

The Editors of the Proceedings of The Nutrition Society accept no responsibility for the abstracts of papers read at ordinary scientific meetings of The Nutrition Society. These are published as received from the authors.

ABSTRACTS OF COMMUNICATIONS

The Ninety-ninth Meeting of The Nutrition Society (Forty-fifth of the Scottish Group) was held in the Department of Biochemistry, University of Glasgow, on Saturday, 11 February 1956, at 2 p.m., when the following papers were read :

The heat increment of a mixture of steam-volatile fatty acids and of glucose in the fasting sheep. By D. G. ARMSTRONG and K. L. BLAXTER, *Hannah Dairy Research Institute, Kirkhill, Ayr*

As part of an investigation of the causes of the high and variable heat losses associated with the ingestion of carbohydrate food in ruminants, three experiments were made with a fasting sheep equipped with a permanent rumen cannula. Following an initial period of starvation during which the rumen was irrigated with a dilute saline solution, a mixture of steam-volatile acids (50% acetic, 30% propionic and 20% butyric on a molar basis) was pumped into the rumen at a slow constant rate during 48 h periods. Glucose was then given under similar conditions, penicillin being added to reduce rumen bacterial activity. The sheep was confined in the respiration apparatus (Blaxter, Graham & Rook, 1954), oxygen consumption, carbon-dioxide and methane production and urinary nitrogen excretion being measured every 12 h. Blood samples were taken every 24 h.

The results are summarized in Table 1. They show that the steam-volatile acid mixture gave rise to no ketosis or acidosis, restored the blood sugar to pre-starvation

Table 1. *Results obtained when steam-volatile acid mixtures or glucose were given to a fasting sheep**

	Steam-volatile acid mixture		Glucose	Values during feeding†	Starvation values on:	
	Exp. 1	Exp. 2			5th day of fast	9th day of fast
Calories given (Cal./24 h)	626	1117	675	3600 (approx.)	Nil	Nil
Heat increment (Cal./24 h)	85	172	42	—	—	—
Percentage increment	13.6	15.4	6.6	—	—	—
CH ₄ production (l./24 h)	0.79	0.15	4.85	20.0	0.71	0.10
Rumen pH	6.00	5.34	6.34	6.2	7.20	7.40
Steam-volatile acids in rumen contents (mg/100 ml.)	5.7	7.1	1.7	9.5	0.5	0.2
Reducing sugar in rumen contents (mg/100 ml.)	Nil	Nil	1452.0	Nil	Nil	Nil
Blood plasma CO ₂ combining capacity (vol./100 ml.)	54.0	46.5	63.0	54.0	52.0	53.5
Blood sugar (mg/ 100 ml.)	43.6	42.0	49.6	41.0	34.4	35.6
Blood ketones (mg/100 ml.)	1.1	4.1	0.7	0.8	9.6	6.8

* The rumen and blood analyses refer to values obtained when the acids or glucose had been given continuously for 48 h.

† 900 g dried grass daily.

levels and resulted in a heat increment of 13–15%. That glucose underwent some fermentation in the rumen is indicated by the rise in methane production and increase in steam-volatile acids. An examination of the flora by Dr C. Higginbottom revealed the presence of *Streptococcus faecalis*, *Pseudomonas fluorescens* and coliform organisms. In vitro fermentations, simultaneously carried out, support the view that the fermentation was of no great magnitude. The heat increment with glucose was 7%, a value which is of the same order as that found in man and dog. It is of interest that a large part of the maintenance net energy requirement of the sheep (1200 Cal.) could be met by steam-volatile acids as Phillipson's (1947–8) calculations suggested several years ago.

REFERENCES

- Blaxter, K. L., Graham, N. McC. & Rook, J. A. F. (1954). *J. agric. Sci.* **45**, 10.
 Phillipson, A. T. (1947–8). *Nutr. Abstr. Rev.* **17**, 12.

Frequency of feeding and energy utilization by sheep. By K. L. BLAXTER, N. McC. GRAHAM and F. W. WAINMAN, *Hannah Dairy Research Institute, Kirkhill, Ayr*

The energy exchange of three adult sheep was measured to find whether their metabolism of a constant ration was affected by the frequency with which it was given. A Latin-square design was employed and the ration of 1100 g dried grass given in one, two or four meals daily. Fasting heat production was determined initially and finally and the energy exchange was also measured when 900 g of the grass were given, thus permitting calculation of net energy values. The passage of food was measured using the method of Balch (1950), and methane production was determined at 2 h intervals in the experiments involving one meal and four meals daily. Methods were those of Blaxter & Graham (1955a) and Blaxter, Graham & Wainman (1955).

The energy-exchange data are summarized in Table 1. Analysis of variance showed that frequency of feeding had no significant effect on the faecal energy loss or on heat production. The rate-of-passage curves similarly showed no differences. However, with once-daily feeding, total methane output dropped significantly by about 10% and its rate of production declined markedly after 12 h. The error

Table 1. *Mean energy losses and net energy per 100 Cal. ingested using fasting as the base-line*

	Feeding interval (h)			Standard error of means
	24	12	6	
Energy lost in:				
Faeces	26.4	28.1	28.2	0.64
Methane*	6.70	7.40	7.43	0.09
Urine	3.67	3.86	4.13	0.14
Heat increment	22.9	23.2	21.8	1.43
Net energy	40.3	37.4	38.5	1.75

* Differences significant at the 5% level.

attached to the net energy values (coefficient of variation 7·8%) was larger than in a previous experiment (Blaxter & Graham, 1955*b*) (coefficient of variation 4·3%). This was thought to reflect individuality of the reactions of the sheep to the experimental regimens.

An exponential equation was fitted to the pooled results giving:

$$S = 2\cdot873 - 4\cdot145e^{-0\cdot12I},$$

where S is the energy retention, and I is the energy intake in Cal. $\times 10^3$ /day. The net energy value calculated from this equation using planes of nutrition of 0 and 0·5 (see Blaxter & Graham, 1955*a*) was 137 Cal./100 g dry matter, compared with 132 calculated from digested nutrients using Kellner's factors.

REFERENCES

- Balch, C. C. (1950). *Brit. J. Nutr.* **4**, 361.
 Blaxter, K. L. & Graham, N. McC. (1955*a*). *J. agric. Sci.* **46**, 292.
 Blaxter, K. L. & Graham, N. McC. (1955*b*). *Proc. Nutr. Soc.* **14**, xv.
 Blaxter, K. L., Graham, N. McC. & Wainman, F. W. (1955). *Proc. Nutr. Soc.* **14**, iv.

Effect of hexoestrol implantation on fattening lambs. By J. C. GILL, *Rowett Research Institute, Bucksburn, Aberdeenshire*

The influence of a single implantation of 15 mg hexoestrol on the rate of live-weight gain of fattening lambs was determined in trials with six farm flocks totalling 524 lambs and one indoor group of thirty lambs penned individually. The farm flocks were run on grass and fed turnips *ad lib.* supplemented with concentrates during the final stages of fattening. The indoor lambs were fed on hay and concentrates.

The hexoestrol pellet was implanted in the ear, and examination by palpation indicated that a considerable amount of pellet remained at the end of trials lasting 29 and 58 days. In the 68-day indoor trial an average of 60% of the pellet was recovered from treated lambs at slaughter. Little or no pellet residue was found in lambs 100 days after implantation.

In one farm trial and in the indoor trial the rates of gain were relatively high and there was, in terms of live-weight gain, a significant treatment difference in favour of the treated lambs. On this farm treated lambs made a daily live-weight gain of 0·315 lb. and controls 0·286 lb. over the 163 days of the trial. In the 68-day indoor trial treated lambs made daily live-weight gains of 0·605 lb. and controls 0·467 lb. On the remaining five farms, where the rates of gain were low, there was no significant treatment difference.

On the one farm where carcass data were obtained there was no significant difference between control and treated animals in respect of length of time to reach slaughter weight, killing out percentage and carcass weight or grade. In the indoor trial there was again no significant treatment difference in either carcass weight or killing out percentage, but carcasses of the control animals, irrespective of sex, graded significantly higher than those of the treated. Compared with the controls there was a thinner layer of external fat on the gigots and less fat on the kidneys of

the treated lambs. Carcass measurements showed the legs of the treated lambs to be significantly longer and the gigots significantly leaner.

The response to the hormone was not affected by sex but, in the indoor trial, mammary development in the treated ewe lambs was considerable and, in consequence, their carcass classification was lowered. Treated wether lambs showed only slight enlargement of the teats and this did not affect carcass classification.

No instance of prolapse or other ill-effect was observed in any of the treated lambs.

Some investigations on the composition of diets for pigs weaned at 8 lb.

live weight. By H. SMITH and I. A. M. LUCAS, *Rowett Research Institute, Bucksburn, Aberdeenshire*

In Exps. 1-3, pigs were weaned at 10 days old, housed individually in cages, and fed water and dry-meal diets *ad lib.* until they reached 25 lb. live weight, when the experiments were terminated. The diets fed were based on dried skim milk, rolled oat groats, white-fish meal, sucrose, dried yeast, cod-liver oil, minerals and antibiotic.

In Exp. 1 food-conversion efficiency was significantly improved by 10% when the crude protein in the diet was raised from 24 to 29%, but higher protein levels brought no further significant improvement. Level of protein within this range did not affect rate of live-weight increase. Food consumption did not increase when 10% sucrose was included in the diet, but there were significant improvements of 8% in rate of live-weight increase and 10% in food-conversion efficiency.

In Exp. 2, pigs fed a diet containing 7% fat grew 4% faster and 6% more efficiently than others fed a diet containing 3.7% fat, but neither difference was significant. There was no advantage in feeding the meal as a slop.

In Exp. 3 an increase in level of antibiotic from 18 to 112 mg/lb. diet and the addition of a trace-mineral supplement each significantly increased rate of live-weight gain by 7% and the effects were additive, but changes in food-conversion efficiency were not significant. The use of a complex vitamin supplement did not affect growth performance.

In all three experiments the growth curve consisted of a 'check' period following weaning, when the pigs grew very slowly, and a 'growing' period, when growth was very rapid. No single treatment tested affected the length of the 'check' period, which was usually 7-14 days.

In Exp. 4, pigs were weaned at 10 days old, fed individually on a standard diet until 25 lb., then fed diets containing either 18, 21, 24 or 27% protein. There was no difference in growth performance between groups.

In Exp. 5 pigs were weaned at either 8, 14 or 20 lb. live weight and fed in groups on standard diets. At 8 weeks old the average live weights were 45, 49 and 46 lb. respectively.

Only two pigs died out of 240 used in Exps. 1-5. Pigs sometimes scoured during

the 'check' period, but this was cured by withholding food, but not water, for 12 h. The average delay between farrowing and effective re-service after weaning a litter at 10 days old was 19 days.

The use of polyethylene glycol as an inert reference substance for the estimation of faecal output. By J. L. CORBETT, T. B. MILLER, EILEEN W.

CLARKE and E. FLORENCE, *Rowett Research Institute, Bucksburn, Aberdeenshire*

Chromic oxide in gelatin capsules is widely used for estimating faecal output of grazing animals. Radiography suggests that difficulties in its use with sheep are due to the eosophageal-groove reflex determining the immediate fate of the capsules (Corbett & Benzie, 1953). Ten 3 g capsules (40 mm long, 15 mm diameter) given to two mature wethers (three administrations) all passed directly to the omasum or abomasum. Five given to two other sheep were all seen at the reticulo-rumen fold where the contents are liable to pass rapidly into the omasum. Both 3 g and 1 g (25 mm long and 10 mm diameter) sizes were similarly distributed in a fifth sheep, but seven 1 g size all entered the rumen of a further animal where best mixing of marker with digesta may be expected. Only one 3 g capsule has been seen in the rumen proper.

Raymond & Minson (1955) used 1 g capsules successfully with sheep. Though they show the high specific gravity of chromic oxide is probably of little importance, water-soluble high molecular-weight polyethylene glycol (P.E.G. 4000) appears to offer advantages as a marker (Sperber, Hydén, & Ekman, 1953).

In a grazing trial 25 g P.E.G., incorporated with chromic oxide in grass-meal cubes, was fed daily to dairy cows. Faeces were collected quantitatively from four cows during eighteen 5-day periods. Actual faeces production was 30–45 kg daily and gave calculated concentrations of 80–55 mg P.E.G./100 g faeces. Determination was by the Shaffer & Critchfield (1947) colorimetric method. Recoveries were low, ranging from 40 to 70%, but none was found in urine. Increasing the preliminary aqueous dilution of faeces to measurable P.E.G. limits gave increasing, though still incomplete, recoveries. Similar results at these low concentrations in vitro suggested adsorption. Apparent losses did not increase with time or on incubation, but were greater with 'grass' than 'winter-ration' faeces. Further work in vitro has confirmed our preliminary investigations and suggests that P.E.G. may be a satisfactory marker if fed to give not less than 250 mg/100 g faeces. A rapid turbidimetric method of estimation (Hydén, 1955) has been found accurate.

Grateful thanks are due to the Kellogg Foundation, U.S.A. for a grant of funds in aid of this research programme.

REFERENCES

- Corbett, J. L. & Benzie, D. (1953). Unpublished observations.
Hydén, S. (1955). *K. LantbrHögsk. Ann.* **22**, 139.
Raymond, F. & Minson, D. J. (1955). *J. Brit. Grassl. Soc.* **10**, 282.
Sperber, I., Hydén, S. & Ekman, J. (1953). *K. LantbrHögsk. Ann.* **20**, 337.
Shaffer, C. B. & Critchfield, F. H. (1947). *Analyt. Chem.* **19**, 32.

A Comparison of herring meal and groundnut meal for milk production in ruminants. By MARGARET I. CHALMERS and S. B. M. MARSHALL (introduced by R. L. M. SYNGE), *Rowett Research Institute, Bucksburn, Aberdeenshire*

In experiments with sheep (Chalmers, Cuthbertson & Synge 1954; Chalmers & Synge, 1954) it was shown that the value of protein to the ruminant animal varies inversely with the extent to which the protein is attacked and deaminated by the micro-organisms of the rumen. Ruminal ammonia concentrations measured on sheep receiving basal diets of hay and cereals, with groundnut meal or herring meal as supplementary sources of protein, showed the ammonia production from groundnut meal to be greater than that from herring meal (Annison, Chalmers, Marshall & Synge, 1954).

Nitrogen-balance experiments on lactating goats fed groundnut meal and herring meal in rations of equal N percentages showed the N utilized (N in milk + N balance) from the herring-meal ration to be greater than that from the groundnut-meal ration.

A comparison of milk yields from two groups of six cows, in which herring-meal and groundnut-meal rations were fed in a double reversal pattern showed the individual yield on herring meal to be 0.6 lb/day greater than that on groundnut meal.

REFERENCES

- Annison, E. F., Chalmers, M. I., Marshall, S. B. M. & Synge, R. L. M. (1954). *J. agric. Sci.* **44**, 270.
Chalmers, M. I., Cuthbertson, D. P. & Synge, R. L. M. (1954). *J. agric. Sci.* **44**, 254.
Chalmers, M. I. & Synge, R. L. M. (1954). *J. agric. Sci.* **44**, 263.

Differences in yield and composition of the milk from right and left breasts. By F. E. HYTEN, *Obstetric Medicine Research Unit (Medical Research Council), Midwifery Department, University of Aberdeen*

In 600 primiparae and 95 multiparae, 24 h milk samples were taken from each breast separately on the 7th postpartum day, and the fat content estimated. Lactose and nitrogen were also estimated in the sample from fifty primiparae and thirty-nine multiparae.

The yield and composition of milk from the two breasts varied widely and unsystematically. Results were the same in primiparae and multiparae.

Yield. The yield from the two breasts differed in 96% of women. In about half, the difference exceeded 40 ml. and in about a quarter 80 ml. The average difference was about 50 ml. (approximately 25% of the mean yield from one breast) and the greatest 340 ml.

Fat. The two breasts produced milk of different fat content in 92% of women. In about half, the difference exceeded 0.3 g/100 ml. and in about one-quarter 0.5 g/100 ml. The average difference was about 0.4 g/100 ml. (approximately 14% of the mean value) and the greatest 4.3 g/100 ml.

Lactose. Differences between the two breasts were relatively small. In over 90% of women tested the difference was under 0.5 g/100 ml. (about 8% of the mean value) and in none was above 1.0 g/100 ml.

Nitrogen. Differences were small. Milk from the two breasts had total nitrogen contents differing by less than 20 mg/100 ml. (about 7% of the mean value) in almost 80% of women tested. For protein, 62% were within 0.1 g/100 ml. of each other and 90% were within 0.2 g/100 ml.

There was no association between yield and any of the constituents, but there was a close positive relationship (significant at 1%) between fat content and protein content, i.e. the higher fat content and the higher protein content were almost always from the same breast.

Preliminary data for the diurnal variation of yield and composition, and for 24 h samples repeated after an interval of some weeks, suggest that the differences in yield between the two breasts remain constant in direction, whereas the differences in composition vary haphazardly.

Differences in yield are probably due to anatomical differences of gland size, but differences in milk composition suggest variations in the physiology of secretion.

The site of action of glucose on protein metabolism during fasting. By
J. G. BLACK, H. N. MUNRO and W. S. T. THOMSON, *Department of Biochemistry,*
University of Glasgow

It has previously been demonstrated (Munro & Thomson, 1953) that administration of carbohydrates to fasting human subjects or to fasting rats causes a reduction in blood amino-acid concentration, whereas the giving of fat under similar circumstances does not have this effect. In the present series of investigations, we have explored the site of deposition of the amino-acids disappearing from the blood after glucose administration.

In the first group of experiments, rats were either fasted for 24 h or fed solely on glucose or olive oil. There was a marked reduction in urinary nitrogen output by the glucose-fed group, but tissue analyses indicated that the retained N was not deposited in the viscera. It must therefore have been retained in the carcass.

In the second series of experiments rats were injected with ³⁵S-methionine and then fed water, glucose or olive oil by stomach tube. The animals were killed 2, 4 or 6 h later and the specific activity of methionine determined for the proteins of liver, intestinal mucosa, diaphragm and leg muscle. There was considerably greater radioactivity in the diaphragm and leg-muscle proteins 4 h after feeding glucose than in the case of the water-fed or fat-fed series. There were no differences in methionine uptake for liver or intestinal mucosa proteins.

In order to study changes in the free amino-acid pool, another group of rats were injected with 2-¹⁴C-glycine before feeding with water, glucose or olive oil. Glycine was isolated from the amino-acid pool of liver and leg muscle. In general, liver and muscle glycine had similar radioactivities except in the case of the glucose-fed rats,

which showed a considerably greater specific activity for muscle free glycine at 4 and 6 h after feeding.

These findings are taken to indicate a specific action of carbohydrate on protein metabolism in muscle.

REFERENCE

Munro, H. N. & Thomson, W. S. T. (1953). *Metabolism*, **2**, 354.