ANALYSIS OF MEALS SERVED IN SURREY SCHOOL CANTEENS

By MARGARET KERLY, FLORENCE MORKAM and KATHLEEN MAGILL,
From the Department of Biochemistry, University College (London) and the Education Department, Surrey County Council

(With 3 Figures in the Text)

The enormous increase in the number of children* eating their mid-day dinners at school canteens came at a time when enlargement of school buildings was impossible and when equipment was difficult to obtain. The following report on meals served in nine canteens illustrates the success that has been achieved in providing adequate meals in spite of great difficulties of preparation and service. The schools were chosen to represent different conditions of environment and type of canteen. Sample meals were analysed and an attempt was made to assess the home food of the children.

METHODS

Schools were visited on three consecutive days (Wednesday, Thursday, Friday). On each day three meals were taken at random from children already served, the portions were weighed and one average meal was put into a jar for analysis. In addition, separate samples of all foods likely to contain vitamin C were put into bottles containing metaphosphoric acid. The whole meals were thoroughly mixed, air-dried at 70–80°, the semi-dry food minced and then ground in a coffee mill. Protein was estimated by Kjeldahl's method, fat by extraction with petrol ether, carbohydrate by difference (after estimation of water and ash content), calcium by a modification of Sobel's and Sklersky's (1938) method, and riboflavin (on a few meals) by the microbiological method. Calorie value was calculated from the protein, fat and carbohydrate content. Ascorbic acid was estimated on the separate samples by titration of the metaphosphoric acid extract with 2 : 6-dichlorophenol-indophenol. These methods should give sufficiently accurate results for assessment of the nutritive value of the meals and can be readily and quickly carried out with ordinary laboratory equipment.

Home food was assessed by asking the children to record daily, on forms provided, everything eaten during the three test days (tea-time on Tuesday until dinner-time on Friday). The forms also allowed space for answers to about twelve questions designed to give some idea of the child's general activity, but as the answers provided little useful information they will not be considered here. From examination of the forms the amount eaten of important foods likely to be in short supply, i.e. animal protein, milk, fruit and vegetables possibly containing vitamin C, was assessed. The results have been tabulated to show the average number of meals per day at which each food was eaten, but no estimate of the quantities consumed has been attempted. Children eating their mid-day dinner at home were also asked to keep similar records. In scrutinizing their forms the mid-day meal was considered separately so that the results might be compared with those of the children taking their dinners at school.

* For S.C.C. Elementary Schools from 14,000 = 16 % in 1940 to 38,355 = 45 % in February 1944.

RESULTS

(1) *School meals*

When serving children at a communal meal some allowance must be made for variation in individual food consumption, and care must be taken to prevent children with small appetites leaving the more nutritious portions of the meal. Canteens vary in their methods. Usually standard portions are served containing a nearly average helping of the main dish, but smaller amounts of vegetables and pudding, the extra food being used for second helpings for those with larger appetites. All children are then expected to eat the whole of the 'standard' portions, thus ensuring a balanced meal and preventing waste. The values shown in Table 1 refer to these standard portions. Many children, in fact, received second helpings, so that the average food intake would be somewhat higher.

Senior children (11–14 years). At four Central School canteens the content of an average meal was calculated from the costing sheets (using Mottram and Radloff's food tables). It will be seen that the

Table 1. *Food value of school meals. Average of meals served on three consecutive days*

			Analysis of 'standard' meals							Calculated value of average meal				
No.	Type	Date	Protein g.	Fat g.	Carbohydrate g.	Cals.	Ca mg.	Vitamin C mg.	Riboflavin mg.	Protein g.	Fat g.	Carbohydrate g.	Cals.	Cost *d.*
					Senior boys, 16 years									
B.*	Rural W.V.S.	Nov. 1942	32	29	93	724	241	30	—	—	—	—	—	—
		May 1943	37	35	88	833	287	54	0·44	—	—	—	—	—
					Senior boys and girls, 11–14 years									
E.	Rural school kitchen	Oct. 1942	48	32	66	764	284	13	—	—	—	—	—	—
		Feb. 1943	17	25	80	612	223	27	0·35	—	—	—	—	—
L.*	Country town W.V.S.	Nov. 1942	28	27	70	656	186	24	—	—	—	—	—	—
		May 1943	28	23	82	660	233	33	0·36	—	—	—	—	—
S.	Rural school kitchen	Feb. 1944	20	22	69	575	177	14	—	27	38	103	894	6·29
C.	Suburban central kitchen	June 1943	27	22	98	692	338	27	—	34	35	126	981	6·91
Mn.	Suburban school kitchen	Sept. 1943	26	26	103	770	320	29	—	32	38	158	1157	—
Me.	Suburban school kitchen	Jan. 1944	26	27	72	652	218	19	0·50	—	—	—	—	—
R.	Suburban central kitchen	Mar. 1944	Boys 27	27	79	681	199	15	—	27	24	115	836	4·90
			Girls 28	15	90	621	255	18	—					
Average			28	25	81	668	243	22	0·41	30	34	125	962	—
Board of Education Standard†			—	—	—	—	—	—	—	20–25	30	— (Ca = 400, C = 50)	1000	—
					Junior boys and girls, 8–10 years									
Mn.		Sept. 1943	17	25	85	652	191	23	—	—	—	—	—	—
Mi.	Rural village hall	Dec. 1943	32	33	82	783	252	27	—	—	—	—	—	—
Me.		Jan. 1944	21	26	68	612	213	18	—	—	—	—	—	—
Average			23	28	78	682	219	23	—	—	—	—	—	—
					Infants boys and girls, 5–7 years									
C.		June 1943	15	18	32	435	105	12	—	—	—	—	—	—
Mn.		Sept. 1943	14	20	68	523	153	24	—	—	—	—	—	—
Me.		Jan. 1944	19	20	57	499	176	16	—	—	—	—	—	—
Average			16	19	52	486	145	17	—	—	—	—	—	—

* At both W.V.S. canteens meals were cooked and served in small halls. † *Board of Education Circular* 1571, 12 Nov. 1941.

standard portions served contained nearly the expected average amount of protein, but only about two-thirds the calorie content, due to the less than average amounts of vegetable and pudding (mainly fat and carbohydrate) served in the standard portion.

In 1941, when special food allowances were made for school canteens, the Board of Education recommended the quantities shown in Table 1 for the average school meal. It will be seen that, when calculated from the costing sheets, the meals at the Central School canteens exceed this level for protein and fat, and are very near in calorie value. The standard portion, as pointed out above, is intentionally smaller than the average.

We do not consider the costing sheets provide adequate data for calculation of average calcium and vitamin C content of the meals, so that we can only compare the Board of Education standards with the analysed values. For calcium this is 60 % and, even when allowance is made for second helpings, it is unlikely that the average school dinner is providing 400 mg. of calcium, although it may be reached at some canteens (e.g. C and Mn, Table 1). The food records of those children who ate the school dinner show that 84 % also drank milk at school. Those children who drank $\frac{1}{3}$ pint would receive a further 230 mg. of calcium, making their daily intake at school at least 470 mg., whilst those who ate second helpings at dinner or drank $\frac{2}{3}$ pint of milk would have a higher intake.

It will be seen from Table 1 that the meals analysed were providing barely half the amount of vitamin C recommended by the Board of Education. As the ascorbic acid content of vegetables varies with the season we visited three of the canteens on three consecutive days each month for a year (May 1942–May 1943), sampling only those foods likely to contain an appreciable amount of the vitamin (Table 2). On only three occasions did we find meals at a Central School canteen containing over 40 mg.; these were all served at a rural school growing its own fruit and vegetables. Two meals, containing 49 and 43 mg. respectively, included large servings of gooseberries, the third (41 mg.) 200 g. of new potatoes, so that they were clearly exceptional. At another rural canteen for evacuated secondary school boys two meals containing over 50 mg. vitamin C were encountered, both contained large helpings of potatoes (200–300 g.) and one (59 mg. C) both cabbage and salad. This canteen regularly served large portions (over 100 g.) of cabbage, but considerable difficulty was experienced in persuading the boys to eat such large amounts.

Loss during cooking of vegetables is always serious, and in those districts where meals are cooked in a central kitchen there is an additional loss during transit. This is illustrated in Fig. 1. Losses in cooking and transit are very variable; they seem to depend on position in the vessels as well as on time of transit, e.g. potato at the top of a boiler suffers serious loss when the lid is opened, for steam to escape, before removal into insulated containers; vitamin is preserved better in a full than in a half-empty container. For potato the loss depends on the method of cooking and serving, being least for potatoes cooked in their skins and greatest for mashed potato. We do no think the best method for large-scale cooking of cabbage has yet been determined, and we find that losses in cabbage cooked in an apparently similar manner on different days may be very variable. When meals must be sent out in containers, vegetables in gravy, containing cabbage and parsley, as well as swedes and turnips, are preferable to a root vegetable. The loss in transit is not great, and the dish has the added value of being easy to serve. It should be noted that, without cabbage and parsley, vegetables in gravy do not provide much vitamin C (Table 3). Salad is a satisfactory source only if it contains cress or raw cabbage, watercress being preferable to mustard and cress because the latter is light and bulky and therefore only a small portion can be eaten. Almost all salads served contained large amounts of lettuce, beetroot or pulses, which reduce the amount of vitamin C contained, even in a large helping, to a small value. In Table 3 are shown the amounts of vitamin C provided by the different vegetables (average values of all our estimations calculated for the size of the portions usually served). The amounts of raw cabbage and watercress provided in most canteens are too small to supply an adequate amount of vitamin C. It is clear that potato and cooked cabbage are the main sources, and it is fortunate that the seasonal variation in vitamin C content of these two vegetables is complementary (Table 2). We think that larger portions of vegetables might be served now that the effect of continued propaganda is being experienced and children are more ready to eat both raw and cooked cabbage. In an experiment in which 14-year-old girls and boys were allowed to help themselves the average portions consumed weighed 250 g. for potato and 190 g. for cabbage. Whilst these amounts are exceptional, senior children should be able to increase their vitamin C intake by eating larger portions of these vegetables. This will mean an increase in the cost of the meal. Cost of individual dishes was worked out for three of the canteens visited and averaged for potato 0·44*d.* and second vegetable 0·9*d.* (cabbage 0·8*d.*, salad 1·3*d.*, and vegetables in gravy 0·7*d.*). These values are higher than the general average for the county over the whole year, but illustrate the large extra cost involved in supplying an increased amount of vegetable.

We think that the average content over the whole year of vitamin C in the meal could be increased to perhaps 30 mg. by improvements in cooking and by serving larger portions of potato and cabbage, but that it is not likely to be increased beyond this figure with the supplies at present available.

analyses of these meals are shown separately in Table 1. The Board of Education recommend that the allowances for Juniors should be three-fourths and for Infants two-thirds of a Senior meal. The meals analysed were mostly up to this level, but the numbers are insufficient to warrant any general

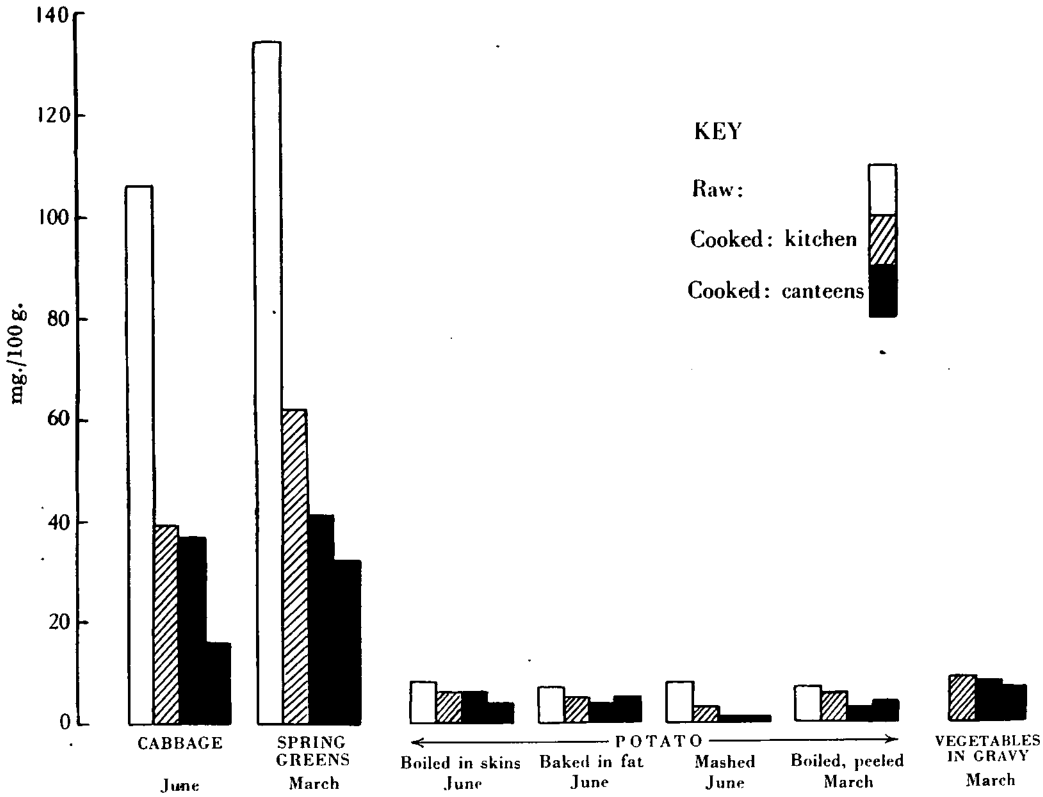

Fig. 1. Effect of cooking and transit on vitamin C content of vegetables.

Table 2. *Effect of season on vitamin C content of* (1) *school meals,* (2) *potato,* (3) *cabbage. May* 1942–*May* 1943

	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Canteens, mg./meal: B.	6	13	36	32	27	33	30	17	26	26	35	23	54
E.	15	26	15	30	31	13	25	14	28	27	26	18	21
L.	8	8	10	16	19	24	24	17	17	17	11	6	33
Potato,* mg./100 g.	3	3	5	15	11	7	11	4	5	5	3	5	3
Cooked cabbage,* mg./100 g.	32	24	23	8	6	20	21	—	26	22	16	19	28

* Average calculated from vegetables served at canteens B and E: Canteen L has not been included as the cooking was bad during a large part of the survey.

Riboflavin was estimated on meals from four canteens. Little variation in the content of different meals was observed (average 0·5 mg.), the highest value, 0·8 mg., being in a meal containing an egg and cheese dish and bread pudding.

Junior and Infants (5–10 years). Some of the centres visited catered for younger children. The discussion. Difficulties of providing adequate amounts of vitamin C are especially great with small children who cannot eat bulky meals.

(2) *Home meals*

The results of our assessment of the children's home food are shown in Fig. 2. The proportion of

Table 3. *Contribution of various foods to the vitamin C content of school meals. Values calculated from the mean of all meals analysed*

	Weight of average portion g.	Vitamin C in average portion mg.
Potato	170	10
Cabbage: Cooked	75	18
Raw*	25	9
Salad	65	18
Watercress	13	11
Tomato	27	5
Vegetables in gravy	170	5
Gooseberries	90	18

* These values are calculated from raw cabbage as served: higher values were often obtained from raw cabbage intended for cooking (see Fig. 1). The low vitamin content may partly be accounted for by selection of the inner leaves, by cutting and loss in any dressing used.

children falling into the different groups varied little with age, sex or district, so that only the final results for all the children questioned are tabulated, except for the consumption of vegetables, where variation with season is shown. Only one rural Central School was visited. Here protein was eaten more frequently than in the suburban schools (50 % of the children ate protein more than once per day compared with the general average of 36 %), but as the numbers were not large the results are not tabulated separately.

It is interesting to find that eating dinner at school made little difference to the frequency with which animal protein and vegetables were eaten at home meals, other than dinner. We think this is an indication that there was also little difference in the amounts eaten, either the child eating his dinner at school was, in a large number of cases, not receiving his full home ration or the child going home to dinner was eating rations of other members of the family (65 % of home dinners contained

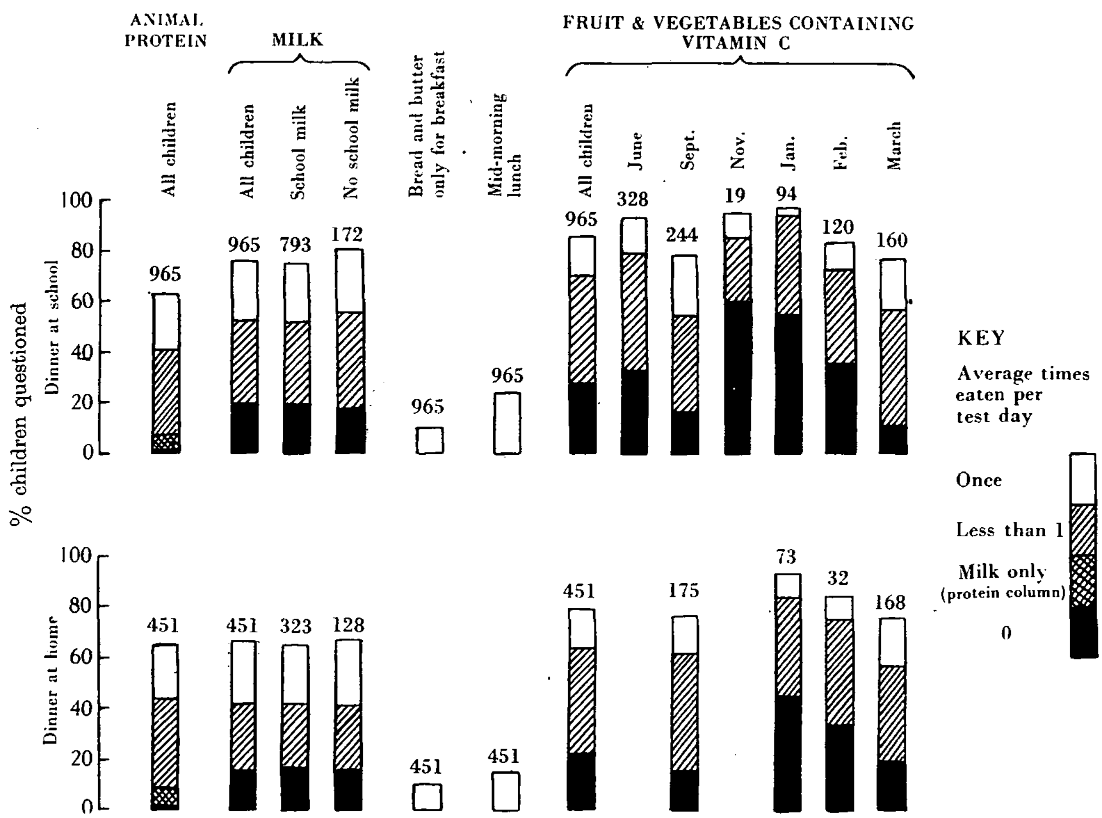

Fig. 2. Comparison of food eaten at home (excluding dinner) by children eating school and home dinners. Figures above columns show numbers in each group.

https://doi.org/10.1017/S0022172400019173 Published online by Cambridge University Press

rationed protein). At least in the mid-week period, we find that 40 % of the children in both groups did not regularly eat animal protein apart from their mid-day meal. 7–9 % ate no protein apart from their dinner, but the majority of these drank some milk.

In assessing vegetable and fruit consumption, all foods that might possibly contain vitamin C have been counted. In spite of this a quarter of the children never ate anything that might contain an appreciable amount of the vitamin, and even in September, the most favourable of the test periods, half the children were not, apart from dinner, regularly consuming any vegetables. Thus, for the majority of the children, vitamin C intake was confined to that provided at the mid-day meal, for the school dinner an average of 22 mg.

In assessing milk consumption those who drank school milk were considered separately from those who did not, but no distinction was made between those taking ⅓ pint and those taking ⅔ pint at school. In counting the number of times milk was drunk at home, cereal and cocoa were included as milk, but not tea or coffee, unless the child specified 'made with milk'. The proportion drinking school milk was higher among those who took the school dinner than among those who went home, 84 % compared with 71 %, but there was very little difference in the frequency of home milk drinking between those who did or did not drink milk at school; evidently dislike of milk drinking was not an important reason for failing to take school milk. Children returning home for dinner drank milk more frequently than those eating the school dinner, 33 % drinking milk more than once per day as compared with 26 %. Whilst frequency of drinking milk gives no quantitative estimate of the amount consumed, our results show that one-fifth took no milk at home, and it is reasonable to suppose that the additional third of the children who, on the average, drank milk less than once per day, were not drinking the minimum ½ pint allowed on their ration.

We have made no attempt to assess the energy value of the home food. 10 % of the children questioned ate nothing other than bread and butter for breakfast on all three test days, many others had bread and butter only on one or two days. The number of children who usually ate a bun or its equivalent at the mid-morning break was counted, but has little relation to the child's general food intake, as many schools discourage this habit, the children being apt to eat so large a quantity of starchy food that they cannot eat their standard portion at dinner and so take an unevenly balanced diet.

In scrutinizing the reports on the content of home dinners note was taken of the frequency and type of animal protein consumption and of foods likely to contain vitamin C (Fig. 3). All children ate animal protein on at least one of the test days and 85 % on all three days. The dishes served are

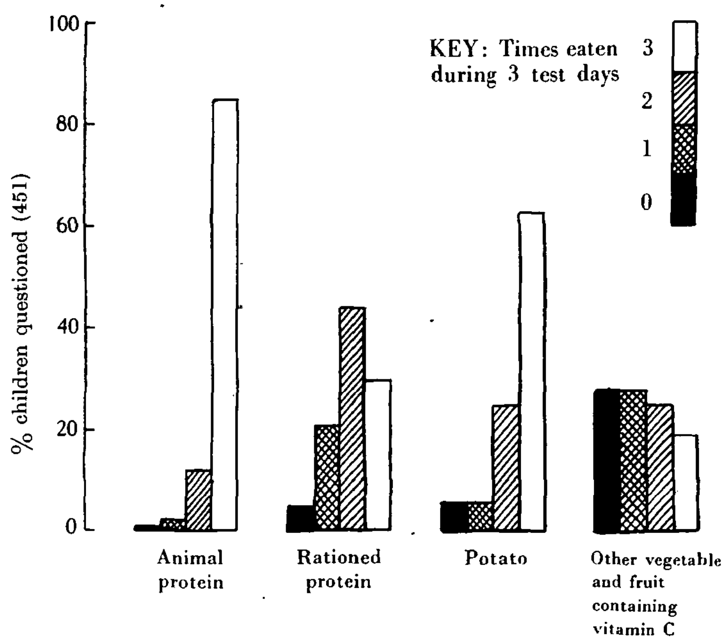

Fig. 3. Food eaten at home dinners.

https://doi.org/10.1017/S0022172400019173 Published online by Cambridge University Press

shown in Table 4. The vitamin C content of the dinners must have varied considerably. Whilst home-cooked vegetables should contain a higher proportion of vitamin than those served in canteens, owing to the shorter time required for preparation, cooking and serving, only 62 % of the children ate potato on every test day and only 45 % of all meals recorded included a second vegetable.

Table 4. *Type of animal protein eaten in home dinners, expressed as a percentage of total meals recorded*

Rationed meat	38	Sausage	15
Rationed tinned meat	8	Fish	10
Bacon and ham	8	Offal	8
Egg	10	Rabbit	2
Cheese	1		

CONCLUSIONS

It has been stated that the school meal should aim to provide one-third of the child's energy intake and two-thirds of his requirements of protein and protective foods. This assumes that his home meals can be expected to provide an ample supply of energy from the more easily obtained foods but only one-third of the necessary protein, vitamin and mineral elements of his diet. Our results emphasize that, for the majority of children examined, this is an under- rather than an over-estimate of the value of the home meals. The economic level of the families from which the children came was varied, but, judging from their general appearance, none came from homes at very low income levels. The inadequacies of their diets were more probably due to difficulties of supply and to their mothers' lack of knowledge.

Until there is more definite information concerning the optimum level of intake for children for the protein and protective foods it cannot be decided whether the school meals do, in fact, or can be expected to, make good these deficiencies in home food. We think it would be difficult to increase materially the protein or calorie value of the school meals on the present rationing levels and at an average cost of 5*d*. per meal for food. Apart from an increase in the fat ration, the most satisfactory method of increasing the energy value would be to serve bread or rusks, which would be inexpensive and would not materially increase the size of the already bulky war-time meal, but this must await the raising of the ban on consumption of bread at communal meals. The canteens we visited were using their full allowance of all rationed foods except for dried egg and dried milk. Caterers should do their utmost to take up their full rations, but cost is a deterrent in using all the egg, and it is not easy to work all the dried milk into the meal. For example, mashing it into potato is an excellent way of introducing milk powder but still further depletes the already low level of vitamin C. Were adequate supplies available and cost no consideration, most caterers would spend more points on tinned meat and increase their consumption of fresh fish, so that the meat ration could be condensed into 3 days instead of 4 and the protein intake increased.

We believe that the canteens visited were a representative sample of those serving S.C.C. schools, and that our results show that, except for vitamin C and calcium content, the meals achieve the standards set by the Board of Education.

It is a pleasure to record our thanks to all those whose co-operation has made this survey possible, we especially thank the Education Committee of the Surrey County Council, the Staffs of all the schools visited and Miss Pantin of the Leatherhead W.V.S.

REFERENCE

SOBEL, A. E. & SKLERSKY, S. (1938). *J. Biol. Chem.* **122**, 665.

(*MS. received for publication* 6. VI. 1945.—Ed.)