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ABSTRACTS OF COMMUNICATIONS

The One Hundred and Thirty-sixth Meeting of The Nutrition Society was held at Queen Elizabeth College, Campden Hill Road, London, W.8, on Saturday, 19 *November* 1960, *at* 10.30 *a.m., when the following papers were read :*

Soup: an appetizer or a food. By THOMAS MCLACHLAN (introduced by A. E. Bender), 4 *Hanway Place, London, W.*1

Soup may be regarded either as a food or as an appetizer and should be prepared and described in such a manner that the consumer is aware of the type of preparation, which he is taking. In times of flood, famine, strikes, or explosions in mines, it is the custom to supply hot soup as an emergency ration. Expressions such as 'a good plate of nourishing soup' are well known, and we have the term 'soup kitchen' to indicate our idea of its value. There is even an organization in London to provide soup and fortified bread to undernourished children in Africa. The need for soup to be more than an aperitif was realized during the war and this led to The Canned Meat and Canned Soup (Control and Maximum Prices) Order (Great Britain. Parliament, 1941), which fixed minimum standards for total solids, protein, and fat for different kinds of soup. With the advent of decontrol a new variety of so-called 'non-liquid soup' was placed on the market and owing to its efficient advertisement has not only obtained a strong foothold in the public economy, but has led to a lowering of the quality of canned soups and to the policy of describing these latter products as 'concentrated'. The public, moreover, believe that these non-liquid soups are better food value and better money value than are canned soups. The results of the analysis of some sixty-four samples of non-liquid soups show that the prepared soup gives a product with about half the calorific value of that of a typical canned soup. When, however, it is remembered that a normal calorie intake per day should be of the order of 3300 kcal and that a 250 ml portion of soup made from non-liquid mixes will provide anything from 40 to 160 kcal with an average of about 70 in the case of soups containing legumes and starch, or from 3 to 14 kcal in the case of so-called meat soups from cubes, it is seen that this is from 0·5 to 5% of the food requirement for a day and that such products can never be regarded as more than appetizers. The public purchasing them are, therefore, being misled as to their real food value.

REFERENCE

Great Britain. Parliament. (1941). *The Canned Meat and Canned Soup (Control and Maximum Prices) Order,* 1941. *S.R. & O.* 1941, no. 2021, amended by *S.R. & O.* 1943, no. 299.

The availability of nutrients in diets containing differing quantities of unavailable carbohydrate: a study on young and elderly men and women. 1. General description and proportionate losses of calories.

By J. V. G. A. DURNIN, *Institute of Physiology, University of Glasgow*

For the purpose of calculating the nutritional value of diets, wide use is made in this and other countries of tables giving the net nutritional value of various foods. These make allowances for losses in digestion and absorption—losses which appear both in the faeces and the urine. The net values have been arrived at, very largely, from Atwater's original studies of about 60 years ago. No systematic study, using a complete range of the available modern chemical techniques, of the losses of calories or of other nutrients in the faeces and urine has ever been made in Great Britain. Since it is possible that the composition of the diet may affect its net nutritional value and since the most important influence might be the amount of roughage —or unavailable carbohydrate—it was decided to investigate the percentage availability of diets containing differing quantities of unavailable carbohydrate on four groups of human subjects, young men, elderly men, young women and elderly women. One diet (diet 1) contained a very small amount of unavailable carbohydrate but was still fairly typical of the food eaten by a large proportion of people in Britain. A second diet (diet 2) contained a moderately large quantity of roughage, in the form of fruit, vegetables and brown bread. Preliminary results on the first group, consisting of twelve young men, are given here. Measurements were done on each diet for a period of 7 consecutive days with periods of adjustment to the foods and to the procedures beforehand. Carmine was given before the first meal and after the last meal to mark the relevant bulk of faeces and the urine passed by each individual subject was also collected during each of the two 7-day experimental periods. The samples of food and faeces and, where appropriate, the urine for the young men have been analysed for the following: total calories, total solids, nitrogen, fat, sugars, starch, pectins, hemicelluloses, pentosans, cellulose, ash and inorganic constituents such as sodium, potassium, calcium, magnesium, phosphorus, sulphur and chloride; alcohol was measured in the beer—a quantity of which was provided free daily. In addition, samples are being analysed by the Medical Research Council Radiobiological Unit at Harwell for stable strontium and strontium 90.

The percentage availability of all of the separate nutrients was significantly less on diet 2 than with diet 1 and this difference was uniform for each subject; e.g. the mean coefficient of available energy was 93·2% for diet 1 and 91·1% for diet 2. The complete results for all four studies will be presented in due course.

These studies were carried out with financial help from the Medical Research Council.

The availability of nutrients in diets containing differing quantities of unavailable carbohydrate: a study on young and elderly men and women. 2. Nitrogen, fat, carbohydrates and some inorganic constituents. By D. A. T. SOUTHGATE (introduced by E. M. WIDDOWSON), *Medical Research Council Department of Experimental Medicine, University of Cambridge*

Total nitrogen, fat, sugars, starch, pentosans, cellulose, potassium, calcium, magnesium, and phosphorus were measured in the food, faeces and, where appropriate, in the urine of twelve young men on the two diets described by Durnin (1961).

The diets differed principally in the amounts of 'unavailable carbohydrate' they contained and the average intakes of the other constituents on the two diets were very similar. There was considerable individual variation in the intakes of fat and sugar because the consumption of butter and sugar was not limited.

The 'unavailable carbohydrate' was almost completely made up of pentosans and cellulose; pectins and hemicelluloses were present only in very small amounts. The average intake of 'unavailable carbohydrate' on the first diet was 67·9 g/week and on the second diet was 150·3 g/week representing 2·4% and 5·1% respectively of the total carbohydrate intake.

The apparent digestibility of all the constituents mentioned, with the exception of sugar and starch, was lower on the diet containing more 'unavailable carbohydrate'. The coefficient of digestibility for nitrogen was 89·6 on the first diet and 86·8 on the second; for fat the corresponding values were 96·4 and 94·8. Larger changes were observed in the apparent digestibility of the inorganic constituents.

The results indicate that the presence of unavailable carbohydrate in a diet may have an appreciable effect on the availability of the other constituents.

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Durnin, J. V. G. A. (1961). *Proc. Nutr. Soc.* **20**, ii.

The role of α–tocopherol in the pig. By W. M. F. LEAT, *School of Agriculture, Cambridge*

Present knowledge seems to indicate that the primary function of tocopherol in smaller laboratory animals is that of a biological anti-oxidant, but evidence is conflicting in larger domestic animals such as the pig. Watts, Cunha & Major (1946) found that the stability of pig back fat was only slightly increased when purified diets were supplemented with tocopherol. However, Carpenter & Lundberg (1949) noticed that the induction time of fat from young pigs not supplemented with tocopherol was much shorter than from pigs supplemented for 12 weeks with tocopherol.

My experiment was designed to investigate the tocopherol requirements of pigs up to 200 lb live weight. Ten piglets from one litter were weaned at 17 days, numbered 1–10, and placed on a diet, the composition of which has been reported elsewhere (Leat, 1959). As it had been shown that this diet did not satisfy the

essential fatty-acid requirement of the pig, it was supplemented with 0·5% olive oil. Pigs nos. 1–5 received the basal diet alone, which contained 0·12 mg total tocopherols/100 g diet, whilst the remaining five animals were supplemented with 10 mg α-tocopheryl succinate/100 g diet.

Growth rate and food consumption were recorded up to slaughter weight, which was 150 lb live weight for pigs nos. 1, 2, 6 and 7 and 200 lb for the remainder. No gross abnormalities were noticed in any of the animals either during life or at slaughter and the back fats were firm and white. The most noticeable difference between the two groups lay in the peroxide content of the body lipids. These had been extracted shortly after slaughter and stored for nine months at 0° when they were analysed. The results are depicted in the table.

Pig no.	1	2	3	4	5	6	7	8	9	10
α-tocopheryl succinate (mg/100 g diet)	—	—	—	—	—	10	10	10	10	10
Growth rate/pig (lb/day)	1·31	1·11	1·49	1·26	1·26	1·20	1·24	1·52	1·26	1·21
Food consumption/pig (lb/day)	3·04	2·66	3·66	3·46	3·14	3·04	2·66	3·66	3·46	3·14
Peroxide value of back fat (μmoles/g)	55	49	65	23	37	1	1	2	1	2
Peroxide value of liver fat (μmoles/g)	—	116	—	84	136	—	11	—	24	7

These observations suggest that although the pig does not require dietary tocopherol for optimum growth up to 200 lb, its presence will lessen the susceptibility of body fats to oxidative rancidity.

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The effect of natural and synthetic fats on the production of atherosclerosis and thrombosis in the rat. By A. N. HOWARD* and G. A. GRESHAM, *Department of Pathology, University of Cambridge*

Thrombosis and atherosclerosis can be produced independently in rats by giving a diet containing two different fats (Gresham & Howard, 1960). Thus butter together with agents which produce hypercholesterolaemia such as cholesterol, cholic acid and thiouracil produce thrombosis in the cardiac chambers, aorta and coronary arteries, and also myocardial infarction. If butter is replaced by arachis oil, no thrombosis or infarction occurs but atherosclerosis of the aorta and coronary arteries is produced closely resembling that seen in man. Butter differs from arachis oil in having a high content of saturated fatty acids and a low content of the diunsaturated acid linoleic. In the present experiments the nature of these differences has been clarified by feeding natural and synthetic fats of widely different compositions. Groups of rats were given a diet containing 40% fat, 5% cholesterol, 2%

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cholic acid and 0·3% thiouracil, until death occurred. Butter, beef fat, hydrogenated arachis oil and two synthetic glycerides monooleate distearate and dioleate monostearate produced thrombosis but no atherosclerosis. All these fats consist chiefly or exclusively of saturated fatty acids linked to oleic acid. Arachis oil (25% linoleic acid) produced atherosclerosis but no thrombosis. Mixtures of butter and arachis oil (1:1), butter supplemented with 8% methyl linoleate and maize oil (60% linoleic acid) produced both atherosclerosis and thrombosis. No lesions were observed with glyceryl trioleate and trilinoleate. It was concluded that saturated fatty acids were involved in thrombosis and that linoleic acid in combination with saturated fatty acids facilitated the production of atherosclerotic plaques.

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Thyroid activity and the dental enamel. By D. E. Hughes and Dagmar C. Wilson, *Department of Biochemistry, University of Oxford*

Experiments with animals strongly support the view that not only is the normal functioning of the thyroid gland essential for correct tooth development (Pitt-Rivers & Tata, 1959) but that the gland also influences enamel formation and may play an important role in the subsequent incidence of dental caries (Bixler, Muhler & Shafer, 1956). The addition of fluoride to the drinking water of rats lowered the incidence of dental caries but there appears to be no synergistic effect between thyroid hormone and fluorine (Muhler, Bixler & Shafer, 1957). A survey has been described of thyroid enlargement in schoolchildren in North Oxfordshire compared with Oxford City (Hughes, Rodgers & Wilson, 1959).

Observations of the dental enamel of fifty-nine children between the ages of 11–16 years who had lived in the Hook Norton district for over 10 years, were made by Mr W. J. Cook, Principal School Dental Officer, Oxfordshire County School Health Authority, in 1957.

In this country no high-iodine, low-fluorine area was available for comparison. A random sample of extracted teeth from residents of Hook Norton district showed in each instance hypoplasia of the dental enamel. Such hypoplasia was absent from the extracted teeth of Oxford residents obtained for comparison.

In 1960 Mr C. H. T. Millar, B.Sc., L.D.S., Chief Dental Surgeon, City of Oxford using techniques similar to those at Hook Norton, examined the teeth of

Enamel-defect rate in Hook Norton and Oxford children compared*

				Percentages		
	<1·05	>1·05	Total	<1·05	>1·05	Total
Hook Norton	39	20	59	66·1	33·9	100
Oxford	34	—	34	100	—	100
Total	73	20	93	—	—	—

*Points allotted to degrees of roughness / Total teeth erupted

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thirty-four schoolchildren aged 12–15 years. The enamel-defect rate was similarly calculated and found to be low.

Comparison of the preliminary results with Hook Norton suggests that the enamel-defect rate among children living in Hook Norton was higher than among a similar group living in Oxford. We suggest that there is a strong case for wider investigations.

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Prevention of enzootic muscular dystrophy by selenium administration.

By K. L. BLAXTER, E. S. R. MCCALLUM and R. S. WILSON, *Hannah Dairy Research Institute, Kirkhill, Ayr*, and G. A. M. SHARMAN and L. G. DONALD, *North of Scotland College of Agriculture, Inverness*

Experiments on commercial farms in north-east Scotland have been continued to test the effectiveness of selenium in preventing enzootic muscular dystrophy in beef calves (Sharman, 1954) and to compare the prophylactic value of Se with that of α-tocopherol. In 1960, 204 calves were divided into groups of 4 and one calf in each group was allocated at random to one of four treatments (a) 15 mg Se by subcutaneous injection within a few days of birth (b) 5 mg Se by injection at 3-week intervals from birth (c) 5 mg Se by mouth at 3-week intervals from birth and (d) no treatment. Se was given as sodium selenate (AR). All animals were examined at intervals for clinical signs of muscular disease, blood was taken for the determination of serum glutamic oxaloacetic transaminase activity (SGOT) by the method of Cabaud, Leeper & Wroblewski (1956), and the presence of dystrophy was confirmed by determination of creatine in the muscle in calves which died. The results of the experiment are given in the table, where they are combined with those obtained in 1959 (Sharman, Blaxter & Wilson, 1959). The results of experiments made in 1953, 1954 and 1955 and 1959 with DL-α-tocopheryl acetate as a prophylactic are given for comparative purposes (Blaxter & Sharman, 1953; Garton, Duncan, Blaxter, McGill,

Incidence of muscular dystrophy in beef calves

Years	Treatment	No. of calves at risk	No. of cases of muscular dystrophy	No of. deaths	Percentage of calves with blood serum SGOT >250 units /100 ml
1960	Single injection Se	51	1	None	2
	3-weekly injection Se	51	1	None	5
	3-weekly oral Se	51	None	None	2
	None	51	11	2	31
1959 and 1960 combined	3-weekly oral Se	109	None	None	—
	None	109	21	3	—
1953, 1954, 1955 and 1959 combined	20 mg α-tocopherol	132	2	None	—
	None	132	27	4	—

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Sharman & Hutcheson, 1956). These results refer to the daily administration of not less than 20 mg α-tocopherol.

The results show that Se was effective in reducing the incidence of muscular dystrophy and that α-tocopherol medication was slightly but not significantly less effective. A single injection of Se afforded the calves considerable but not complete protection.

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Protein as a source of energy for synthesis of fat in sheep. By A. K. Martin and K. L. Blaxter, *Hannah Dairy Research Institute, Kirkhill, Ayr*

Two sheep with permanent fistulas of the abomasum and two with rumen fistulas were used in twelve experiments to measure the utilization of casein as an energy source in the synthesis of body fat. Each sheep was given a basal ration sufficient to result in a small retention of energy, and containing more protein than it required. Supplements of casein supplying 500–1100 kcal or 13–30 g nitrogen/24 h were then given by infusion into either the abomasum or the rumen for periods of 7 days. The metabolism of carbon, N and energy was measured by closed-circuit respiration calorimetry both during the periods when casein was infused and during periods of 14–21 days before and after the infusions when the basal ration was given alone. From the increments in the measurements of metabolism when casein was given, the utilization of the energy of casein was determined with the results given in the table. They show that casein given by rumen infusion resulted in larger losses of

	Route of administration	
	Rumen	Abomasum
Apparent digestibility (kcal/100 kcal casein)	90·1±6·1	99·7±5·8
Methane production (kcal/100 kcal casein)	7·6±1·16	0·6±0·92
Urine energy (kcal/g urinary N)	10·1	7·8
Metabolizable energy (kcal/100 kcal casein)	62·0±3·6	87·3±3·6
Net energy (kcal/100 kcal casein)	31·1±3·6	56·7±3·6
Net availability of metabolizable energy	50·2±3·2	64·7±3·2

energy in the faeces, as methane, in urine and as heat, than were found when the casein was given by abomasal infusion. Kellner & Köhler (1900) found that the net availability of the metabolizable energy of wheat gluten given to steers by mouth was 47·6% and Heim (1956) found a value of 45·9% in comparable experiments with sheep. The experiments with rumen infusion of casein agree with these results. Experiments by Fingerling, Köhler & Reinhardt (1912–13) with pigs and by Kriss, Forbes & Miller (1934) with rats, gave values of 74·1 and 68·6% respectively for the net availability of the metabolizable energy of protein. The value obtained on

abomasal infusion of casein in sheep approached these values in the simple-stomached animals, and the results together suggest that the species difference in the utilization of protein as an energy source is largely due to losses of energy consequent upon microbial action in the rumen.

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The protein value of human breast milk. By B. S. PLATT and D. S. MILLER, *Human Nutrition Research Unit, National Institute for Medical Research, The Ridgeway, Mill Hill, London, N.W.7*

The composition of human breast milk is known to differ from that of cow's milk (Platt & Moncrieff, 1947). The calories derived from the protein of cow's milk are twice those from the protein of human milk. However, the results of two studies in the literature (Henry, Kon & Mawson, 1950; Tomarelli, Minnick, D'Amato & Bernhart, 1959) did not show a significant difference between the quality of the proteins from these two sources. This is surprising in view of the difference in 'protein scores' (cow's milk 78, human milk 100 (FAO, 1957)), and the difference in casein: whey protein ratios (cow's milk 6 : 1, human milk 1 : 2 (Mellander & Vahlquist, 1959)).

The study of Henry *et al.* (1950) was complicated by the intolerance of the rat to high concentrations of lactose in the diet fed. Tomarelli *et al.* (1959) avoided this by freeing the protein assayed from lactose (a procedure which may have damaged the protein). In the present work net protein utilization (N.P.U.) was measured by the method of Miller & Bender (1955); rats were used which had been accustomed to a high intake of lactose during the previous week (2 days at 15%, 2 days at 20% and 3 days at 25%). No diarrhoea or other disturbances were observed when the rats were subsequently fed a diet containing 50% dried human milk, i.e. 25% lactose. The data are presented in the table with comparable figures for cow's milk and are in substantial agreement with the protein scores given by FAO.

	N.P.U. (standardized) (%)	Protein calories (%)	N.P.U. (operative) (%)	N.D-p. Cals (%)
Human milk	100	10·0	87	8·7
Cow's milk	85	20·0	59	11·9

Using the figures presented, it is possible to calculate (Miller & Payne, 1960*a*,*b*) the N.P.U. (operative) at the level of protein found in the two milks and hence the net dietary-protein calories % (N.D-p. Cals %) (Platt & Miller, 1959), a measure of both the quantity and quality of the proteins as consumed. It will be seen that the chief factor influencing the protein values expressed in the table is the concentration

of protein. The N.D-p. Cals % of human milk corresponds to the safe practical allowance of protein for infants (FAO, 1957).

We are indebted to Dr G. G. A. Mastenbroek, chief of the Mothermilk Centre of the Netherlands Red Cross, Amsterdam, for supplying us with freeze-dried human milk.

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Coprophagy and vitamin B_{12} in the rat. By T. B. MORGAN, *Department of Nutrition, Queen Elizabeth College, University of London* and MARGARET E. GREGORY, S. K. KON and J. W. G. PORTER, *National Institute for Research in Dairying, Shinfield, Reading*

Barnes, Fiala, McGehee & Brown (1957) have demonstrated the prevalence of coprophagy in rats kept in cages fitted with raised mesh screens. Recently Morgan (1960), using the anti-coprophagy device described by Barnes *et al.* (1957), has shown that starch refection occurs only when rats eat their faeces and he has suggested that the term refection be abandoned. Further proof of the extent of coprophagy has now been obtained. Rats have been given a diet low in vitamin B_{12} and the effect of preventing coprophagy on the amount of this vitamin in the stomach has been investigated.

Male albino rats of about 150 g weight were given *ad lib.* a diet containing 80% α-protein, 15% arachis oil, 5% salts and all vitamins except vitamin B_{12}; 1 g of this diet contained 0·0003 μg vitamin B_{12} as determined by *Lactobacillus leichmannii* assay. After 2 weeks the rats were divided into three groups and housed individually in cages fitted with raised mesh screens. Anti-coprophagy cups were fitted to the rats in two of the groups. The collected faeces were removed from the cups daily. The faeces from the rats in one of the groups were discarded whereas those from the other group were returned to them daily ground up in their diet. After 1 week on these treatments the rats were killed. The amounts of vitamin B_{12} activity in their stomach contents were determined by assay with *L. leichmannii*, the papain digestion technique of Gregory (1954) being used. The mean amount of vitamin B_{12}-active compounds in the stomach contents of fifteen rats prevented from eating their faeces was 0·0008 μg (range 0·0038–0·0002), whereas that of fifteen rats not prevented from access to their faeces was 0·015 μg (range 0·040–0·0012) and that of sixteen rats given their faeces in their diet was 0·013 μg (range 0·072–0·0005).

These findings confirm that rats kept on screens eat at least some of their faeces. Further it is evident that coprophagy is likely to vitiate attempts to produce vitamin B_{12} deficiency. This phenomenon may also be responsible for the difficulties experienced by some workers in determining vitamin B_{12} by the rat-growth assay.

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The calorie value of sorbitol. By T. B. MORGAN and JOHN YUDKIN, *Department of Nutrition, Queen Elizabeth College, University of London, W.8*

Sorbitol has been used by diabetics as a substitute for sugar for nearly 30 years, chiefly because it does not cause an appreciable rise in blood glucose. More recently, as an illogical extension of this, it has been widely assumed that sorbitol is a suitable substitute for sugar in diets designed for weight reduction, and large amounts are consumed in so-called sugar-free confectionery, fruits in syrup and fruit juices.

We have assessed the calorie value of sorbitol by comparing it with glucose in its effect on growth in rats, according to the method of Oser & Melnick (1947) and Rice, Warner, Mone & Poling (1957). The rats were given weighed amounts of a complete carbohydrate-free diet, daily, with 0·5 g of either cellulose, or glucose, or sorbitol. In four separate experiments the gain in weight of the rats given sorbitol was greater than that of rats given cellulose, and the same as that of rats given glucose. The same results were obtained when coprophagy was prevented. Thus it appears that sorbitol has about the same calorie value as glucose.

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Effect of ascorbic acid and of cellulose on the thiamine requirement of the rat. By T. B. MORGAN and JOHN YUDKIN, *Department of Nutrition, Queen Elizabeth College, University of London, W.8*

It was shown by Daft & Schwarz (1952) that rats fed a thiamine-deficient diet are able to survive if they are given ascorbic acid at a level of 5% of the diet. We were at first unable to repeat these observations. We then fed a carbohydrate-free diet, on which our rats normally survive for many months without dietary thiamine. Addition of 5% ascorbic acid to this diet resulted in the appearance of thiamine deficiency in six out of eight rats; the other two survived for several months. Thus ascorbic acid acts like carbohydrate in increasing thiamine requirements of at least some rats. When the experiment was repeated with gridless cages, none of the rats

died. This was due to intestinal thiamine synthesis followed by coprophagy, for the prevention of coprophagy abolished the vitamin-sparing effect of ascorbic acid in the same way as it abolishes that of sorbitol and other polyols (Morgan & Yudkin, 1960).

In all these instances of vitamin sparing, there was a considerable enlargement of the caecum. We have observed too that the caecums of rats fed stock diets containing cereals are larger than those of rats fed purified diets containing polyols. We therefore investigated whether the enlarged caecum was, by itself, sufficient to produce a thiamine-sparing effect. Rats were fed carbohydrate-free, thiamine-free diets with 20% cellulose, and maintained in gridless cages. The cellulose, like the ascorbic acid, produced thiamine deficiency, but this time in spite of the absence of grids. The caecums of these rats were found to be enlarged to about the same extent as those of rats fed sorbitol. Thus an enlarged caecum appears not to be a sufficient condition for thiamine sparing. It is probable that it is also necessary to have some slowly absorbed dietary component such as sorbitol as part of the medium for the caecal flora which synthesize thiamine.

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Farmers balancing of feedstuffs. By J. W. TOMKINS (introduced by R. J. L. ALLEN), *Apethorpe, Peterborough*

This system is distinguished from other known systems in that it is now possible to list all feeding-stuffs with one number which really shows the degree out of balance, so that only foods showing zero have the correct nutritive ratio.

Foods with a surplus of starch are known as starchy foods. Foods such as oilcakes, fish meal etc., are known as protein foods. By multiplying the protein equivalent of any food by the desired nutritive ratio and comparing the figure so obtained with the starch equivalent, the food can, if the number is greater than the starch equivalent, be put into the protein list, and the food is given a number being the difference after subtracting the starch equivalent. In the case of the starchy food, the number remaining after the multiplied protein has been subtracted is put into the starch list.

With foods listed with each number into its nutritive-ratio column it is then a simple and straightforward matter to produce a ration with any number of foods without any try and try again procedure. The method is as follows.

Having decided which foods it is desirable to include in a ration, the quantity in, say, cwt is listed; usually in the starch foods first. The number of cwt of each is multiplied by its appropriate number and the product will show how much these foods are out of balance. The protein foods are then added until a zero figure is obtained. The ration is then accurately balanced.

Animal rations
How to achieve a balanced ration

You wish to balance a ration for weaners and have barley, wheat and blood meal at your disposal

		Starch
1 cwt barley	42	42
2 cwt wheat	2×34	68
		110 units

110 units of starch have to be balanced by the equivalent in protein, in this case blood meal, from the chart. You will see that 1 cwt of blood meal = 209 units; you will, therefore, need ½ cwt of blood meal (or 105 units) to balance your ration.

A ration balanced to within 10% of the total starch units is quite satisfactory.

	Weaners to 80 lb dairy ration 4 : 1 ratio	Store pigs 80–120 lb 5 : 1 ratio	Pork pigs 120–180 lb 6 : 1 ratio	Pigs over 180 lb 7 : 1 ratio
Barley	42	35	28	20
Maize	48	40	33	25
Oats	30	22	15	7
Wheat	34	25	15	6
High-quality middlings	22	10	0	14
Middlings	4	0	10	21
Beet pulp, dry	40	45	50	55
Bran	13	1	10	12
Blood meal	209	277	346	415
Decorticated groundnut	92	133	175	216
White-fish meal	173	205	258	311
Herring meal	153	210	267	324
Soya-bean meal	88	126	164	202
Beans	13	32	52	72
Linseed cake	25	52	80	107

DEMONSTRATION

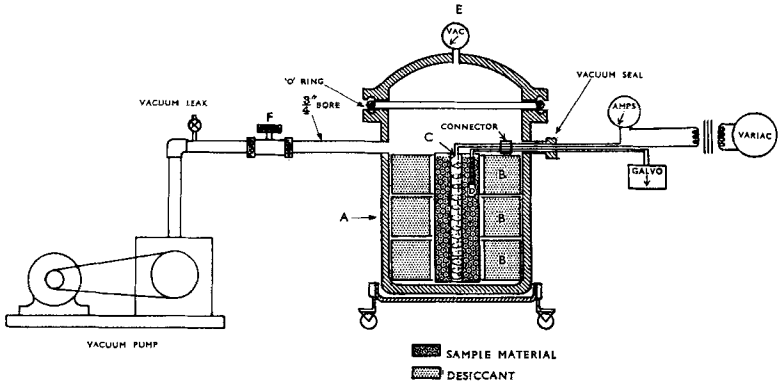
The use of a desiccant in the freeze-drying of foods on a laboratory scale.

By P. R. PAYNE, D. S. MILLER and B. S. PLATT, *Human Nutrition Research Unit, Nutrition Building, National Institute for Medical Research, Mill Hill, London, N.W.7*

The drying of heat-labile materials may be achieved by drying in air, with solvents, or by lyophilization. For the examination of human foods the last-mentioned is to be preferred, as changes of nutritive value are minimal (e.g. due to heat damage, loss of fat and fat-soluble nutrients, or retention of traces of solvent).

Commercially available apparatus for freeze-drying is both expensive and unsuitable for foods; the drier described here is simple to operate and avoids the use of refrigeration plant or corrosive desiccants.

The freeze-drying unit consists of a cylindrical vacuum tank $13\frac{1}{2}$ in. diameter × 20 in. long. Inside are three annular baskets (B) 13 in. diameter × 6 in. deep, made from perforated metal sheet, each having a central hole $4\frac{1}{2}$ in. diameter and containing 10 kg of activated alumina pellets (Peter Spence & Sons Ltd, Widnes, Lancs). A copper constantin, thermocouple (D), frozen into one of the lumps of sample, gives an indication of temperature and progress of drying.



SCHEMATIC DIAGRAM OF FREEZE-DRYING APPARATUS

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In operation, the material to be dried is prefrozen and broken into $\frac{3}{4}$ in. lumps. The vessel is evacuated to a pressure of less than 1 mm Hg as indicated by the capsule gauge (E). The valve (F) is then closed, and the pump stopped; heat is applied to the sample, by means of the electric heater (C) at the rate of 100W and is then progressively reduced until, after about 5 h, the power level is ·10W. This is maintained for a further 19 h, after which most materials are completely dry. The alumina pellets can then be regenerated by heating to 260° for 3–4 h.

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