately after weaning (W)*

	Ewe 1			Ewe 2			Ewe 3		
	P	L	W	P	L	W	P	L	W
Dry matter intake (kg)	1·7	1·8	1·8	1·7	1·8	1·8	1·7	1·7	1·8
Nitrogen intake (g)	40	41	44	40	42	43	40	40	43
Dry matter digestibility	0·67	0·72	0·70	0·65	0·69	0·68	0·67	0·71	0·71
Proportion of food digestible organic matter apparently digested in the rumen	0·44	0·56	0·55	0·32	0·61	0·46	0·57	0·62	0·66
Ammonia concentration in rumen fluid (mg/100 ml)	8·7	11·7	13·8	8·7	8·9	19·9	17·0	20·0	27·0
Non-ammonia nitrogen passing the abomasum (g)	42	38	39	49	35	47	43	36	40
Nitrogen disappearing in the small and large intestine (g)	33	30	28	39	35	27	35	31	29

The results support the suggestion made by Graham & Williams (1962) from their observations on the stimulatory effect of pregnancy on the rate of passage of food residues in the ewe, that such an effect may lead to a depression in the over-all digestibility of some rations. In addition the results suggest that on the present ration the depression in digestibility is detectable prior to the food entering the small intestine and may increase the amount of dietary non-ammonia nitrogen reaching the abomasum.

Graham, N. Mc. & Williams, A. J. (1962). *Aust. J. agric. Res.* **13**, 894.

Daily variations in the composition of cows milk. By J. L. CLAPPERTON, D. REID and AGNES G. WILSON, *The Hannah Research Institute, Ayr KA6 5HL*

In experiments involving lactating animals, it is common practice to collect samples of the milk from a number of successive milkings and to prepare a composite sample for analysis. This procedure leads to the day-to-day variations in milk composition being ignored when the results are statistically analysed. However, we recently conducted a trial in which milk composition was monitored daily as the diet was gradually changed from high roughage to low roughage. Surprisingly large variations were observed during this period, and it was therefore decided to investigate in more detail the changes which occur in milk composition from day-to-day.

Four groups, each consisting of 4 dairy cows, were offered different diets (see Table 1) and milk compositions were determined on 3 consecutive days of each week for a period of at least 5 weeks. The animals were milked at 06.00 hours and at 15.00 hours, and composite daily milk samples were prepared by combining portions of the morning and evening milk in proportion to the milk yield. Fat, protein and lactose contents of the samples were determined in an Infra-Red Milk Analyser (Grubb Parsons Ltd., Newcastle upon Tyne), and are recorded in Table 1 together with the appropriate standard deviations.

Table 1. *The mean fat, protein and lactose content of the milk of 4 groups of 4 animals collected on 3 successive days and the standard deviation*

Diet	Milk fat (%)	Crude protein (%)	Lactose (%)
Dried grass–flaked maize 1	2·43±0·29	—	—
Dried grass–flaked maize 2	3·26±0·46	3·46±0·05	4·90±0·06
Hay–sugar beet pulp–concentrate	3·86±0·25	3·42±0·04	4·48±0·05
Grazing	3·26±0·58	3·10±0·05	4·79±0·05

Whilst it is not surprising that the fat content shows the greatest day-to-day variation of the milk components, the magnitude of the effect is remarkable. Even on the hay–sugar beet pulp–concentrate diet, which gave the least variable fat content, the coefficient of variation over a 3-day period was 6·5%, whilst at the other extreme, obtained with grazing animals, the corresponding value was 17·8%.

The cholesterol content of household diets in Britain. By JOSEPHINE A. SPRING, JEAN ROBERTSON and D. H. BUSS, *Nutrition Section, Ministry of Agriculture, Fisheries and Food, London SW1P 2AE*

The cholesterol content of most Western diets has been estimated to be between 500 and 1000 mg/d (Davidson *et al.* 1975), with that in the UK being at the lower end of this range (Shaper & Marr, 1977). We have now calculated the cholesterol content of the average household diet in Britain as 405 mg/person per d, with that in England 405 mg/d, in Wales 415 mg/d and in Scotland 390 mg/d. This was done by applying the cholesterol values selected for *McCance and Widdowson's The Composition of Foods* (Paul & Southgate, 1978) to the amounts of almost all foods recorded by the 44,777 households which participated in the National Food Survey between 1970 and 1975 (Ministry of Agriculture, Fisheries and Food, 1977). The following foods contributed:

	Britain		England	Wales	Scotland
	% of total	mg/d	(mg/d)	(mg/d)	(mg/d)
Eggs	34·3	139	138	136	145
Meat, total	24·5	99	100	101	89
Beef	4·7	19	18	18	24
Lamb	2·8	11	12	12	5
Pork	1·9	8	8	8	3
Bacon and ham	3·0	12	12	14	10
Liver and other offal	3·5	14	15	11	11
Poultry	3·2	13	13	14	9
All other meat products	5·4	22	22	24	27
Fish	2·8	11	11	11	10
Milk, liquid	13·5	55	55	53	53
Cheese	2·8	12	12	11	10
Butter	12·5	51	51	66	45
Margarine	1·3	5	5	4	5
Lard	1·3	5	6	6	3
Cakes and pastries	4·2	17	17	17	18
All other foods	2·7	11	11	11	12

The totals are especially sensitive to the value chosen for eggs, ours being derived from those of Tolan *et al.* (1974). But this would not affect the remarkable similarity of intakes in the three countries.

Davidson, S., Passmore, R., Brock, J. F. & Truswell, A. S. (1975). *Human Nutrition and Dietetics* 6th ed. London: Churchill Livingstone.

Ministry of Agriculture, Fisheries and Food. (1977). *Household Food Consumption and Expenditure:* 1975. London: HM Stationery Office.

Paul, A. A. & Southgate, D. A. T. (1978). *McCance and Widdowson's The Composition of Foods.* London: HM Stationery Office.

Shaper, A. G. & Marr, J. W. (1977). *Br. med. J.* 1, 867.

Tolan, A., Robertson, J., Orton, C. R., Head, M. J., Christie, A. A. & Millburn, B. A. (1974). *Br. J. Nutr.* 31, 185.

The vitamin status of elderly independent people living at home in an Australian community. By DELIA M. FLINT, K. SHANNON and A. PARISH, *School of Science, Deakin University, Geelong, Victoria, Australia*

Elderly people form the largest dependent group in the Australian community and in recent years attention has been drawn to the existence of vitamin deficiencies in institutionalized elderly people. Few evaluations of the nutritional status of the elderly in Australia have been reported and for this reason the status of the elderly person living independently at home was evaluated first. As part of the study the vitamin B_6, riboflavin, folic acid and vitamin B_{12} status of a representative group of elderly people in the Geelong region was assessed.

It was found that all the people studied were in a good vitamin status as indicated by some of the haematological data illustrated in Table I.

Table 1. *Mean values for haematological measurements*

	n	Method of measurement	Result mmol/l	Standard Range mmol/l
Serum folate	40	Radioimmunoassay	11·3±0·24	>4
Serum vitamin B_{12}	40	Radioimmunoassay	351·7±2·67	−220 −740
			Activity coefficient	Activity coefficient
Riboflavin	20	Enzyme kinetics	1·32±0·26	1·40
Vitamin B_6	20	Enzyme kinetics	1·10±0·13	1·50

The dietary intake of these vitamins together with other nutrients was also estimated, using food composition tables.

The information obtained has provided base-line data which can be referred to as standard ranges for the healthy elderly person, when comparing the health of these people to that of the institutionalized elderly.

Branched-chain fatty acids of fallow deer perinephric triacylglycerols. By A. SMITH and W. R. H. DUNCAN (introduced by G. A. GARTON), *Rowett Research Institute, Bucksburn, Aberdeen AB2 9SB*

The branched-chain fatty acids normally occurring in ruminant animals are mostly of the iso and anteiso series and account for 1–2% of the total fatty acids (Garton, 1964). Analysis of the perinephric triacylglycerols of semi-feral fallow deer (*Dama dama dama*) showed that of the total fatty acids 15·5% were branched-chain components. The branched-chain fatty acids (as their methyl esters) were isolated from the hydrogenated total fatty acid methyl esters by urea adduct formation and analysed by a combination of high resolution gas chromatography and mass spectrometry. Included in the branched-chain acids were 9·0% iso acids and 2·9% anteiso acids; methyl-substituted iso acids and anteiso acids, together with monomethyl-substituted acids were also present. The acids varied in chain length from 11 carbon atoms to 17 carbon atoms and methyl substitution occurred on the even-numbered carbons relative to the carboxyl group. Whereas the predominant iso acids and methyl-substituted iso acids had chain lengths of 13 and 15 carbon atoms, with 14-methylpentadecanoic acid being the major component, the anteiso acids and methyl-substituted anteiso acids had chain lengths of 14 and 16 carbon atoms. Phytanic acid (3,7,11,15-tetramethylhexadecanoic acid), and its catabolites, pristanic acid (2,6,10,14-tetramethylpentadecanoic acid) and 4,8,12-trimethyltridecanoic acid were also identified.

The biosynthesis of the unusual amounts of iso acids with chain lengths of 13 and 15 carbon atoms is possibly associated with a blockage at the acyl-CoA dehydrogenase step in the catabolism of the amino acid valine; isobutyryl CoA could thus be available in increased concentration and act as 'primer unit' for fatty acid synthesis. The substitution of methylmalonate for malonate in the fatty acid biosynthetic pathway (Scaife & Garton, 1975) is evidently responsible for the methyl-substituted iso and anteiso acids and the monomethyl-substituted acids. It is noteworthy that dimethyl-branched acids containing either a terminal iso structure or a terminal anteiso structure have been isolated from the wax ester fatty acids of vernix caseosa lipid (Nicolaides *et al.* 1976).

Garton, G. A. (1964). In *Metabolism and Physiological Significance of Lipids*, p. 335 [R. M. C. Dawson & D. N. Rhodes, editors]. London: John Wiley and Sons.
Nicolaides, N., Apon, J. M. B. & Wong, D. H. (1976). *Lipids* 11, 781.
Scaife, J. R. & Garton, G. A. (1975). *Biochem. Soc. Trans.* 3, 993.

Fatty acid composition of tissue lipids of rats given dietary branched-chain fatty acids. By A. SMITH, A. K. LOUGH and C. R. A. EARL, *Rowett Research Institute, Bucksburn, Aberdeen AB2 9SB*

The fatty acids of depot lipids of sheep and goats given carbohydrate-rich (cereal) diets comprise enhanced proportions (up to 10%) of branched-chain fatty acids (BCFA) (Garton *et al.* 1972). A concentration of mono-, di- and trimethyl-substituted fatty acids was prepared by hydrogenation and urea adduct formation of the total fatty acids of subcutaneous adipose tissue of barley-fed lambs. These mixed BCFA were added to a basal Oxoid diet given to appetite to 21 d-old female Hooded Lister rats for a period of 14 d. The influence of the mixed BCFA was compared to the effect of additions, to the same basal diet, of 3,7,11,15-tetramethylhexadecanoic acid (phytanic acid), 3-methylhexadecanoic acid, 4-methylhexadecanoic acid and *n*-hexadecanoic acid (palmitic acid). The incorporation of the acids into the tissue lipids of liver, heart, brain, kidney and sciatic nerve was examined, as was their disappearance from the tissues when the animals reverted to the basal diet.

Animals which received diets containing 5% by weight of the fatty acid supplements showed reduced growth. The extent to which growth was retarded varied and, in increasing order of effect, was as follows: palmitic acid, mixed BCFA, 4-methylhexadecanoic acid, 3-methylhexadecanoic acid, phytanic acid.

The inclusion of the mixed BCFA at various levels in the diet showed that up to 10% by weight of diet could be tolerated and that rats which received mixed BCFA to a level of 7·5% by weight of diet over the 14-d period had growth rates only slightly lower than those of control animals given palmitic acid.

At the lowest level of intake of the mixed BCFA (2·5%), the proportions of BCFA in the neutral lipid and phospholipid fatty acids of liver were 15 and 9% respectively; BCFA accumulated to the extent of 10% in kidney and 15% in heart. In the livers of animals given mixed BCFA as 10% of the diet, branched-chain components accounted for 39% and 33% of the total fatty acids of the neutral lipids and the phospholipids and for 36% and 50% of the total fatty acids of the kidney and heart. When the animals reverted to the basal diet, the proportions of BCFA in their tissue lipids fell markedly.

The proportions of BCFA in the lipids of brain and sciatic nerve were about 3% and 13% respectively in rats given the mixed BCFA in the range 2·5–10% by weight of the diet.

Garton, G. A., Hovell, F. D. DeB. & Duncan, W. R. H. (1972). *Br. J. Nutr.* **28**, 409.

The characterization of body-weight losses in the newly weaned sow. By P. E. ZOIOPOULOS, J. H. TOPPS and P. R. ENGLISH, *School of Agriculture, 581 King Street, Aberdeen AB9 1UD*

Soon after weaning sows lose weight and the magnitude of this loss appears to be directly related to the sow's intake during lactation (Lodge *et al.* 1961). The nature of the weight loss is unknown (O'Grady *et al.* 1975). It is frequently assumed that apart from a reduction in gut fill most if not all of the decrease is body water. The main object of this study was to measure in sows the loss in body water during the week following weaning. Measurements were made by the deuterium oxide dilution technique following an overnight fast and certain blood and urine characteristics were also studied. Two diets were given to four pairs of sows so that one sow in each pair was fed *ad lib.* and the other a restricted amount for the whole lactation. Results are given in Table 1.

Table 1. *Individual sow body-weight loss before fasting (BF), after overnight fasting (AF) and body water loss (BW) estimated from D_2O space (kg), in the week after weaning*

	Restricted feeding			*Ad lib.*		
	BF	AF	BW	BF	AF	BW
	14·0	9·50	4·90	21·0	19·0	17·3
	12·0	7·50	7·80	10·0	8·00	7·10
	11·0	3·50	3·90	23·0	20·5	13·2
	14·0	6·50	1·40	10·5	4·00	1·30
Mean	12·8	6·75	4·50	16·1	12·9	9·73

Body water loss was significantly less ($P<0.05$) than weight loss, measured in fasted animals but losses of water appeared to be considerable in 6 out of 8 animals. The estimated body water expressed as a percentage of total body-weight ranged from 56 to 72 which suggests that the fat reserves of some animals were excessively depleted.

Excretion of urinary N, urea and creatinine, and levels of plasma urea were higher a week after weaning, while those for plasma free fatty acids and the hydroxyproline index, as given by Whitehead (1965), were lower. These differences suggest that some depletion of body tissue occurred in the sows following weaning.

Lodge, G. A., McDonald, I. & MacPherson, R. M. (1961). *Anim. Prod.* 3, 269.
O'Grady, J. F., Elsley, F. W. H., MacPherson, R. M. & McDonald, I. (1975). *Anim. Prod.* 20, 257.
Whitehead, R. G. (1965). *Lancet* ii, 567.

Digestion by growing pigs of fibrous diets measured over-all and at the terminal ileum. By P. E. ZOIOPOULOS, J. H. TOPPS and P. R. ENGLISH, *School of Agriculture, 581 King Street, Aberdeen AB9 1UD*

This study was undertaken to assess the role of the pig's large intestine in the digestion of fibrous diets. Four growing pigs each fitted with a simple cannula at the terminal ileum (Livingstone *et al.* 1977) were used to compare the digestion of three diets, each containing a fibrous, protein-rich byproduct, with a conventional diet containing soya-bean meal according to a latin square design. The four diets were made isonitrogenous by the inclusion (g/kg) of soya-bean meal 125, malt culms 200, dried distillers grains with solubles (dark grains) 300 or weatings 650. In a second trial, the digestion of three diets each containing a fibrous source of low nutritive value was compared with that of a conventional barley–fish meal diet. The sources examined and their level of inclusion (g/kg) to make the three diets isonitrogenous and equivalent in fibre were oat husks 335, barley straw 250 or sawdust 240. Chromic oxide was used as a reference substance. Results are given in the table.

Table 1. *Apparent digestibility coefficients for dietary organic matter and nitrogen at the terminal ileum and overall*

	Organic matter digestibility		N digestibility	
	to ileum	overall	to ileum	overall
Trial 1				
Barley + soya-bean	0·75	0·82	0·75	0·76
Barley + malt culms	0·70	0·78	0·67	0·69
Barley + dark grains	0·66	0·73	0·62	0·67
Barley + weatings	0·62	0·68	0·67	0·63
SE* of difference between means	0·010	0·008	0·016	0·010
Trial 2				
Barley–fish meal	0·78	0·82	0·71	0·78
Barley–fish meal + straw	0·59	0·67	0·35	0·76
Barley–fish meal + sawdust	0·53	0·62	0·54	0·73
Barley–fish meal + oat husks	0·38	0·62	0·50	0·77
SE† of difference between means	0·027	0·018	0·017	0·016

*5 df, one missing value with barley/dark grains.
†2 df, SE do not apply to oat husk diet.

Organic matter digestibility, both overall and to the terminal ileum, was depressed by all six fibrous substances. The extent of digestion of nitrogen in the large intestine was greater with the bulkier materials which may be due to poor mixing of digesta and enzymes in the small intestine. Conversely it would seem that for fibrous protein sources digestion in the large intestine has little effect on nitrogenous components encrusted in the cell wall. Bulk *per se* while causing a considerable reduction in digestion of nitrogen to the terminal ileum had no effect over-all (Murray *et al.* 1977).

Livingstone, R. M., Fowler, V. R., White, F. & Wenham, G. (1977). *Vet. Rec.* **101**, 368.
Murray, A. G., Fuller, M. F. & Pirie, A. R. (1977). *Anim. Prod.* **24**, 139.

The effect of a chloroform-containing confection on rumen fermentation in sheep. By S. BASMAEIL and J. L. CLAPPERTON, *Hannah Research Institute, Ayr KA6 5HL*

Previous work (Clapperton, 1974) has shown that, when chloroform is given into the rumen of sheep, methane production is markedly reduced and there are changes in the proportions of the volatile fatty acids in the rumen liquor. In Britain, a popular confection or 'sweet' used to relieve sore throats contains, according to the manufacturer, 2% chloroform. The effect of this readily available solid form of chloroform on the rumen fermentation of sheep was therefore investigated.

Two series of experiments were carried out. In the first, freshly-powdered 'sweet' material was mixed with rumen liquor and buffer at 500 mg/l and incubated at 39° for 3 h. In the second, sheep given a basal diet of hay and concentrates were given 3 g/d of the 'sweet' material either directly through the fistula or else the powdered material was mixed with the food.

	Incubation experiments			Sheep experiments			
Supplement	None	'Sweet'	SE	None	Per os	Per fistula	SE
Fatty acid concentration (mmol/l)							
2:0	36·2	29·9	1·32	72·7	64·2	53·4	1·60
3:0	24·7	25·7	0·74	21·6	25·4	24·2	0·84
4:0	9·6	9·7	0·13	16·2	19·5	17·9	0·89
Total volatile fatty acid	71·7	65·3	1·42	117·6	114·8	101·9	0·52
CH_4/CO_2 in incubation				0·46	0·33	0·16	0·023

The results are shown in the table. In the incubation system, the addition of the 'sweet' material reduced the amount of acetic acid accumulating in the incubation mixture but had no effect on the amount of either propionic acid or butyric acid accumulating. In the animal, similar effects were observed on acetic acid concentration but here there were increases in the concentration of both propionic and butyric acids. The amount of methane produced was markedly reduced. The addition of powdered material to the food was less effective than the introduction of the material through the fistula.

The results show that chloroform incorporated into a confectionary material can affect the rumen fermentation. Powdering the material reduces its efficacy but, unfortunately, the 'sweets' themselves are not palatable to sheep and cannot be used directly to control rumen fermentation.

Clapperton, J. L. (1974). *Br. J. Nutr.* 32, 155.