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ABSTRACTS OF COMMUNICATIONS

The Two Hundred and Third Meeting of the Nutrition Society was held at the Sir John Atkins Laboratories, Queen Elizabeth College, London, W8, on Friday, 27 September 1968, *at* 11.15 *h, when the following papers were read:*

Vitamin nutrition of patients on regular dialysis treatment (RDT). By J. C. MACKENZIE, *Regional Renal Unit, St Bartholomew's Hospital, London, EC*1, and J. E. FORD, *National Institute for Research in Dairying, Shinfield, Reading*

The treatment of chronic renal failure presents unique problems in nutrition and the patients, maintained on closely restricted diets, are eminently suitable for nutritional studies. Conventional treatment involves the use of high-calorie diets providing 18–20 g protein/day (Giovannetti & Maggiore, 1964) which, although maintaining a precarious nitrogen balance, are deficient in vitamins and iron. With the advent of regular dialysis treatment (RDT) it became possible to allow a more generous protein intake (50–70 g) but the prolonged cooking times and the leaching effect of large volumes of water necessary to rid the diet of excess sodium and potassium reduced the content of most vitamins to well below the accepted daily requirements. In addition, there was a significant dialysis loss of vitamins during treatment. In six patients established on RDT, thiamine, nicotinic acid, pantothenic acid, biotin and vitamin B_6 were all lost during dialysis, in amounts approximately equal to the 24 h urine loss in healthy adults. Folic acid and riboflavine were lost in considerably greater amounts, but there was no detectable loss of vitamin B_{12}. All the patients had low plasma folate, averaging 3·9 ng/ml as compared with the normal range of 6–18 ng/ml, and indeed megaloblastic marrow changes, attributed to folate deficiency, have been reported in chronic renal failure. The RDT diet supplied daily only 74 μg free folate, compared with about 200 μg in normal diets. Loss of folate during 14 h dialysis averaged 80 μg, calculated from the drop in plasma folate across the dialyser, or 30 μg from direct assay of folate in the dialysing fluid.

Studies with tritiated folic acid showed normal absorption from the gut, and so the low plasma folate presumably reflects an adverse equilibrium between dietary intake of the vitamin, the losses during dialysis and the requirements for metabolism. Nevertheless there was no progressive depletion of tissue stores as indicated by the red cell folate, which remained within the normal range during the period of this study. Furthermore, early megaloblastic marrow changes observed in the patients did not respond to saturation doses of folic acid.

Patients may enter the RDT programme with depleted vitamin stores and continue to subsist on a highly refined diet low in water-soluble vitamins. Multivitamin preparations containing thiamine, riboflavine, nicotinic acid and ascorbic acid are generally given, but with the improved plane of nutrition and the marked cellular regeneration associated with RDT, the range of supplemental vitamins should perhaps be extended.

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The nutritional effects of ϵ–*N*–acylation on free and peptide–linked lysine.

By J. BJARNASON* and K. J. CARPENTER, *School of Agriculture, University of Cambridge*

It has been hypothesized that strong heating of pure proteins may result in condensations between ϵ-NH_2 groups of lysine and carboxylic groups to give enzyme-resistant amide linkages. ϵ-*N*-acetyl-L-lysine has shown activity for rats both orally and by injection (Neuberger & Sanger, 1943). However, mammalian kidneys contain ϵ-lysine acylase which hydrolyses ϵ-*N*-formyl and acetyl lysines but is almost inactive with larger acyl groups (Paik & Benoiton, 1962).

We assayed materials for their activity in stimulating rat growth on a lysine-deficient basal diet (Carpenter, 1957). Bovine plasma albumin (BPA) was treated so that 85% of the ϵ-NH_2 lysine groups were acetylated while other groups were untouched. BPA containing approximately 14% H_2O was also severely heated in sealed ampoules at 145° for 27 h. In Expt 2 we used the same basal diet, but aimed to obtain standard growth by adding 0·133% 'available lysine' from lysine, acetyl lysine or BPA or by adding propionyl lysine or heated BPA with extra free lysine. We analysed urine and faeces from individual rats (two rats/treatment). Free urinary lysine was similarly low for all treatments. Total urinary lysine was determined after acid hydrolysis and ninhydrin reaction on eluates from column chromatography. The quantities excreted by rats receiving supplementary lysine alone were taken as base-lines; additional quantities from other rats were expressed as percentages of the total lysine in the other supplements consumed.

Table 1

	Expt 1. Relative activities for growth	Expt 2. Apparent recoveries in excreta of unavailable lysine from test materials (%)	
		(*a*) Urine	(*b*) Faeces
L-Lysine	(100)	(0)	(0)
ϵ-*N*-Acetyl-L-lysine	57	16	18
ϵ-*N*-Propionyl-L-lysine	0	37	18
BPA	94	1	13
Acetyl-BPA	69	—	—
Heated BPA	5	3	50

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Unhydrolysed urine from rats receiving acetyl or propionyl lysine contained material that moved in thin-layer chromatography like the compounds themselves. These lysine derivatives can apparently be absorbed intact and rats have no mechanism for utilizing propionyl lysine. However, the heated BPA did not give significant amounts of urinary 'bound lysine'. Less severely heated material will now be tested.

It is interesting that peptide linking of the acetyl lysine units in BPA has not further reduced their availability. Acetylating ovalbumen inhibited its digestion by pepsin and reduced its digestion by papain (Tazawa, 1943) and the 'available methionine' in our acetyl-BPA, assayed with *Streptococcus zymogenes* (Ford, 1962) was 65% that of untreated BPA.

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A comparison of the Carpenter and Silcock methods for available lysine determination in protein concentrates and diets. By H. OSTROWSKI* (introduced by F. W. H. ELSLEY), *Rowett Research Institute, Bucksburn, Aberdeen, AB2 9SB*

The nutritive value of protein in foods is directly related to the 'available' lysine content and in recent years several methods have been proposed for determining 'available' lysine in feedstuffs (Rao, Carter & Frampton, 1963 *a*,*b*; Roach, Sanderson & Williams, 1967). Two of them, those of Carpenter (1960) and R. Silcock & Sons Ltd (Roach *et al.* 1967), have been compared by determining with both methods the 'available' lysine in each of twelve samples of protein concentrate (meat and

Table 1

	'Available' lysine (mg/g)			
	Analysed		Computed	
	Carpenter*	Silcock	Carpenter	Silcock
Protein concentrates:				
Meat and bone meal	25·01 (99·1)	24·58	—	—
White fish meal	45·04 (88·6)	43·36	—	—
Soya-bean meal	21·67 (83·2)	19·74	—	—
Groundnut meal	14·10 (76·3)	12·42	—	—
Diets containing†:				
17·6% meat and bone meal	7·39 (82·2)	6·64	6·5	6·3
9·7% white fish meal	7·54 (82·0)	6·48	6·5	6·3
20·3% soya-bean meal	7·68 (82·2)	6·56	6·5	6·1
31·4% groundnut meal	7·51 (81·3)	6·21	6·5	6·1

*Value of recovery of ϵ-DNP-lysine in parenthesis.

†The diets contained 58·6% barley meal, 10% weatings, the protein concentrate, and cassava meal and maize starch to equate 'available' lysine.

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bone meal, fish meal, soya-bean meal and groundnut meal). Using results from Carpenter's method, four diets for growing pigs were prepared, each theoretically providing 0·65% 'available' lysine. Ten samples of each diet were then analysed for 'available' lysine.

A general comparison of the two methods has been made and also the differences between predicted (calculated) and actual values have been calculated with the results given in Table 1. These results show that in animal protein concentrates the 'available' lysine values obtained using the two methods differed only slightly, but with vegetable protein concentrates Carpenter's method gave notably higher values. When the results from Carpenter's method were used for the preparation of four diets, in each case the determined 'available' lysine values of the diets were 12–15% higher than the calculated ones. There were, however, less marked differences using the Silcock method, which gave lower values of 'available' lysine in the diet and closer agreement with the calculated levels. The difference between the methods was greatest with the diets containing vegetable protein concentrates and least with animal protein concentrates. The greater difference between the two was associated with lower recoveries of ϵ-DNP-lysine with plant proteins.

The author wishes to thank the Food and Agriculture Organization of the United Nations for the funds which made this work possible.

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An electrophoretic study of groundnut protein fractions prepared by different methods. By R. DAWSON, *Rowett Research Institute, Bucksburn, Aberdeen, AB2 9SB*

Arachin and conarachin were first separated by Johns & Jones (1916) by 20% and 100% saturation with $(NH_4)_2SO_4$ respectively of a NaCl extract of groundnut meal. Later Jones & Horn (1930) claimed that arachin was not completely precipitated until 40% saturation was attained and that conarachin was precipitated at between 70 and 80% saturation. In both cases a sharp separation was claimed. Tombs (1965) found that arachin was specifically and quantitatively precipitated by the addition of molar $CaCl_2$ solution.

We have prepared arachin and conarachin by the methods of both Jones & Horn and Tombs and have found that the former gives an arachin to conarachin ratio of about 5:1 whereas the latter gives a ratio of about 2:1. We decided therefore to examine the various fractions obtained by the different methods by disc electrophoresis on polyacrylamide gel.

We have found that when the $(NH_4)_2SO_4$ saturation was increased in steps of 10% material was precipitated at every stage from 20 to 100% saturation. The fraction precipitated at 20% saturation was similar in amount, nitrogen content (14·6%) and percentage of total nitrogen (41·42%) and had the same electrophoretic pattern as the 'arachin' precipitated by $CaCl_2$ in the Tombs (1965) method (14·89% N, 41·45% of total N).

'Conarachin' prepared by the Tombs method by dialysing the supernatant after removal of the 'arachin' had the same electrophoretic pattern as the 'conarachin' prepared by the Johns & Jones (1916) method but differed in nitrogen content and yield (16·59% N, 26·2% of total N and 15·99% N, 19·7% of total N respectively). 'Conarachin' prepared by the Tombs (1965) method by acidification of the supernatant after removal of the 'arachin' was smaller in amount and nitrogen content than the 'conarachin' prepared by dialysis (15·48% N, 21·2% of total N and 16·59% N, 26·2% of total N respectively) and had the same electrophoretic pattern as the material precipitated at 30% saturation with $(NH_4)_2SO_4$.

The electrophoretic pattern of the 'arachin' prepared according to Johns & Jones (1916) or Tombs (1965) showed two main components with R_f of about 0·25 and 0·4 (presumably dimer and monomer respectively). The 'conarachin' pattern was much more complex and consisted of about twelve bands with R_f ranging from about 0·25 to about 0·75.

It would appear, therefore, that the fractions obtained by the Tombs (1965) procedure are comparable with those obtained by the Johns & Jones (1916) procedure but not with those prepared according to Jones & Horn (1930).

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The influence of diets containing low or high levels of fish meal, casein plus gelatin or meat meal on the survival of chicks infected with *Salmonella gallinarum*. By R. Hill and I. M. Smith, *Royal Veterinary College, University of London*

Smith & Chubb (1957) found greater survival of 9-week-old cockerels infected orally with *Salmonella gallinarum* and given a diet consisting solely of 10% fish and 90% wheat meals than in similarly infected birds given 40% fish and 60% wheat. In similar experiments but using 2-week-old cockerels and the diets suitably supplemented with vitamins and trace elements results for survival were essentially the same: a significantly greater survival occurred with 10 than 40% fish meal, notwithstanding the poorer growth of birds given the 10% diet. In a series of nine experiments there was considerable variability among results and in two the effect was reversed; however the mean effect was highly significant with 42% survival for 10% fish meal compared with 18% for 40% fish meal.

Diets consisting of semi-purified nutrients with protein provided as casein plus gelatin were prepared with protein levels of 16 and 36%, similar to those of the 10 and 40% fish meal diets respectively. Using these semi-purified diets no effect of level of protein on survival of infected chicks was found.

Also with diets similar to those containing fish and wheat meals but with meat meal replacing fish, no difference in survival of infected chicks was found between those given 10% meat and those given 40% meat meal.

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The concentration of copper, zinc and manganese in the liver of African children with marasmus and kwashiorkor. By P. J. WARREN*, J. D. L. HANSEN and B. H. LEHMANN, *Departments of Medicine and Child Health, The University of Cape Town, Observatory, Cape, Republic of South Africa*

Kwashiorkor and marasmus are conditions of protein-calorie malnutrition occurring in young children. Severe kwashiorkor is known to produce an inbalance

Table 1

		Total N	
% Water	Total lipids (mg/g dry tissue)	mg/g dry tissue	mg/g lipid-free dry tissue
	Kwashiorkor, ten cases		
51·0 ±2·4	679·1 ±32·5	35 ±0·2	128·5 ±20·6
	Marasmus, seven cases		
67·5 ±3·7	342·7 ±73·5	90·2 ±12·8	131·5 ±8·8
	Controls, eight cases		
73·8 ±0·7	198·8 ±13·3	116·5 ±5·1	145·0 ±6·2

	μg trace element								
	Per g whole dry tissue			Per g lipid-free dry tissue			Per g N lipid-free dry tissue		
	Zn	Cu	Mn	Zn	Cu	Mn	Zn	Cu	Mn
				Kwashiorkor, ten cases					
	31·4 ±3·5	3·9 ±0·3	1·64 ±0·2	116·0 ±16·9	11·4 ±2·1	5·6 ±0·8	898·6 ±56·4	114·9 ±26·2	48·4 ±9·1
				Marasmus, seven cases					
	111·4 ±23·3	14·8 ±4·9	5·7 ±1·3	156·6 ±19·3	21·0 ±5·4	8·3 ±1·4	1179·7 ±41·7	272·6 ±116·5	62·9 ±8·5
				Controls, eight cases					
	162·9 ±·139	22·2 ±3·6	6·6 ±0·9	203·7 ±14·3	28·0 ±5·2	8·3 ±1·29	1425·5 ±150·9	189·1 ±24·3	57·2 ±6·5

Values are means of determinations with their standard errors.

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of the major mineral elements of the body. Depletion of potassium and magnesium are often seen in acute cases. Symptoms of microcytic hypochromic anaemia, severe skin lesions, depigmentation of hair and skin and the malformation of hair keratin are frequent findings in protein-calorie malnutrition of the kwashiorkor type. Similar effects in animals can be produced by depleting them of their normal requirements for copper and zinc (Underwood, 1962). Manganese deficiency in young guinea-pigs can produce ataxia and head tremor (Everson, Hurley & Geiger, 1959). In a few of the children with severe kwashiorkor, a form of persistent shaking or tremor has been observed during their rehabilitation in hospital. These observations prompted us to determine the concentrations of Cu, Zn and Mn present in the livers of children with kwashiorkor and to compare these findings with those obtained from cases of marasmus, and other children who had died from other causes. A summary of the results is shown in Table 1.

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Observations on the passage of food through the gastro-intestinal tract of the rat. By ANNE W. MITCHELL and D. A. T. SOUTHGATE, *Dunn Nutritional Laboratory, Infant Nutrition Research Division, University of Cambridge and Medical Research Council*

The classical concepts of the digestive process maintain that ingestion of food is followed by a period of mixing with the gastric secretions in the stomach followed by the discharge of discrete amounts of chyme into the small intestine.

As a result of some experiments originally designed to compare the rate of passage of foods based on different cereals, we have made some observations which would appear to suggest that the rate processes in the rat are somewhat more complex than the classical concepts suggest.

In two series of experiments rats were either allowed to feed freely for a short time or given a fixed amount by stomach tube of a diet which had been uniformly marked with carmine. The animals were fasted for 24 h before being fed and killed at intervals up to 4 h after feeding. In all but two of sixty-seven rats studied the carmine-marked food had reached the ileo-caecal junction within 30 min after feeding.

The contents of the stomach were removed and moisture, starch and acid-fibre measured. The results showed that the stomach emptied approximately exponentially, as observed by Reynell & Spray (1956), but the concentration of acid-fibre in the stomach contents increased with time showing that some preferential emptying of the stomach occurred. In eight of nine rats killed after a 24 h fast there were

small amounts of residual matter very rich in fibre lodged as a pellet in the pyloric antrium. No real differences were observed between the rates of passage in the rats allowed to feed freely, and those fed by stomach tube.

It is hoped that by extending these studies, it may be possible to formulate a mathematical model describing the digestive processes.

The authors would like to thank Dr E. M. Widdowson for help with the animals and for her advice and encouragement. A. W. Mitchell would also like to thank the Weston Research Laboratories for financial support.

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The relation between dietary intake and the transfer of vitamin A from a cat to her kittens. By PATRICIA P. SCOTT, *Department of Physiology, Royal Free Hospital School of Medicine, London, WC1*, and S. Y. THOMPSON, *National Institute for Research in Dairying, Shinfield, Reading*

Vitamin A (retinol) was estimated, at termination, in the liver, kidneys and stomach contents from two groups of kittens. The mothers of group 1 were fed either a good mixed diet providing 2–4 μg retinol/g wet diet, or an experimental diet supplemented with 5000 μg retinol per week; mothers of group 2 received either a mixed diet low in fat and deficient in retinol or an unsupplemented high-fat experimental diet. No differences were apparent, as far as retinol is concerned, in the results obtained on the mixed and experimental diets. The kittens were either newborn unsuckled, suckled (24 h to 3 weeks) or with access to their mothers' diet.

The mean retinol content per g fat from stomach contents of kittens up to 72 h postpartum was 87 μg in group 1 (eighteen kittens) and 19 μg in group 2 (five kittens); several in group 2 had empty stomachs. Between 1 and 3 weeks of age, group 1 gave a mean of 53 μg (twenty-four kittens) and group 2 10 μg (five kittens). The fall in the retinol content of the mature milk of group 1 was significant ($P < 0.01$), but that for group 2 was not. The mean values for the stomach contents of the

Table 1. *Mean retinol concentrations in liver and kidneys of kittens from mothers on diets of different retinol content*

		Retinol (μg/g wet tissue) for kittens:				
		Unsuckled	Suckled,	Suckled,	Suckled,	Suckled,
Vitamin A intake	Tissue		<24 h	<48 h	3 weeks	5–9 weeks
Adequate (group 1)	Liver	8·3 (7)	24·9 (9)	64·3 (8)	120·7 (7)	161·9 (11)
	Kidneys	4·6 (7)	4·7 (9)	6·4 (8)	15·7 (8)	36·9 (15)
Low (group 2)	Liver	0·6 (6)	1·0 (5)	—	0·8 (5)	0·7 (12)
	Kidneys	1·1 (6)	1·7 (5)	—	5·0 (8)	25·0 (13)

Figures in parentheses are the numbers of kittens from which the mean is derived.

older kittens (5–9 weeks), 24 μg retinol/g fat for group 1 (twelve animals) against 7·5 μg for group 2 (eight animals), were significantly different ($P<0.01$).

The results for the tissues are given in Table 1. The mean retinol content per g wet tissue showed a significant increase in the liver ($P<0.001$) with suckling and age, even when growth is ignored; in group 2 the liver changes were not significant at any stage of growth. Since the normal adult cat's kidney contains greater concentrations of vitamin A than that of any other species, a mean value of 50 μg/g having been recorded by Moore, Sharman & Scott (1963), it was of interest that there was no significant increase in the kidneys over the first 48 h postpartum. Thereafter the concentration rose slowly, but at 5–9 weeks the difference between groups 1 and 2 was not quite significant at the 5% level, in sharp contrast to the concentration in the liver.

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Vitamin A as a possible factor in human teratology. By Isabel Gal, *Institute of Child Health, London*, I. M. Sharman, *Dunn Nutritional Laboratory, University of Cambridge and Medical Research Council*, J. Pryse-Davies, *Queen Charlotte's Maternity Hospital, London*, and T. Moore, *Strangeways Research Laboratory, Cambridge*

Vitamin A deficiency has long been recognized as one of the dietary defects which can cause congenital malformations in farm and experimental animals (Hale, 1935). Malformations can also result from excess of vitamin A (Cohlan, 1953). There is still no evidence, however, to implicate the vitamin A status in human teratology. The collection of such evidence must be difficult. Thus: (1) The foetus is vulnerable to teratogenic factors in its development. Consequently several months, possibly with changes in the maternal diet, may intervene between the infliction of injury and the eventual emergence of the malformed offspring. (2) If observations on the vitamin A status of the mother or foetus at parturition are accepted as rough guidance to the status in early pregnancy then not only low values, but also unduly high values, must be suspect. (3) An abnormal vitamin A status in the foetus could result not only from abnormality in the maternal vitamin A status, but also from defects in the placenta and the foetal circulation, which could be secondary to teratogenic factors other than vitamin A. (4) In animals, injuries to the foetus can arise from overdoses of vitamin A which cause no obvious injury to the mother. In view of the medical importance of human malformations, however, we have made such comparisons as seemed feasible between the vitamin A status in malformed and normally formed (normal) offspring, and their respective mothers.

Vitamin A was estimated by the $SbCl_3$ method in blood plasma collected from mothers shortly after the production of malformed or normal offspring. No evidence was found of unduly low ranges of values after the production of malformed offspring;

the possibility that the range is significantly raised is under further investigation.

In estimating vitamin A in livers from malformed and normal foetuses unexpectedly large differences were sometimes found between the concentrations in different lobes. Means were usually taken, therefore, for samples collected from different parts of the liver. Virtually no vitamin A was found in the gall-bladder or its contents. The results on liver confirmed previous findings that the range of levels in normal foetuses is much lower than would be expected in their mothers. Only traces of carotenoids were present. The same findings held good for malformed foetuses. Great variation was found between individual foetuses. Thus our highest value (152 μg/g) was found for a 38-week-old anencephalic stillborn baby, and our lowest (3 μg/g) for a 34-week-old baby which died soon after birth from Rhesus incompatibility with no additional congenital malformation.

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Serum fructose levels in male and female baboons following single intravenous injections of fructose. By M. H. JOURDAN (introduced by I. MACDONALD), *Department of Physiology, Guy's Hospital Medical School, London, SE1*

Coltart (1968) found that sexually mature female baboons had no rise in serum glyceride concentrations when on a diet containing 75% sucrose, but that in male baboons on such a diet the serum glyceride concentrations rose. Macdonald & Roberts (1967) found that a meal containing glucose produced a fall in serum glyceride concentrations of male baboons, but that a sucrose meal produced a rise. Since sucrose is a disaccharide which on hydrolysis yields equal molecular amounts of glucose and fructose, interest has centred on the part that fructose might play in the observed differences.

Rapid intravenous injections of 20% fructose solution (0·5 g fructose/kg bodyweight) were given to eight mature female baboons, eight mature male baboons and two immature female baboons, lightly tranquilized with phenycyclidine (Sernylan; Parke-Davis) after a 16 h fast. Venous blood was taken before the infusion, and at 5, 15, 30, 45, 60 and 90 min after the end of the infusion, and the serum fructose concentration and serum glucose concentration were measured (Roe, 1934; Faulkner, 1965). Urine was collected during some of the experiments and the fructose excretion estimated.

In each instance from a point in time 15 min after the end of the injection the serum fructose concentration fell exponentially. This can be specified by a 'half life'. It was found that the mature female baboons had a significantly greater fructose half-life than the mature male baboons ($P<0{\cdot}025$), while the two immature female baboons had fructose half-life values within the male range ($P>0{\cdot}3$). There was no

significant difference between the urinary excretion of fructose in the groups of baboons. In all animals the serum glucose concentration rose immediately after the fructose infusion, but fell, often below the fasting level, in the later samples. These changes in serum glucose with time in the male baboons were indistinguishable from those in the females.

Because the variance of fructose half-life values for the mature female baboons was greater than for the mature male baboons, six mature female baboons were given intravenous fructose infusions at the time of ovulation, and midway between ovulations. No consistent change due to the phase of the oestrus cycle was detected.

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Plasma lipids, glucose tolerance, insulin levels and body-weight in men after diets rich in sucrose. By STEPHEN SZANTO and JOHN YUDKIN, *Department of Nutrition, Queen Elizabeth College, London, W8*

As part of an investigation into the possible role of dietary sucrose in the causation of ischaemic heart disease, we have studied the effect of a high-sucrose intake in nineteen healthy men, aged 21–44 years. After a week's preliminary study, ten of the subjects (group A) were given for the next 2 weeks a diet high in sucrose. For the following 2 weeks—weeks 4 and 5—they reverted to their normal diets, for the next 2 weeks—6 and 7—they were given diets with virtually no sucrose, and finally they were again allowed to eat their normal diet. The remaining nine subjects (group B) followed a similar procedure, but took the low-sucrose diets in weeks 2 and 3, and the high-sucrose diets in weeks 6 and 7. At the end of the 1st week, and thereafter at intervals of 2 weeks, the subjects were weighed, their glucose tolerance determined, the insulin response to this test measured, and the serum lipids assayed.

The average carbohydrate intake throughout the experiment was a little less than 500 g a day. The average daily intake of sucrose was about 165 g in the normal diets, 440 g in the high-sucrose diets and less than 10 g in the low-sucrose diets.

There was no change in the glucose tolerance of either group during any part of the experimental period. Nor was there any difference in the levels of cholesterol or phospholipids. The triglycerides showed a significant rise at the end of the sucrose period, and a reversion to normal during the subsequent 2-week rest period.

At the end of the period on the sucrose diet, six of the subjects developed hyperinsulinism. In addition, these same six subjects showed a significant increase in weight after their consumption of the high-sucrose diet although there was no significant increase in calorie intake. These changes had disappeared, or nearly disappeared, after the 2-week rest period. The intake of sucrose of these six subjects

was not significantly different from that of the thirteen subjects who did not show these effects on insulin levels or body-weight.

The influence of coffee drinking on plasma lipids and fasting blood glucose in healthy human volunteers. By D. J. NAISMITH, P. AKINYANJU and JOHN YUDKIN, *Department of Nutrition, Queen Elizabeth College, London, W8*

In a longitudinal study of the dietary habits of some 2000 male subjects, a positive relationship was found between coffee consumption and the development of coronary heart disease (Paul, Lepper, Phelan, Dupertius, MacMillan, McKean & Park, 1963). This observation was not confirmed in a later survey, but a positive and statistically significant correlation between coffee intake and serum lipid concentrations was found in male survivors of myocardial infarction (Little, Shanoff, Csima & Yano, 1966).

The present report deals with the influence of coffee drinking on the plasma concentrations of the major lipid fractions and on the fasting blood glucose in twenty healthy adult volunteers with an average age of 32.

From records of the number of cups of tea and coffee consumed for 10 consecutive days, the 'background' daily intake of caffeine for the individual and for the group was calculated. A fasting blood sample was then taken for analyses. During the next 14 days, each subject drank ten cups of decaffeinated coffee per day totalling 20 g Sanka 'instant' coffee containing 12 mg caffeine, and a second blood sample was then taken. For the following 20 days, ten cups of coffee (20 g Maxwell House 'instant' coffee; 875 mg caffeine) were consumed daily, and the final blood sample was drawn. The subjects were asked to make no changes in their customary diets apart from avoiding other caffeine-containing beverages, and to make no alterations to their normal social activities.

The mean 'background' caffeine intake for the group was high (560 mg/day) and had the same value for the fourteen men and six women. After 2 weeks on an almost caffeine-free regimen, plasma cholesterol and phospholipid levels were increased, while triglyceride levels were substantially reduced. Blood glucose was also reduced, but to a small extent only. These changes were statistically highly significant.

With the re-introduction of caffeine into the diet, the picture was reversed. The plasma cholesterol and phospholipids fell to near normal values, and the triglyceride concentration rose. These changes in lipid values were again statistically highly significant. Blood glucose, however, failed to respond to the very considerable increase in dietary caffeine.

No correlation was found between the individual 'background' caffeine intake and glucose, or any of the plasma lipid fractions.

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The nutritional value of the low-carbohydrate diet used in the treatment of obesity. By ANNE L. NICHOLSON and JOHN YUDKIN, *Department of Nutrition, Queen Elizabeth College, London, W8*

The low-carbohydrate diet for the treatment of obesity consists of a voluntary restriction in dietary carbohydrate only; no restriction is imposed on dietary protein or dietary fat. The effect is a reduction in calories, no significant change in protein, and either no change or a slight reduction in fat (Yudkin & Carey, 1960); other nutrients were not calculated at that time. Although widely used by physicians in this country (Yudkin, 1968), this diet is said by many authorities in America to be potentially dangerous. It has been claimed, for example, that it is likely to lead to dietary deficiency in calcium, vitamin A, riboflavine, thiamine, ascorbic acid and folic acid (Hodges, Bloom, Goldsmith, Krehl, Leverton, White & Young, 1966).

We have assessed the nutritional value of the diets of eight women and three men both when they were eating their normal diets and when they changed to the low-carbohydrate diet. The subjects kept a daily record of all food and drink they consumed, whenever possible by weight. After they had recorded their normal diet for 2 weeks, they were given instructions in the low-carbohydrate diet (Yudkin, 1958), and kept records of their food consumption for a further 2 weeks. We then calculated the intake of nutrients in both periods by computer.

The changes in calories, protein and fat were similar to those found by Yudkin & Carey (1960). On average, the daily energy content of the diet fell by about 800 kcal and the carbohydrate content by about 140 g. The small decreases in protein and in fat were not significant. Small increases or decreases in vitamins A and D, thiamine, riboflavine, nicotinic acid, ascorbic acid, calcium and iron, were also not significant. But there was a significant increase in thiamine, riboflavine, and nicotinic acid when these were expressed in relation to calorie intake.

We did not directly assess the intake of folic acid, the only other nutrient mentioned by Hodges *et al.* (1966) as likely to be deficient, but the intake of meat and leafy vegetables was such that deficiency was most unlikely. Nor is the low-carbohydrate diet, as it is consumed rather than as it is imagined, likely to lead to the other dangers enumerated by Hodges *et al.*: ketosis, dehydration, increased blood level of uric acid, and increased serum lipids.

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An evaluation of English diets of the 1860s. By D. J. ODDY and JOHN YUDKIN, *Department of Nutrition, Queen Elizabeth College, London, W8*

The first large-scale dietary surveys in Britain were carried out by Edward Smith

(Smith, 1863, 1864). They related to cotton workers unemployed during the cotton famine and households of low-paid workers. We have analysed 582 household diets. Some two-thirds of the calories came from carbohydrate, largely from bread and potatoes. The intake of meat, milk and fats was low, and of fish, cheese and eggs almost negligible. Because of some uncertainties in the material presented by Smith, it would be unwise to draw precise quantitative conclusions from the data. But some general conclusions are warranted.

(1) The better-off workers ate not only more of the more expensive foods like meat, milk, fats and sugar, but also more of the cheapest foods like bread and potatoes. This agrees with the suggestion that calorie intake may be below true requirements if the available food is not sufficiently palatable (Yudkin, 1963).

(2) When cotton workers were plunged into poverty, they largely retained the high sugar consumption to which they had become accustomed during their earlier relative affluence, whilst they reduced their consumption of meat to a level lower than that of any of the other groups of poor workers. There was thus a displacement of nutritionally desirable foods by nutritionally undesirable foods of higher palatability, a situation for which there is other evidence (Yudkin, 1964).

(3) Families of a similar social level today take some 50% more fat and well over 100% more sugar than families of 100 years ago. This higher increase of sugar compared with fat is similar to that reported occurring in America since the 1890s (Antar, Ohlson & Hodges, 1964), and supports the suggestion that sugar rather than fat is involved in the causation of ischaemic heart disease and other 'diseases of affluence' (Yudkin, 1963).

(4) Iron intake was somewhat higher in the 1860s than it is today—12·5 mg daily compared with 10·8 mg. The severe form of anaemia known as chlorosis was unlikely to have been due to a simple dietary deficiency of iron.

(5) Calcium intake was much less than it is today—360 mg compared with 820 mg. If it is true that the prevalence of senile osteoporosis has increased during the last 100 years, it is unlikely that it is due to a dietary deficiency of calcium.

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The nutritive value of Professor Chittenden's low-protein diet. By ALISON PAUL and J. P. GREAVES, *Ministry of Agriculture, Fisheries and Food, Great Westminster House, Horseferry Road, London, SW1*

The experiments that Chittenden conducted upon himself in 1904 are often quoted by proponents of a low-protein diet. At the age of 47, he remained in allegedly

good health for 9 months on a diet containing about 40 g protein, his weight remaining constant at 57 kg. He weighed his food intake only during two balance studies of 6 and 5 days conducted after 6 and 9 months on the diet respectively. He did however analyse daily his urinary nitrogen, which averaged 5·6 g/day (Chittenden, 1904). During the two balance periods the average daily N balance was respectively +0·18 g on an N intake of 6·40 g (40 g protein), and −0·07 g on an intake of 5·86 g (37 g protein). Details of the diets are given by Chittenden (1904, 1907) and Hindhede (1913). The foods eaten in the balance periods were similar to those eaten over the whole 9 months.

We have calculated the nutrient content of the diet during the second balance period, 23–27 June 1904, using the food composition tables of Watt & Merrill (1963). The daily energy value ranged from 1400 to 1770 kcal, averaging 1530 kcal, close to Chittenden's estimate of 1550 kcal. N intake ranged from 4·73 to 6·93 g/day, averaging 5·98 g (37 g protein; 40% from animal sources; protein calories %= 9·7). Average daily calcium intake was 320 mg, iron 6·3 mg, vitamin A 700 μg retinol equivalents (1 μg retinol equivalent =3·33 i.u. retinol or 10 i.u. β-carotene), thiamine 0·58 mg, riboflavine 0·71 mg, nicotinic acid 6·0 mg, and ascorbic acid 116 mg. The nicotinic acid in cereals has been taken to be unavailable; if the contribution of tryptophan to nicotinic acid is included, the average intake of nicotinic acid equivalents may have been 13 mg/day.

According to modern views on requirements this diet, although it may provide physiologically sufficient amounts of protein, provides insufficient energy and nutrients other than vitamins A and C to enable it to be recommended for groups of adult men.

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