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PROCEEDINGS OF THE NUTRITION SOCIETY

ABSTRACTS OF COMMUNICATIONS

The Four Hundred and Forty-third Meeting of the Nutrition Society was held at the Faculty of Letters Lecture Theatre, University of Reading, Reading, on Monday and Tuesday, 14/15 September 1987, when the following papers were presented as posters:

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Effects of isomeric fatty acids on essential fatty acid metabolism in the rat. By J. D. EDWARDS-WEBB, I. E. SAMBROOK and V. A. WELCH, *AFRC Institute of Food Research, Reading Laboratory, Shinfield, Reading RG2 9AT* and M. I. GURR, *Milk Marketing Board, Thames Ditton KT7 0EL*

The British diet contains 40% of energy as fat, and it can be estimated that 20% of this fat could be provided as isomeric fatty acids in industrially hardened and ruminant fats and oils. The presence of large amounts of these fatty acids in association with low intakes of essential fatty acids could lead to disturbances of essential fatty acid metabolism (Gurr, 1983). To test for such disturbances, six groups of six rats were given diets for 12 weeks post-weaning containing 40% of energy as fat. The diets contained either 40 (diets L) or 90 (diets H) g linoleic acid (as soya-bean oil)/kg total fatty acids. The remainder of fat was provided as equal amounts of saturated fatty acids (as hydrogenated tallow) and monounsaturated fatty acids (as triolein) (diets L0 and H0).

Isomeric fatty acids (as hydrogenated fish oil) were added at the expense of monounsaturates so that either 100 or 200 g isomeric fatty acids/kg total fatty acids were provided (diets L10, L20, H10, H20).

All rats grew at similar rates, and no overt signs of essential fatty acid (EFA) deficiency were seen. The ratio of 20:4*n*–6/18:2*n*–6 fatty acids in plasma was higher for the L diets (2·2) than for the H diets (1·6), suggesting greater Δ6-desaturase activity at the lower EFA intake. However, there was a tendency for this proportion to fall as the isomeric fatty acid content of the diets increased for both L and H groups of diets. For diets H0, H10 and H20 only trace amounts of 20:3*n*–9 were detected in plasma, but for diets L0, L10 and L20 the levels were 7·8, 10·2 and 12·9 mg/g plasma fatty acids respectively, suggesting increased production of this fatty acid in diets containing lower levels of EFA and at increasing isomeric fatty acid levels. However, the levels of 20:3*n*–9 remained well below that typical of EFA deficiency.

Gurr, M. I. (1983). *International Dairy Federation Bulletin*, Document 166.

Transport inhibition: an alternative dietary treatment for phenylketonuria? By M. G. DAVIS and S. E. FRANCIS, *Division of Biological Sciences, Hatfield Polytechnic, Hatfield, Herts AL10 9AB*

The established dietary treatment for phenylketonuria by restricting phenylalanine intake is both tedious and costly, therefore, it is of potential clinical benefit to search for an alternative approach to the problem. The present study examines the inhibitory effect of chemical analogues of phenylalanine on rat intestinal uptake of phenylalanine. This in vitro system provides a model for investigating the control of human absorption of dietary phenylalanine.

Everted segments were prepared from the jejunum of fasted male Wistar rats (three per treatment) and incubated for 25 min in Krebs–Ringer bicarbonate buffer (pH 7·4, 37°) containing L-[^{3}H]phenylalanine with or without analogues present. Uptake of phenylalanine was determined as described by Crawhall & Davis (1969).

Kinetic analysis indicated that two systems were operating for phenylalanine transport, one operating below 0·5 mM and the other above 1·0 mM, with overlap between these concentrations. The effects of analogue inhibitors on transport are shown in the Table and indicate maximum inhibition by methionine and tryptophan of greater than 50%. Tyrosine only caused significant inhibition of the low-concentration transport system whereas all the other analogues caused inhibition of both systems.

Percentage inhibition of transport of phenylalanine

(Values are means of triplicate determinations with their standard errors)

	Phenylalanine concentration (mM)					
Inhibitor (5 mM)	0·1		0·5		1·0	
	Mean	SE	Mean	SE	Mean	SE
L-Histidine	43	4·0	35	2·7	26	2·0
L-Methionine	51	4·4	33	3·1	29	2·2
L-Tyrosine	42	4·0	4	0·3	1	0·1
L-Tryptophan	53	5·0	22	1·0	20	2·0
L-Phenylalaninol	35	3·3	18	1·2	29	2·0

These results indicate that analogue inhibitors either alone or in combination may provide an alternative dietary treatment for phenylketonuria by means of reducing the absorption of dietary phenylalanine.

Crawhall, J. C. & Davis, M. G. (1969). *Biochemical Journal* **112**, 571–578.

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Effects of two levels of dietary protein on food intake and carcass composition of broiler birds given glucose in the drinking water. By E. A. ENGKU AZAHAN, KAREN K. A. PAULSEN and J. M. FORBES, *Department of Animal Physiology and Nutrition, University of Leeds, Leeds LS2 9JT*

In a previous experiment (Engku Azahan & Forbes, 1987) on growing cockerels of an egg-laying strain, food intake was observed to be depressed while energy consumption was maintained in birds offered glucose in the drinking water. The present study extended the previous work to broilers, at the same time investigating the possibility of a differential response to diets of two levels of protein.

Thirty-five cockerels of a broiler strain, aged 20 d, were allocated to five groups. One group was killed for the estimation of initial carcass composition while the remaining groups were arranged in a 2×2 factorial design. The treatments involved two levels of dietary protein (195 and 150 g/kg) and two sources of drink (glucose solution (91·5 g glucose/l) and tap water). All fluids and foods were given *ad lib.* for 35 d. Birds were caged individually so that food and fluid intakes and faecal output could be monitored. At the end of the experiment birds were killed for carcass analysis. The results are summarized in the Table.

Group . . .	LW	LG	HW	HG	SED
Food intake (g/35 d)	4499·9[a]	3635·9[b]	4201·9[a]	4175·6[a]	218·3
Fluid energy intake (MJ/35 d)	—	8·68[a]	—	9·56[a]	0·54
Total energy intake (MJ/35 d)	77·22[a,b]	71·07[b]	77·18[a,b]	85·27[a]	4·01
Gain in carcass energy (MJ/35 d)	13·90[c]	12·29[c]	18·14[b]	21·37[a]	1·40
Carcass protein (g/bird)	391·3[b]	369·4[b]	537·6[a]	522·4[a]	30·02
Carcass fat (g/bird)	300·6[b]	271·9[b]	341·4[b]	472·8[a]	44·26
Gain in body-weight (g/bird)	1588·5[b]	1375·1[b]	2093·3[a]	2210·7[a]	119·9

H and L, high- and low-protein diets respectively; G and W, glucose solution and tap water respectively.
[a,b,c] Values in the same row with different superscript letters were significantly different ($P<0·05$).

Intake of the low-protein diet was depressed by inclusion of glucose in the drinking water whereas intake of the high-protein diet was not. Thus, those birds on HG consumed more energy which was deposited principally as additional fat. An adequate supply of protein therefore seems to be necessary if the intake of glucose is not to depress food intake.

Engku Azahan, E. A. & Forbes, J. M. (1987). *Proceedings of the Nutrition Society* **46**, 32A.

Lack of effect of intraportal infusions of amino acids and ammonia on food intake in sheep. By M. H. ANIL and J. M. FORBES, *Department of Animal Physiology and Nutrition, University of Leeds, Leeds LS2 9JT*

Several amino acids and ammonia have been proposed as possible factors in the control of food intake in sheep (Baile & Martin, 1971) and in rats (Jeanningros, 1984). The present study was designed to investigate the hepatic action of some amino acids and ammonia infused into the hepatic portal vein.

Five adult castrated sheep, weighing between 55 and 60 kg, prepared under general anaesthesia with chronic catheters in the hepatic portal vein were used. They were fed *ad lib.* on a complete pelleted diet (g/kg; oil 30, crude protein (nitrogen × 6·25) 140, crude fibre 155) and received infusions (in a 5 × 5 Latin-square design) of the following into the hepatic portal vein at a rate of 1 ml/min for 3 h starting at 10.00 hours: (1) L-lysine (3·6 g), (2) ammonium chloride (12 g), (3) leucine (4·2 g), (4) threonine (2·4 g), each in 180 ml saline (9 g sodium chloride/l) which was also used as control. The levels used were similar to those of previous work (Baile & Martin, 1971). Food intakes were measured every 30 min from 09.30 hours when fresh food was offered, until 15.00 hours, 2 h after the infusions ended. The results were subjected to analysis of variance.

The mean (SEM) food intakes (g) during the infusions were saline 255 (35), lysine 234 (58), ammonium chloride 211 (53), leucine 334 (52), threonine 609 (308). Compared with the saline infusions none of the treatments had a significant effect on food intake. The high mean intake during threonine infusions was due to two very high intakes which could not be explained.

The results suggest that ammonia absorbed from the rumen does not act on the liver to depress intake in sheep, at least in the short term. Nor is there any indication that any of the amino acids tested may have a role, through the hepatic route, in controlling food intake in ruminants. The longer term effects may be different.

This work was supported by the Agricultural and Food Research Council.

Baile, C. & Martin, D. (1971). *Journal of Dairy Science* **54**, 897–905.
Jeanningros, R. (1984). *Journal of the Autonomic Nervous System* **10**, 261–268.

Food intake and growth of broiler chickens following removal of the abdominal fat pad.

By C. G. TAYLOR and J. M. FORBES, *Department of Animal Physiology and Nutrition, University of Leeds, Leeds LS2 9JT*

Force-feeding of chicks to increase their total daily feed intake causes a reduction in voluntary feed intake and an increase in body fat. Return to normal *ad lib.* feeding results in a fall in body fat and a gradual return to pre-treatment levels of intake (Lepkovsky & Furuta, 1971) which could be ascribed to a 'lipostatic' control of feed intake. Conversely, a period of underfeeding is followed by hyperphagia until body fat levels are restored. However, force-feeding or underfeeding impose many changes on the birds in addition to fatness; the present experiment investigated an alternative method of manipulating body fat without a period of abnormal nutrition.

Eighteen female broiler chicks were caged individually at 51 d after hatching and allocated to three groups. Feed intakes and body-weights were recorded to 69 d at which time one group was slaughtered for initial carcass analysis, one group was subjected to surgical removal of the abdominal fat pad under general anaesthesia and the third was sham operated. Intakes and body-weights were monitored to the 98th day when the birds were slaughtered and their carcasses analysed.

Effect of surgical removal of the abdominal fat pad of 10-week-old female broiler chickens on weight gain and feed intake

	Sham operated		Lipectomized	
	Mean	SE	Mean	SE
Body-weight gain (g):				
During 3 weeks before operation	758	25	802	61
During 4 weeks after operation	1100	49	1153	94
Total feed intake (g):				
During 3 weeks before operation	3631	225	3658	141
During 4 weeks after operation	5455	170	5400	313
Live wt before slaughter (g)	4271	101	4117	154
Carcass wt including fat pad (g)	3656	91	3496	35
Fat-pad wt (g):				
At operation	—		85	6
At slaughter	190	12	—	

Values for sham operated and lipectomized chickens were not significantly different.

The results show that removal of the fat pad (mean weight 85 g at operation; this was 13·6% of the total fat content of the initial slaughter group) had no effect on the subsequent feed intake, weight gains or carcass composition and suggest that the modern broiler chicken does not control its feed intake in order to attain a 'target' amount of body fat.

Lepkovsky, S. & Furuta, F. (1971). *Poultry Science* **50**, 573–577.

The effect of diets adequate and deficient in calcium on the activities of intestinal plasma membrane ATPases and blood pressure in normotensive and spontaneously hypertensive rats. By PETER BLAKEBOROUGH, SHEILA G. NEVILLE and BRIAN A. ROLLS, *Human Nutrition Department, AFRC Institute of Food Research, Reading Laboratory, Shinfield, Reading RG2 9AT*

The present study investigated possible associations of hypertension with defects in intestinal calcium transport. Groups of ten spontaneously hypertensive (SHR) and normotensive control (WKY) rats were maintained from 8 weeks of age on semi-synthetic diets containing (mg/g) 6 Ca, 4 sodium (adequate in Ca, +Ca) or <1 Ca, 4 Na (deficient in Ca, −Ca). From 12 weeks of age systolic blood pressures were measured by tail-cuff sphygmomanometry. At 18 weeks the rats were killed and brush-border and basolateral membranes were prepared from the small intestines.

Blood pressures were higher in SHR compared with WKY rats and, for SHR rats only, in −Ca compared with +Ca animals. Activities of Na^+, K^+-ATPase (*EC* 3.6.1.37) in basolateral membranes and alkaline phosphatase (*EC* 3.1.3.1) and Ca^{2+}-ATPase (*EC* 3.6.1.38) in both membranes were all lower in SHR than in WKY rats, when fed on +Ca diets. The activities of these enzymes tended to be higher in animals given −Ca rather than +Ca diets, especially for SHR rats, although the differences were not all significant. Activities of other marker enzymes for brush-border (e.g. alanine aminopeptidase (*EC* 3.4.11.2) and basolateral (e.g. Mg^{2+}-ATPase) membranes were unaffected by strain of rat, or diet.

Strain of rat and type of diet . . .	WKY +Ca		WKY −Ca		SHR +Ca		SHR −Ca	
	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM
Blood pressure (mmHg)	132	4	138^{NS}	4	180***	3	191*	3
Specific activity of enzymes:								
Basolateral membranes:								
Na^+, K^+-ATPase§	2·18	0·67	2·98^{NS}	0·61	1·13*	0·07	2·0**	0·37
Alkaline phosphatase‡	6·73	0·85	7·73^{NS}	1·82	3·79**	0·42	5·1†	1·08
Ca^{2+}-ATPase§	115·81	8·6	143·39†	·19·31	89·49*	9·86	106·73†	1·55
Mg^{2+}-ATPase§	127·8	12·3	151·59^{NS}	21·49	114·25^{NS}	35·17	91·67^{NS}	10·37
Brush-border membranes:								
Alkaline phosphatase‡	11·85	1·58	13·38^{NS}	3·48	6·4**	0·63	8·38*	0·82
Ca^{2+}-ATPpase§	160·25	38·48	120·33^{NS}	20·5	90·22**	5·59	112·65*	2·39
Alanine aminopeptidase‡	0·41	0·03	0·47^{NS}	0·06	0·42^{NS}	0·04	0·36^{NS}	0·04

Results are means, with their standard errors, of at least three experiments.

NS, not significant. $^{\dagger}P<0·15$, $*P<0·05$, $**P<0·025$, $***P<0·001$. Values in the SHR +Ca column compare results between WKY +Ca and SHR +Ca. Values in the WKY −Ca and SHR −Ca columns compare results between WKY +Ca and WKY −Ca, and SHR +Ca and SHR −Ca respectively.

‡μmol/min per mg protein. §μmol/h per mg protein.

These results support the hypothesis of altered Ca metabolism in the hypertensive state. High-affinity Ca^{2+}-ATPase and alkaline phosphatase catalyse the active transport of Ca across cell membranes which functions in intestinal Ca absorption. Na^+, K^+-ATPase activity aids in Ca absorption via Na^+–Ca^+ exchange. The partial activation of these ATPases in the Ca-deficient rats may be an adaptation to increase Ca absorption, but if so, it has not been successful in preventing even higher blood pressures. The results do indicate that dietary manipulation of Ca can affect both blood pressure and some mechanisms of Ca absorption.

Follow up of energy intake and growth of children initially breast-fed. By A. A. PAUL, A. E. BLACK and R. G. WHITEHEAD, *MRC Dunn Nutrition Unit, Milton Road, Cambridge CB4 1XJ*

We have previously reported that Cambridge breast-fed babies consumed less dietary energy than amounts recommended and that, apart from the first 4 months, growth in weight and length up to 12 months of age showed a deceleration relative to standard growth charts (Whitehead & Paul, 1984).

Thirty-one of the initial cohort of forty-eight Cambridge babies were followed up to 3 years of age and thirty-seven of them were measured at 6 to 7 years old. Weighed food intakes for 4 d at 12 months, and 7 d at 15, 18, 24 and 36 months were carried out as described by Black *et al.* (1983).

	Energy intake (MJ/d kcal/d in parentheses)						Wt (kg)			
	Boys			Girls			Boys		Girls	
Age (months)	*n*	Mean	SD	*n*	Mean	SD	Mean	SD	Mean	SD
24	13	4·22 (1002)	0·78 (186)	9	4·03 (958)	0·50 (119)	12·20	1·20	11·61	0·83
36	18	4·96 (1179)	0·78 (184)	13	4·62 (1099)	0·50 (119)	14·53	1·56	14·16	1·35
80	22	—	—	15	—	—	22·23	2·57	22·39	3·41

The children have continued at a low level of energy intake compared with recommendations, taking some 1·3 MJ (300 kcal)/d less than Department of Health and Social Security recommended daily amounts from 1 to 3 years.

Mean weight and length showed a further decline relative to American standards (Hamill, 1977) to reach the lowest values (20th to 30th centiles) at 15–18 months, but in spite of the apparent energy shortfall, almost returned to the 50th centile by 3 years of age. At 6–7 years, there was little further change in centile position, apart from the girls' weight which was above the standard 50th centile.

Thus the influence of initial mode of feeding lasts well into early childhood. It is more likely to be the result of overall eating patterns and lifestyle rather than the receipt of breastmilk *per se*.

The authors thank S. J. Wiles, J. Evans, K. C. Day and P. A. Norris for assistance.

Black, A. E., Cole, T. J., Wiles, S. J. & White, F. (1983). *Human Nutrition: Applied Nutrition* **37A** 448–458.

Hamill, P. V. V. (1977). *U.S. Department of Health, Education and Welfare Publication* No. PHS 78–1650. Hyattsville, MD: National Center for Health Statistics.

Whitehead, R. G. & Paul, A. A. (1984). *Early Human Development* **9**, 187–207.

Temperature, food form and the food intake of broiler chickens. By M. A. R. HOWLIDER and S. P. ROSE, *School of Agriculture, 581 King Street, Aberdeen AB9 1UD*

High temperatures decrease the voluntary food intake of growing poultry (Charles *et al.* 1981). Also, if poultry are given a meal-form (coarsely ground) food then their voluntary food intake is decreased compared with birds given a pelleted food (Reece *et al.* 1984). Pelleting of poultry foods incurs additional costs and also requires relatively expensive machinery which may not always be available locally. The objective of the present study was to investigate the differences in food intakes of broiler chickens kept at different temperatures and assess whether pelleting is necessary at high environmental temperatures when low food-intakes are expected.

Ross 1 broiler chickens (*n* 1280) were kept in eight identical rooms from 3 to 7 weeks of age. The rooms were kept at constant temperatures of 17·5, 18·3, 21·2, 21·4, 24·8, 25.1, 28·7 and 29·2°. Within each room there were four pens and the male and female broilers were given food (13 MJ metabolizable energy/kg, 209 g crude protein (nitrogen × 6·25)/kg) in meal form or steam pelleted (3 mm pellets).

There was a linear decrease ($P<0·01$) in food intake with increasing temperature for all treatment groups (Table). The regression coefficients of the male birds given food in ground or pelleted form were similar, but food intake was increased by 7% ($P<0·05$) for the males given the pelleted food. The regression coefficients of food intake with temperature for the female birds were similar but there was no significant difference in intakes of the ground and pelleted foods. The growth rate and food conversion ratio of all the birds were highly correlated to their food intakes.

Regression equation values of food intake (kg) with temperature (°) for broilers given meal or pellets (standard errors in parentheses)

	Regression coefficient	Intercept	Variance accounted for (%)
Males, meal	−0·042 (0·0071)	4·523 (0·1680)	82·7
Males, pellets	−0·052 (0·0103)	4·990 (0·2437)	77·6
Females, meal	−0·049 (0·0074)	4·367 (0·0074)	86·3
Females, pellets	−0·047 (0·0068)	4·382 (0·1600)	87·0

The results indicate that the increased food intake obtained by pelleting broiler food is greater in male than in female birds. The size of the increase in food intake due to pelleting was similar regardless of temperature, even though increasing temperatures decreased food intakes.

Charles, D. R., Groom, C. M. & Bray, T. S. (1981). *British Poultry Science* **22**, 475–481.
Reece, F. N., Lott, B. D. & Deaton, J. W. (1984). *Poultry Science* **63**, 1906–1911.

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The effect of basal diet on rumen protein degradability measurements derived using an *in situ* polyester bag technique. By J. A. LEES and E. L. MILLER, *Department of Applied Biology, University of Cambridge, Cambridge CB2 3DX*

The extent of degradation of dietary protein in the rumen is a key factor in new methods of evaluating protein requirements of ruminants and protein values of feedstuffs. The synthetic fibre bag method (Mehrez & Ørskov, 1977) of determining degradability (dg) is being investigated by a collaborative trial as potentially the most appropriate method currently available. Recent studies (e.g. Vik-Mo & Lindberg, 1985) have suggested that values determined by this technique are influenced by the nature of the basal diet offered to the animal, particularly extremes of roughage, starchy cereals and protein content. To investigate the extent of this variation, the dg of five food samples was measured in four sheep offered, in period 1, dried grass cubes (G; 1000 g/d) and, in period 2, a restricted starch concentrate (C; 400 g/d) plus hay (H; 600 g/d). G contained 142 g crude protein (nitrogen × 6·25, CP)/kg and 481 g ash-free neutral detergent fibre (NDF)/kg; C contained 168 g CP/kg and 169 g NDF/kg, and H contained 77 g CP/kg and 552 g NDF/kg on a fresh weight basis.

Five test foods were prepared and dg determined as recommended by Cottrill & Evans (1984) using incubation periods of 0, 3, 6, 9, 12, 18, 24 and 48 h. Disappearance of N from polyester bags (42 μm pore size) at each time interval were compared using analysis of variance. N disappearance curves were derived according to Ørskov & McDonald (1979) and predicted dg calculated for a fractional outflow rate of solid particles from the rumen of 0·05/h, as suggested for sheep by the Agricultural Research Council (1984).

Predicted crude protein dg

		Test food					
Period	Basal diet	Soya 1	Soya 2	Rapeseed	Barley	Hay	SE (23 df)
1	Grass cubes	0·717	0·681	0·715	0·812	0·493	0·0196
2	Concentrate + hay	0·645	0·636	0·683	0·763	0.405	

N disappearance from the bags was greater for each incubation time in period 1 when the sheep were offered G (3, 6, 9 and 24 h, $P<0·001$; 18 h, $P<0·01$; 12 and 48 h, $P<0·05$). There was no difference for 0 h samples. Predicted dg values were significantly greater ($P<0·001$) on the G basal diet. There was no interaction of feed with basal diet indicating all feeds were similarly influenced by basal diet.

This research was funded by MAFF.

Agricultural Research Council (1984). *The Nutrient Requirements of Ruminant Livestock*. Suppl. no. 1. Farnham Royal, Slough: Commonwealth Agricultural Bureaux.

Cottrill, B. R. & Evans, P. J. (1984). *Estimation of Protein Degradability*. Interdepartmental Protein Working Party. Unpublished circular.

Mehrez, A. Z. & Ørskov, E. R. (1977). *Journal of Agricultural Science, Cambridge* **88**, 645–650.

Ørskov, E. R. & McDonald, I. (1979). *Journal of Agricultural Science, Cambridge* **92**, 499–503.

Vik-Mo, L. & Lindberg, J. E. (1985). *Acta Agriculturae Scandinavica* **35**, 117–128.

Consumer attitudes to liquid milk. By GILLIAN WRIGHT, *Food Policy Research Unit, School of Biomedical Sciences, University of Bradford, Bradford, West Yorkshire BD7 1DP*

Price, availability, quality and taste are the traditional elements of food demand. Milk as a commodity which is purchased daily by almost 90% of households, is particularly susceptible to demand change. Total demand for milk is falling and there is a shift towards consumption of low-fat varieties of milk (Fallows, 1986).

A 2-year (1985–86) study was designed to investigate changes in milk consumption, attitudes and knowledge. The survey was administered to a sampling frame designed to obtain representative households within the area covered by the Milk Marketing Board for England and Wales.

The purchase statistics in Table 1 show a shift towards low-fat milks. Table 2 shows that milk is regarded as a natural, versatile food which is good value for money. The results of the present study of purchase behaviour and consumer attitudes demonstrates that concern about diet and health issues has had a significant influence on these purchasing patterns.

Table 1. *Milk purchasing from all sources over the previous 4 weeks (no. of respondents 576; % of total respondents in parentheses)*

Type of milk purchased	1985	1986
Pasteurized (whole milk)	478 (83)	445 (77)
Semi-skimmed	103 (18)	166 (29)
Skimmed	142 (25)	151 (26)
All milk	572 (99)	574 (99)

Table 2. *Attitudes towards liquid milk (no. of respondents 576; values are % of total respondents)*

Year	Agree	Don't know	Disagree
	'Milk is full of natural goodness'		
1985	95	1	4
1986	87	4	9
	'Milk is a very versatile food'		
1985	99	0	1
1986	95	2	3
	'Milk is good value for money'		
1985	96	1	3
1986	95	2	3

It is clear from the present study that although the image of milk is extremely good, some unfavourable responses are beginning to appear, which may help to explain why sales of whole milk are falling. By contrast, demand for low-fat milks is growing.

The author acknowledges the support of the Milk Marketing Board for England and Wales.

Fallows, S. J. (1986). *Changes in the UK Milk Industry*. University of Bradford: Food Policy Research Unit.

The manipulation of milk fat composition by including naked oats in a silage-based diet for dairy cows. By P. A. MARTIN and P. C. THOMAS, *Hannah Research Institute, Ayr KA6 5HL*

Substituting oats for barley in a hay-based diet for cows reduces the saturated and increases the monounsaturated fatty acid content of the milk fat (Martin & Thomas, 1987). In the present experiment, three levels of oats inclusion were compared in silage-fed heifers to assess the effects which oats might have in silage-based diets. As the effects of oats appear to derive from an enhanced supply of C18 fatty acids, the oats used were a naked variety (Rhiannon) of high-lipid content.

Eight Friesian heifers were used in a duplicated 4×4 Latin-square experiment. They received grass silage *ad lib.* and 5·9 kg dry matter (DM)/d of one of four isonitrogenous mixes containing approximately 800 g cereal/kg DM, the remainder being soya-bean meal and a mineral mixture. The cereal comprised barley and oats (containing 25·6 and 88·8 g fatty acids/kg DM respectively) in ratios of 100:0, 64:36, 31:69 and 0:100. Total fatty acid intakes were 200, 310, 412 and 513 g/d and corresponding intakes of C18 acids were 155, 250, 339 and 426 g/d.

Barley:oats	100:0	64:36	31:69	0:100	SED
Silage intake (kg DM/d)	6·61	6·51	5·88	5·46	0·2***
Metabolizable energy intake (MJ/d)‡	146	150	147	146	2
Milk yield (kg/d)	14·8	15·2	15·4	15·3	0·3
Fat yield (g/d)	634	640	639	596	14*
Protein yield (g/d)	487	495	494	498	10
Fatty acids (g/kg total fat)					
Saturated (4:0–18:0)	778	743	704	675	9***
Monounsaturated (16:1–18:1)	195(20)†	235(27)	273(30)	304(27)	9***(7)
Polyunsaturated (18:2–18:3)	26	22	23	22	3

SED, standard error of difference.

*$P<0·05$, ***$P<0·001$.

†Values in parentheses are *trans*–18:1.

‡Metabolizable energy values assumed were: silage 11·1, soya-bean meal 13·4, barley 12·8, naked oats 14·7 MJ/kg DM.

Of the diets compared, that containing 69% oats in the cereal DM produced the optimal response (see Table). This level of substitution of oats for barley was without effect on milk-fat yield and led to the production of milk fat of a significantly reduced saturated and increased monounsaturated fatty acid content. At a higher level of inclusion, oats led to reductions in silage intake and milk-fat yield, probably because of adverse effects of the additional fat on rumen fermentation. The results indicate that in cows given grass silage diets, marked changes in milk fatty acid composition can be achieved without depressing milk-fat yield by the dietary inclusion of moderate amounts of oats.

Martin, P. A. & Thomas, P. C. (1987). *Proceedings of the Nutrition Society* **46**, 114A.

Influence of baked beans on plasma lipids in pigs fed on a hypercholesterolaemic diet. By SUSAN M. SHUTLER and A. G. LOW, *AFRC Institute for Grassland and Animal Production, Shinfield, Reading RG2 9AQ* and ANN F. WALKER, *University of Reading, Whiteknights, Reading RG6 2AP*

Various legumes can lower plasma-cholesterol levels in rats (e.g. Soni *et al.* 1982) and man (e.g. Anderson *et al.* 1984). Baked beans are a popular legume product consumed widely in the UK. The effect of baked beans on plasma-lipid levels has been studied using pigs made hypercholesterolaemic by diet.

Twelve growing Large White × Landrace boars received a high-fat, semi-purified diet supplemented with 10 g crystalline cholesterol/kg (diet A) for 2 weeks. Rations (30 g/kg body-weight per d) were given twice daily at 08.30 and 15.30 hours. After this their fasting plasma-cholesterol levels (taken by venepuncture) were raised significantly ($P<0.05$) over basal values. The animals were then allocated to two groups (six pigs per group) having similar mean plasma-cholesterol levels. The control group continued to receive diet A; the experimental group received diet B, a modification of diet A, which included 300 g baked beans in tomato sauce/kg (on a dry matter basis). Diets A and B were standardized for all nutrients, fibre and cholesterol.

After 4 weeks on the diets, there were marked differences in plasma-lipid levels between the two groups (mean total cholesterol (mg/l): control 3058 (SD 1865), beans 1859 (SD 635)). However, these were not significant due to the large standard deviations about the mean values, attributable to a wide spectrum of responsiveness to dietary cholesterol among the animals. Those who showed a response to dietary cholesterol also responded favourably to baked beans. In contrast, non-responders were not affected by cholesterol supplementation or by beans. When a comparison was made between the responders alone (four pigs per group), the difference between control and bean groups was significant for total cholesterol and the high-density lipoprotein (HDL)–cholesterol ratio (Table).

	Control group Responders		Bean group Responders		$P<$
	Mean	SD	Mean	SD	
Plasma cholesterol (mg/l)	4089	1235	2073	584	0·05
HDL-cholesterol (mg/l)	606	145	678	104	NS
HDL:total cholesterol ratio	0·17	0·08	0·35	0·12	0·05

NS, not significant.

We conclude that baked beans are able to lower plasma-cholesterol levels in hypercholesterolaemic pigs.

S.M.S. is supported by a MAFF postgraduate studentship. The beans were kindly supplied by Heinz.

Anderson, J. W., Story, L., Sieling, B., Chen, W. J. L., Petro, M. S. & Story, J. (1984). *American Journal of Clinical Nutrition* **40**, 1146–1155.

Soni, G. I., George, M. & Singh, R. (1982). *Indian Journal of Nutrition and Dietetics* **19**, 84–190.

Influence of baked beans on plasma-lipid levels in normal human volunteers. By SUSAN M. SHUTLER, *AFRC Institute for Grassland and Animal Production, Shinfield, Reading RG2 9AQ* and JACKI A. TREDGER and GEMMA M. BIRCHER, *University of Surrey, Guildford, Surrey GU2 5XH*

Beans of several types have been reported to lower plasma-cholesterol levels in hyperlipidaemic humans (e.g. Jenkins & Jepson, 1982). We have investigated the effect of habitual consumption of baked beans on the fasting levels of plasma lipids in normolipidaemic human volunteers.

Thirteen male students consumed one 450 g can of baked beans in tomato sauce, daily, for 14 d, as part of their normal diet. After a 14 d washout period, eleven of the students went on to consume one 440 g can of spaghetti in tomato sauce, daily, for 14 d (control period). Fasting blood samples were taken frequently throughout the experiment.

Three-day diet diaries revealed that eating beans or spaghetti increased the percentage of energy derived from carbohydrate (from 42 to 47%), and decreased that from fat (from 36 to 32%), compared with pre-trial values. Bean consumption also resulted in increased protein and dietary fibre intakes (from 85 to 97 g/d and from 25 to 60 g/d respectively).

After beans, total plasma cholesterol and high-density lipoprotein (HDL)-cholesterol levels were reduced significantly (paired *t* test), but the HDL:total cholesterol ratio was unchanged. In contrast, after spaghetti, total cholesterol levels were not different from baseline, but HDL-cholesterol and the HDL:total cholesterol ratio were significantly reduced (Table).

	Baseline (*n* 13)		Beans (*n* 13)		Spaghetti (*n* 11)	
	Mean	SD	Mean	SD	Mean	SD
Total cholesterol (mg/l)	1960	312	1732**	387	1937	289
HDL-cholesterol (mg/l)	522	75	444***	73	402***	73
HDL:total cholesterol ratio	0·27	0·063	0·26	0·057	0·21***	0·056
Triglycerides (mg/l)	965	405	1034	436	1193	552

Values significantly different from baseline: $^{**}P=0{\cdot}011$, $^{***}P<0{\cdot}001$.

Change in total cholesterol level was related to change in the consumption of cholesterol (r 0·56) and protein (r 0·54) during the bean period, but not during the spaghetti period. Change in HDL-cholesterol was inversely related to change in fat consumption during the bean period (r −0·76) but positively related to change in fat during the spaghetti period (r 0·68).

We conclude that baked beans are able to lower total plasma-cholesterol levels in normolipidaemic humans, whilst maintaining the HDL:total cholesterol ratio.

S.M.S. is supported by a MAFF postgraduate studentship. The beans and spaghetti were kindly supplied by Heinz.

Jenkins, D. J. A. & Jepson, E. M. (1982). In *Lipoproteins and Coronary Atherosclerosis*, pp. 247–255 [G. Noseda, C. Fragiacomo, R. Fumagalli and R. Paoletti, editors]. Amsterdam: Elsevier Biomedical Press.

Effect of dietary saturated and polyunsaturated fats on the composition of bile in pigs. By N. JADIDI[1], I. E. SAMBROOK[1], R. W. OWEN[2] and M. I. GURR[1], [1]*Human Nutrition Department, AFRC Institute of Food Research, Reading Laboratory, Shinfield, Reading RG2 9AT* and [2]*PHLS Centre for Applied Microbiology and Research, Bacterial Metabolism Research Laboratory, Porton Down, Salisbury, Wiltshire SP4 0JG*

The ability of dietary polyunsaturated fats to lower plasma cholesterol concentrations compared with that of saturated fats has often been related to increased excretion of total steroids in the form of bile acids and cholesterol in bile.

Thirty-two Large White × Landrace growing boars, previously fed on a standard pelleted weaner diet, were given diets containing either butter or polyunsaturated margarine (200 g/kg) with the cholesterol content of the margarine diet made equal to that of the butter diet (2 g/kg).

Plasma cholesterol concentration was significantly lower for the margarine group after 2 weeks, and continued lower for the whole 8 week feeding period.

Plasma cholesterol concentrations (mg/l)

	Start			2 weeks			4 weeks			6 weeks			8 weeks		
	Mean	SEM	*n*	Mean	SEM	*n*	Mean	SEM	*n*	Mean	SEM	*n*	Mean	SEM	*n*
Butter	889	34·4	16	963	27·1	16	925	24·8	13	950	37·2	11	1040	35·9	12
Margarine	929	46·3	15	790	45·1	15	710	34·8	12	846	37·0	10	908	37·1	13
		NS			$P<0·01$			$P<0·001$			NS			$P<0·05$	

NS, not significant.

Bile was collected from some of these pigs, which were surgically fitted with a re-entrant bile duct catheter, over a period of 5 h immediately following feeding. A representative sample of bile from each animal was analysed for its bile acid and cholesterol contents by gas liquid chromatography–mass spectrometry. The total flow of bile over 5 h was not significantly different (mean values: butter diet, 587 (SEM 23·8, *n* 5) *v.* margarine diet, 543 (SEM 51·5, *n* 4) ml), although over 24 h periods there can be large differences between diets in total bile flow (Sambrook, 1981).

Bile composition (mg/ml)

		Glycine-conjugated bile acids		Taurine-conjugated bile acids		Total conjugated bile acids		Cholesterol	
	n	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM
Butter	5	13·3	3·33	3·5	0·90	16·8	3·50	0·4	0·11
Margarine	4	13·8	1·69	2·3	0·43	16·2	2·00	0·5	0·08

Values for the butter and margarine groups were not significantly different (Student's *t* test).

The total bile acid content of bile was very similar for the two groups. The cholesterol concentration of bile in the margarine group was slightly higher than that in the butter group; however, the difference was not statistically significant. Although these results indicate that the nature of dietary fat does not greatly affect the composition of bile, even a small difference in composition over long periods of time may produce physiologically significant differences in amounts of cholesterol excreted.

Sambrook, I. E. (1981). *Journal of the Science of Food and Agriculture* **32**, 781–791.

Endocrine control of lipogenic enzyme activity in adipose tissue from lactating ewes. By R. G. VERNON, M. BARBER and E. FINLEY, *Hannah Research Institute, Ayr KA6 5HL* and M. R. GRIGOR, *Department of Biochemistry, University of Otago, Dunedin, New Zealand*

Administration of growth hormone (GH) to animals leads to a loss of body fat while elevated levels of serum GH during early lactation in ruminants are probably partly responsible for the loss of lipid from adipose tissue in this state (Vernon, 1980). Maintenance of adipose tissue explants from lactating sheep in tissue culture for 48 h showed that GH antagonized an increase in the rate of fatty acid synthesis induced by insulin plus dexamethasone (a glucocorticoid analogue), (Vernon & Finley, 1986). In the present study we again maintained explants of adipose tissue from lactating sheep in culture for 48 h exactly as before (Vernon & Finley, 1986) and measured the activities of acetyl-CoA carboxylase (*EC* 6.4.1.2) and fatty-acid synthase (*EC* 2.3.1.85) (Vernon & Taylor, 1986) in the explants before and after tissue culture.

	Acetyl-CoA carboxylase*		
Treatment	Active state	Total	Fatty acid synthase
Before tissue culture	0·00[a]	0·59[a]	6·2[a]
After tissue culture			
No hormones	0·03[a]	1·04[a]	7·7[a]
Ins + Dex	0·85[b]	2·33[b]	10·7[b]
Ins + Dex + GH	0·18[a]	1·70[ab]	9·4[b]
Ins + Dex + Act D	0·00[a]	0·60[a]	7·3[a]
SE of difference (*n*)	0·22(5)	0·46(4)	0·69(5)

Ins, insulin 17 nM, Dex, dexamethasone 10 nM; GH, growth hormone 4·5 nM; Act D, actinomycin D 80 nM.

[a,b] Values in a column with different superscript letters differed significantly: $P<0·05$.

*Activities are expressed as nmol/min per 10^6 adipocytes.

Tissue culture for 48 h resulted in an increase in the total acetyl-CoA carboxylase and fatty acid synthase activities (Table) but the proportionate increase was small compared with the increase (about 25-fold) in lipogenic flux under these conditions (Vernon & Finley, 1986). GH did not block the increase in fatty acid synthase and only partly prevented the increase in (total) acetyl-CoA carboxylase. In contrast there was a 28-fold increase in the activity of acetyl-CoA carboxylase in the active state (mostly due to activation of pre-existing enzyme) during tissue culture in the presence of insulin and dexamethasone; this was prevented by the addition of GH or of actinomycin D (an inhibitor of RNA synthesis) (Table). Thus an important site of GH action in adipose tissue is the transduction system whereby insulin activates acetyl-CoA carboxylase, the key enzyme of lipogenesis.

Vernon, R. G. (1980). *Progress in Lipid Research* **19**, 23–106.
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Vernon, R. G. & Taylor, E. (1986). *Journal of Animal Science* **63**, 1119–1125.

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Response of rat caecal metabolism to white and wholemeal breads given at two fat levels.

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Evidence is accumulating that diet may influence the metabolic activities of the large-bowel flora. We have reported that replacement of white by wholemeal bread altered rat caecal metabolism with increases in the molar proportion of butyrate at the expense of acetate (Key & Mathers, 1987). The latter study used diets low in fat (30 g maize oil/kg) so it was of interest to know whether similar changes would occur on diets with fat concentrations more typical of those in Western communities.

Four groups of six rats (initial weight 231 g) were housed individually in metabolism cages and offered diets containing freeze-dried white (W) or wholemeal (B) bread each with two levels of maize oil. The low-fat diets (W, B) contained (g/kg) 900 bread and 30 oil while the high-fat diets (WF, BF) contained 750 bread and 170 oil, together with adequate amounts of minerals, vitamins and amino acids. After 21 d, blood was collected from the hepatic portal vein and the heart, and caecal contents were sampled.

	Diet					Significance of dietary effects		
	W	WF	B	BF	SEM	Bread	Fat	Interaction
Proportion of individual VFA (mmol/mol caecal contents):								
Acetic acid	739	761	602	627	12·6	***	NS	NS
Propionic acid	151	150	110	114	6·2	***	NS	NS
Butyric acid	68	62	252	225	13·9	***	NS	NS
3-Hydroxybutyrate (μmol/l blood):								
Hepatic portal	69	59	113	103	5·7	***	NS	NS
Heart	71	70	122	110	5·5	***	NS	NS

NS, not significant; ***$P<0·001$.

Diet had no effect on caecal pH (6·1 (SE 0·05)) or total volatile fatty acids (163 (SE 3·4) mmol/kg). The molar proportion of butyrate in caecal contents from rats given wholemeal-bread diets was 3·7 times greater than in those given white bread and balanced by reductions in acetate and, to a lesser extent, propionate. The increases in caecal butyrate were associated with increased concentrations of 3-hydroxybutyrate in blood from the portal vein and heart.

In summary, major alterations in rat caecal metabolism provoked by replacement of white by wholemeal bread were (1) unaffected by dietary fat concentrations and (2) accompanied by increased 3-hydroxybutyrate supply to the liver and peripheral tissues.

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Key, F. B. & Mathers, J. C. (1987). *Proceedings of the Nutrition Society* **46**, 11A.

Dried molassed and plain sugar-beet pulp in diets for growing pigs. By A. C. LONGLAND, A. G. LOW and H. D. KEAL, *AFRC Institute of Grassland and Animal Production, Shinfield, Reading RG2 9AQ* and J. I. HARLAND, *British Sugar plc, PO Box 26, Oundle Road, Peterborough PE2 9QU*

Traditionally, growing pigs have been fed on diets largely based on cereals. However, there is increasing interest in the use of alternative feedstuffs, particularly in areas where cereals are expensive, or their availability is limited. We present preliminary results on the performance of growing pigs fed on diets containing up to 450 g dried sugar-beet pulp/kg, a highly fibrous source of energy.

Equal numbers of male and female Large White × Landrace pigs (initial weight 18·3 kg) were given diets containing (g/kg) 0, 150, 300 or 450 molassed (M) or plain (P) sugar-beet pulp (coded C, 15M, 30M, 45M, 15P, 30P and 45P respectively). Diets were based on barley, soya-bean meal and fishmeal, and were formulated to contain 9·5 g lysine and 13·8 MJ digestible energy/kg. Each diet was offered to four pigs individually housed without bedding, and with continuous access to feed and water. Weights of feed refusals were recorded daily, and pigs once weekly. Pigs were slaughtered in the week after attaining 77·5 kg live weight, and cold-carcass measurements taken 24 h later.

	C	15M	30M	45M	15P	30P	45P	LSD
Daily intake (g)	2041	2091	1985	2243	2128	1939	1777	244·7
Daily live-wt gain (g)	780	847	751	700	795	690	614	151·9
Feed: gain	2·61	2·49	2·66	3·22	2·73	2·83	2·96	0·53
Killing out percentage	74·2	75·3	72·6	70·1	72·7	70·5	66·1	3·75
Daily carcass gain (g)	611	655	553	519	590	495	419	107·4

LSD, least significant difference ($P<0·05$).

For most measurements there were no significant differences between diets 0, 15M, 15P, 30M or 30P, but performance fell significantly when diets 45M and 45P were given. The results show that young pigs are able to grow rapidly on diets containing up to 300 g sugar-beet pulp/kg. It is presumed that a substantial part of the energy was supplied in the form of volatile fatty acids produced by microbial fermentation of the non-starch polysaccharides in sugar-beet pulp.

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The digestibility of growing-pig diets containing dried molassed or plain sugar-beet pulp.

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We have shown that young pigs are able to use the non-starch polysaccharides (NSP) in sugar-beet pulp (SBP) as an energy source (Longland *et al.* 1988). In the present study we determined the apparent digestibility in growing pigs of diets containing 0, 150, 300 or 450 g molassed or plain SBP/kg (coded C, 15M, 30M, 45M, 15P, 30P and 45P respectively). Diets were based on barley, soya-bean meal and fishmeal, and were formulated to contain 9·5 g lysine and 13·8 MJ digestible energy/kg. Each diet was offered to four pigs (initial weight 30 kg), which were wet-fed twice daily at 40 g/kg body-weight per d. Total faecal collections were made for 7 d after a 7 d adaptation period. Pigs were subsequently maintained on their respective diets until they had attained live weights of approximately 50 kg, whereupon faeces were collected for a second period of 7 d. Sub-samples of feed and faeces were analysed for NSP (according to Englyst & Cummings, 1984), gross energy (GE), dry matter (DM) and nitrogen.

Apparent digestibility

	Period 1				Period 2			
Diet	NSP	GE	DM	N	NSP	GE	DM	N
C	0·52	0·79	0·81	0·77	0·78	0·87	0·87	0·84
15M	0·66	0·78	0·80	0·77	0·82	0·86	0·86	0·84
30M	0·74	0·76	0·77	0·72	0·84	0·83	0·84	0·77
45M	0·74	0·71	0·71	0·66	0·86	0·82	0·83	0·77
15P	0·78	0·78	0·80	0·79	0·83	0·84	0·85	0·80
30P	0·80	0·80	0·78	0·71	0·84	0·82	0·82	0·79
45P	0·58	0·62	0·64	0·49	0·87	0·82	0·82	0·73
LSD	0·126	0·95	0·110	0·116	0·089	0·062	0·054	0·078

LSD, least significant difference ($P<0·05$).

During periods 1 and 2, digestibilities of GE, DM and N were similar for all diets except 45P. The digestibility of NSP in most SBP diets was significantly greater than that of the control in period 1. By period 2 pigs had largely adapted to their diets, and those fed on diet 45P digested GE and DM to a similar extent as, and NSP more efficiently than, the control. However, although the digestibility of diet 45P was improved, it was still significantly lower than that of the control. This may partly explain the lower performances of pigs fed on diet 45P noted by Longland *et al.* (1988).

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Englyst, H. N. & Cummings, J. H. (1984). *Analyst* **109**, 937–942.
Longland, A. C., Low, A. G., Keal, H. D. & Harland, J. I. (1988). *Proceedings of the Nutrition Society* **47**, 102A.

The digestion of three sources of dietary fibre by growing pigs. By A. C. LONGLAND and A. G. LOW, *AFRC Institute of Grassland and Animal Production, Shinfield, Reading RG2 9AQ*

We have demonstrated that growing pigs can digest and utilize the fibrous, non-starch polysaccharide (NSP) fraction of sugar-beet pulp (SBP) to a high degree (Longland *et al.* 1988*a*,*b*). In order to determine more precisely which NSP components were being utilized, we examined the apparent digestibilities in 35-kg pigs of the individual monomeric constituents of NSP fractions in a refined form of SBP (Fibrex), and also in wheat bran and wood cellulose (Solkafloc) to serve as comparisons.

Each NSP source was included (100 g/kg) in three semi-purified diets which contained maize starch as the only other carbohydrate source. Six pigs received each diet: they were wet-fed, twice daily at 40 g/kg body-weight per d.

After a 6-d adaptation period, all faeces were collected for 7 d. Sub-samples of diets and faeces were analysed for NSP constituents, by the method of Englyst & Cummings (1984). Fibrex, wheat bran and Solkafloc diets contained 62, 35 and 82 g NSP/kg respectively.

Apparent digestibility

	Fibrex		Solkafloc		Wheat bran	
Monomers	Mean	SE	Mean	SE	Mean	SE
Rhamnose	0·973	0·0011	—	—	—	—
Arabinose	0·996	0·0003	—	—	0·124**	0·0615
Xylose	0·680	0·0630	0·562	0·0714	0·629	0·0865
Mannose	0·973	0·0267	—	—	—	—
Galactose	0·943	0·0141	—	—	0·191**	0·0903
Glucose	0·864	0·0181	0·713	0·2039	0·343*	0·1470
Uronic acids	0·995	0·0010	—	—	0·485**	0·0149
Total NSP	0·948	0·0070	0·736	0·1532	0·506*	0·0790

Significantly different from Fibrex diet: $*P<0·05$, $**P<0·01$.

With the exception of xylose, the NSP components of the Fibrex diets were digested to a similar and very high degree by all pigs. This contrasted with the highly variable and relatively poor digestion of the NSP components of the Solkafloc and wheat-bran diets. This shows that young pigs can readily degrade the polysaccharide complexes in certain forms of dietary fibre, and this may indicate the potential for such feeds in practical pig diets.

Englyst, H. N. & Cummings, J. H. (1984). *Analyst* **109**, 937–942.

Longland, A. C., Low, A. G., Keal, H. D. & Harland, J. I. (1988*a*). *Proceedings of the Nutrition Society* **47**, 102A.

Longland, A. C., Low, A. G., Keal, H. D. & Harland, J. I. (1988*b*). *Proceedings of the Nutrition Society* **47**, 103A.