TWENTY-SEVENTH SCIENTIFIC MEETING—THIRTEENTH SCOTTISH MEETING

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LOSSES OF NUTRIENTS IN THE PREPARATION OF FOODSTUFFS

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Some Aspects of the Waste Problem: Cooking and Plate Waste

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Waste, as understood in this paper, covers inedible material such as bone, and edible material lost in cooking or discarded in the preparation of food, and plate waste. Some of the data have already been published (Andross, 1939, 1940, 1941); some are now presented for the first time.

Waste in the Preparation of Egg Dishes

Shelling. When a raw egg is removed from the shell a small amount of edible white is left. This averages about 1·5 per cent. of the edible matter.

Hard Boiled Egg. Hard boiled eggs are sometimes difficult to peel and the loss of white sticking to the shell may be as high as 15 per cent.

Poached Egg. The loss in poaching eggs is by powdering and solution in the water. Powdering loss averages about 10 per cent. of the protein and loss by solution, about 5 per cent. The loss by powdering may be reduced by adding sufficient salt, and stirring the water causes the outer layer of white to wind round the inner layers and so reduces waste. The best medium for poaching eggs is 500 ml. water, 10 ml. vinegar and 5 g. salt. Excess of vinegar causes the inner white to pucker. Soft water gives an egg of attractive appearance but powdering loss is high. The loss from preserved eggs is higher than from fresh.

Scrambled Egg. In order to reduce waste in scrambling eggs, the aim is to increase the temperature interval between setting and curdling. Curdling always means high plate waste. The addition of 20 ml. milk per egg gives an interval of 10° C. between coagulation and curdling. Coagulation occurs between 65° and 75° C.

Fried Egg. The main difficulty in frying eggs is the control of the temperature of the fat. The correct temperature is 126° C. but that is difficult to maintain without a thermostatically controlled pan. The temperature of "smoking fat", 235° C., is too high. At this temperature the white rises in bubbles and the outside layers are charred. The bubbles contain fat which may raise the fat content of the egg to 20 per cent. and as much as 20 per cent. of the protein may be so denatured as to be indigestible.

Omelettes. For cooking omelettes the pan should be smooth and "seasoned" so as to prevent sticking. During the cooking water is evaporated and, to prevent toughness, water, not milk, should be added, 10 ml. per egg.

The losses of protein in the cooking of eggs are summarized in Table 1.

TABLE 1

PERCENTAGE LOSS OF PROTEIN IN THE COOKING OF EGGS

Method of cooking	Shell	Pan	Bowl	Spoon	Charred residue	Total
Scrambled	1·5	6·5	1·5	3·6	—	13·1
Fried at 126° C. ..	1·5	—	—	—	—	1·5
Fried at 235° C. (smoking)	1·5	—	—	—	7·4	8·9
Omelette	1·5	—	1·5	—	—	3·0
Poached { on pan .. / in water .. }	1·5	{ 2·6 solid residue / 3·5 suspension }				{ 7·6

Custards and Custard Puddings. These stick to the pan in which they are cooked, even if the pan is wetted with either water or milk. Continuous stirring reduces the amount of dehydrated matter adhering to the bottom. On the average the percentage waste is as follows: total solids 10·0, protein 8·3, carbohydrate 10·3 and fat 3·0. Thus custards are almost as wasteful as scrambled egg and even the steam heated boilers used in big canteens do not greatly reduce the waste. Slow heating, where no flour is added, increases the temperature margin of safety and helps to avoid curdling.

Dried egg, properly reconstituted, gives similar results, but careless blending increases the loss through splashing and imperfect mixing.

Waste in Boiling Milk

In boiling milk, loss occurs as curd and skin. The curd sticks to the pan, and possibly 80 per cent. of consumers remove the skin. The loss in boiling milk is often overlooked because of the simultaneous loss of water which amounts to 75 ml. per pint. If boiled milk be diluted to the original volume, the following percentage losses are found: total solids 13·3, ash 5·7, Ca 13·7, P 5·4, protein 13·5, fat 23·5, lactose 1·9, albumin 74·1 and vitamin C 90. Removal of the curd from the pan and conservation of the skin reduces the losses but there is still some loss. For instance, the loss of protein is still 6·3 per cent., suggesting that volatile nitrogenous substances may be lost in boiling.

Most of the albumin of milk is lost in boiling. This is unfortunate since human milk has a higher albumin content than cow's milk and the child presumably needs this protein.

The fat of the skin of boiled milk has a lower melting point and a higher iodine value than butter fat, and the cream line of boiled milk is only half that of raw. Presumably some fat is held in cells in milk and it is the cells which disintegrate, liberating the fat, and sinking to coagulate on the bottom of the pan.

In general it would probably be safe to say that there is a loss of 10 per cent. of the nutrients in boiling milk.

Cooking and Table Waste of Fish

Boiling. Boiled fish may lose as much as 14 per cent. of its protein by leaching and powdering off. This is a wasteful method of cooking unless a sauce or soup is made with the water. The fish should be put to boil in boiling water but the powdering loss may be increased to 50 per cent. of the protein if the water boils violently. If the quantity of water is too small for quick coagulation of protein or the heating to boiling too slow, the losses by leaching are increased. The addition of vinegar or lemon juice to the water helps to coagulate the protein.

Frying. Deep frying is the least wasteful method of cooking fish. White fish fried in this way loses little but water, and the fat content is low. The temperature must not be too high or the covering (oatmeal, batter, egg and bread crumb) will char before the fish is cooked. Shallow frying is bad practice since the fish tends to crumble and the loss of protein may be as high as 40 per cent. with fish such as whiting and haddock.

Oily fish are different; they lose fat, especially herring. The fat of herring is just under the skin and 50 per cent. may be lost in cooking. Herring should therefore be cooked in its own fat. Salmon loses 10 per cent. of its fat in boiling.

The losses in plate waste of some of the common fish are shown in Table 2.

TABLE 2

PLATE WASTE IN FISH

Kind of fish	Method of cooking	Weight after cooking g.	Weight of edible part g.	Waste per cent.	Waste in bone g.	Waste in fat g.	Waste in skin g.
Lemon sole, Faroe, whole	Deep fried	306	180	41·2	30	—	96
Plaice, whole	Baked	400	160	60·0	80	—	160
Haddock, whole ..	Deep fried	270	130	51·8	110	—	30
Whiting, whole ..	Steamed	432	170	60·6	202	—	60
Cod, slice	,,	260	220	19·2	24	—	16
Herring, whole ..	Grilled	94	55	36·2	34	5	—
Salmon, tail	Boiled	440	285	35·2	40	5	110

Herring skin is very thin and has been taken as edible.

It seems a pity that more fish is not supplied filleted. The bones and skin could then be used to make fishmeal and manure and the gross waste reduced.

Cooking and Table Waste of Meat

In the study of meat waste, in home produced and imported meats, different cuts of each and different methods of cooking were compared.

The cooking methods were standardized so that all samples were cooked until the inside temperature was 77° C. Standardized ovens were used with a higher temperature (setting 14) for sealing and a lower (setting 7) for cooking.

The study of plate waste showed that few people consume their meat fat, and some eat only about a third of a meat helping. This shows the futility of assessing individual food intake from the amounts served.

Mutton. The data for mutton are shown in Table 3.

TABLE 3

COOKING LOSSES AND PLATE WASTE IN MUTTON

Cut	Origin	Method of cooking	Weight		Loss of weight per cent.	Weight eaten g.	Waste as percentage of cooked weight	Nature of waste		
			Raw g.	Cooked g.				Bone g.	Fat g.	Skin g.
Loin chop	British	Grilled	157·5	120·5	23·5	86·8	28·0	15·0	15·0	3·7
	New Zealand	,,	140·0	122·0	12·9	68·0	44·3	15·0	31·5	7·5
Gigot chop	British	,,	150·0	90·0	40·0	49·0	45·5	7·5	30·0	3·5
	New Zealand	,,	150·0	90·0	40·0	54·5	39·4	10·0	22·5	3·0
Leg roast	British	Roasted	3330·0	2460·0	26·1	2063·0	16·1	255·0	75·0	67·0
	New Zealand	,,	2580·0	2020·0	21·8	1120·0	44·5	390·0	120·0	390·0
Loin roast	British	,,	1095·0	693·0	36·7	408·0	41·1	109·0	102·0	74·0
	New Zealand	,,	990·0	688·0	30·5	304·0	55·8	94·0	226·0	64·0
Neck	British	Stewed	485·0	421·0	13·2	263·0	37·5	112·0	36·0	10·0
	New Zealand	,,	580·0	477·0	17·8	301·0	36·9	84·0	30·0	62·0

The average loss of weight in cooking was greater for home produced (27·9 per cent.) than for New Zealand (24·6 per cent.) mutton. This might be because the melting point of home mutton fat is 35° C. as against 38° C. for New Zealand mutton. Analysis of the raw and cooked products showed that home mutton lost on the average 45·3 per cent. of its moisture, 54·2 per cent. of its fat and 10·5 per cent. of its protein. The corresponding losses for New Zealand mutton were 63·2, 40·2 and 4·6 per cent. The greater loss of moisture from New Zealand mutton means a drier meat with less flavour. The protein and fat lost in cooking should not be real waste, because the fat should be saved and used, and the protein made into gravy.

The average plate waste for home mutton was 33·6 per cent. of cooked weight and for New Zealand mutton 44·2 per cent., the losses of skin, fat and bone amounting to 3·03, 4·94 and 9·55 per cent., respectively, of meat as bought for British mutton, and 11·86, 9·68 and 13·36 per cent. for New Zealand mutton.

Analysis of the edible portion gave the following results as percentages of edible cooked weight: water 45·8, protein 31·6, fat 21·4, ash 1·6 for home mutton, and water 44·8, protein 25·5, fat 28·0 and ash 1·0 for New Zealand mutton. No protein is lost in drip from home produced mutton and the meat is juicier.

Beef. The data for beef are shown in Table 4.

The average losses of weight in cooking were 22·8 per cent. for British and 26·6 per cent. for Argentine beef. The difference is negligible. It was found that the protein waste in cooking imported beef was very low, giving a thin flavourless gravy which increases plate waste. The melting point of British beef fat is lower than that of Argentine beef fat. This gives greater fat loss in cooking and less fat waste on plates. The cooking fat can be used; plate fat usually cannot. Water does not dry off home meat to the same extent as off imported. This suggests that the water is held in a different way in the home fed meat. Imported meat sometimes shrinks very badly and the meat seems drier after cooking.

TABLE 4

Cooking Losses and Plate Waste in Beef

Cut	Origin	Method of cooking	Weight		Loss of weight per cent.	Weight eaten g.	Waste as percentage of cooked weight	Nature of waste		
			Raw g.	Cooked g.				Bone g.	Fat g.	Skin g.
Fillet	British	Grilled	573	494	13·8	390	21·1	—	82	22
	Argentine	,,	2220	1577	29·0	1172	25·7	—	180	225
	Australian	,,	1020	650	36·3	490	24·6	—	—	160
Sirloin	British	Roasted	2400	1680	30·0	1050	37·5	330	120	180
	Argentine	,,	2430	1613	33·6	843	47·7	400	170	200
Rolled roast	British	Roasted (pot)	1020	960	5·9	661	31·1	—	171	128
	Argentine	,,	840	523	37·7	347	33·7	—	96	80
	British	Roasted	1245	675	45·8	453	32·9	—	64	158
	Argentine	,,	1275	759	40·5	416	45·2	—	192	151
Rib roast	British	Roasted (pot)	1605	1065	33·4	595	44·1	200	200	70
	Argentine	,,	2115	1755	17·0	705	59·8	360	480	210
	British	Roasted	1410	930	34·0	493	47·0	220	167	50
	Argentine	,,	1260	930	26·2	210	77·4	240	360	120
Shoulder steak	British	Stewed	540	480	11·1	367	23·4	—	98	15
	Argentine	,,	480	430	10·4	228	47·0	—	172	30
	British	Stewed (cass.)	480	420	12·5	330	21·4	—	75	15
	Argentine	,,	480	390	18·7	225	42·3	—	135	30
	British	Braised	480	390	18·7	330	15·4	—	45	15
	Argentine	,,	480	360	25·0	240	33·3	—	90	30

The average plate waste is less from home than from Argentine beef, 30·4 per cent. of cooked weight for the former and 45·8 for the latter. The loss in bone, fat and skin was 7·7, 10·5 and 6·7 per cent. of raw weight for British, and 8·6, 16·2 and 9·3 per cent. for Argentine, beef.

Imported meat is coarser and probably older. Further, chilling and freezing may be satisfactory for large scale storage but the butcher puts the meat in a refrigerator overnight and the final result is that muscle fibres are ruptured, muscle serum leaks out and valuable protein and much of the flavour is lost.

Analysis of the edible cooked portion gave the following percentage composition: British beef, water 50·3, protein 29·8, fat 21·2, ash 1·6; Argentine beef, water 48·8, protein 25·0, fat 23·6 and ash 1·2. The slightly higher moisture content of the British beef means a juicier meat. Ash as well as protein is lost in the drip from the imported meat; pigment is also lost. A test of consumers' preferences gave 400 votes for flavour to home meat and 60 to imported. Poor colour and lack of flavour increase plate waste.

Saving could be effected if the custom were adopted of removing fat, skin and bone from the plates before serving vegetables. The fat could then be rendered down and the skin and bone used for stocks and gravies.

It is worth while noting that rolled roasts are not too economical. Waste material gets rolled inside. Rib roasts have a high proportion of bone to meat.

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An average allowance of 30 per cent. of fresh weight would cover cooking and plate waste in beef, excluding bone.

Losses in Vegetables

The losses in the preparation of vegetables vary with season and demand. For instance, leeks show less waste in war time because the shortage of onions has increased the demand. Vegetables bought in a wilted condition are wasteful. Wastage of potatoes is high in a year like this when they have been frosted. Other circumstances also affect waste. Since green vegetables have been sold by weight more waste is passed on to the consumer. McCance, Widdowson and Shackleton (1936) give a percentage loss of 25 for Brussels sprouts. In Scotland at present the percentage is nearer 50.

Table 5 gives unpublished records of waste made during four separate years. The vegetables were bought in different types of shop in Glasgow and the west of Scotland.

TABLE 5

WASTE IN PREPARATION OF VEGETABLES AS PERCENTAGE OF PURCHASED WEIGHT

Kind of vegetable	Percentage lost in different years			
	1938	1940	1943	1945
Broad beans	70	68	67	72
Broccoli	50	54	60	58
Brussels sprouts	33	45	50	45
Cabbage	40	41	40	40
Cauliflower	50	36 to 70	80	58
Cress	40	36	30	45
French beans	5	3	6	4
Kale	40	56	43	45
Lettuce	24	25	26	25
Parsley	—	—	—	64
Green peas	65	62	60	64
Spinach	25	35	50	64
Beetroot	40	43	40	50
Carrot	30	32	40	50
Celery	75	50	42	29
Leek	70	75	50	30
Onion	10	17	20	—
Parsnip	40	35	25	35
Potatoes	30	26	23	40
Turnip	50	54	30	37

The cost per lb. of the edible portion of the vegetables is shown in Table 6.

If, as Olliver (1941) has shown, there is a loss of up to 75 per cent. of vitamin C when green vegetables are stored, if half the vegetable is rejected because it is wilted and in cooking 50 per cent. of the remaining vitamin C is leached out and 30 per cent. destroyed, vitamin C becomes an expensive item in the diet if shop bought green vegetables are the only source. Fortunately there are potatoes and occasionally oranges. Table 7 indicates the condition in which green vegetables were bought in different shops.

About half the vegetables were in good condition, the others wilted. These will already have lost most of their vitamin C, and much of their vitamin A, iron and calcium will be discarded in the outer leaves.

TABLE 6

COST PER POUND OF THE EDIBLE PORTION OF VEGETABLES

Kind of vegetable	Cost of edible portion per lb. in different years			
	1938	1940	1943	1945
	s. d.	s. d.	s. d.	s. d.
Broad beans	3 4	3 1½	3 0½	3 4¾
Broccoli	1 0	1 1	1 3¾	1 2¼
Brussels sprouts	0 7½	0 10	0 10½	0 7½
Cabbage	0 6	0 5	0 5	0 7
Cauliflower	1 0	1 4	2 8¼	1 7¾
Cress	3 0	3 6	4 6	4 5
French beans	0 5	0 5	0 9	0 9
Kale	0 6	0 7	0 9	0 9
Lettuce	1 8	3 4	3 6	3 7½
Parsley	—	—	—	4 5¼
Green peas	1 2½	1 2	1 1	2 9¼
Spinach	1 5	—	1 3¾	3 0
Beetroot	0 4	0 4	0 5	1 4
Carrot	0 3¼	0 3½	0 3¼	0 6¼
Celery	2 0	1 0	0 10½	1 0½
Leek	0 5 each	0 6 each	0 10 each	0 10½ each
Onion	0 3¼ "	0 3½ "	0 8 "	— "
Parsnip	0 5	0 4	0 3¾	0 6¼
Potatoes	0 1¼	0 1¼	0 1¼	0 1¼
Turnip	0 3	0 3	0 2¾	0 2¾

Table 8 shows the cost of the standard daily requirements of vitamin C, vitamin A, calcium and iron from vegetables compared with other sources. It is obvious that, apart from the cost, the quantities required of wilted

TABLE 7

CONDITION OF VEGETABLES ON PURCHASE

Type of shop	Spring cabbage	Parsley	Cress	Broccoli	Spinach	Lettuce
Medium grade	Good	Withered	Limp	None	Limp	Good
Suburban	Bruised	Good	None	Withered	None	Limp
Low grade (1)	Good	Faded	"	None	"	Withered
" " (2)	"	Good	"	"	"	Good
City	Fair	Fair	Very good	Good	"	"
Top grade city	Good	Very good	Fair	Fair	Good	Very good
Suburban (1)	"	Poor	Good	Good	Poor	Good
" (2)	Withered	Withered	Withered	Withered	Fair	None

green vegetables could not be eaten and that green vegetables are clearly much too bulky to serve as the main sources of calcium and iron.

These results, showing the great losses of essential food constituents which occur under the present system of distribution, point clearly to

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the need for improvement in the method of supply. Vegetables should be procurable fresh from market gardens close to consumption centres. This should be treated as essential in town planning. Each district, school and hospital should have its own market garden.

TABLE 8

COST OF DAILY STANDARD REQUIREMENT OF 30 mg. OF VITAMIN C, 3000 I.U. OF VITAMIN A, 0·67 g. OF CALCIUM AND 15 mg. OF IRON DERIVED FROM FRESH AND WILTED GREEN VEGETABLES COMPARED WITH THAT FROM OTHER SOURCES

Source	Vitamin C 30 mg.		Vitamin A 3000 I.U.		Ca 0·67 g.		Fe 15 mg.	
	Amount required oz.	Cost d.	Amount required oz.	Cost d.	Amount required lb.	Cost s. d.	Amount required lb.	Cost s. d.
Spring cabbage, fresh	5	2¼	37	12	3	1 3	5	2 4
Spring cabbage, wilted (2 days old)	17	7½	60	20	4½	2 0	9	4 0
Spinach, fresh ..	8	6	3	2½	2¼	2 6	1¼	1 3
Spinach, wilted (2 days old) ..	30	24	8	6	7	7 0	4	4 0
Cauliflower, fresh	5	2½	—	—	1½	1 1½	1½	1 1½
Cauliflower, wilted (2 days old) ..	24	16	—	—	4	3 0	4½	3 6
Lettuce, fresh ..	10	20	10	20	6	16 0	1½	4 0
Lettuce, wilted (2 days old) ..	30	60	12½	25	8	21 4	2	5 4
Carrot	—	—	3	½	—	—	—	—
Orange	2	1	—	—	—	—	—	—
Turnip, boiled ..	4	¾	—	—	—	—	—	—
Potato ,, ..	15	4/5	—	—	—	—	5	0 5
Egg	—	—	7	8	—	—	10 eggs	2 1
Milk	—	—	—	—	1 pint	0 4½	—	—
Bread, National ..	—	—	—	—	2	0 4½	1 5/16	0 3

Plate Waste in Canteens

An attempt was made to estimate the plate waste of protein, carbohydrate and fat in canteens.

Schools. Nine schools were chosen at random out of a group supplied from one kitchen where the food was known to be well cooked. The waste from each school was mixed, weighed and sampled for analysis. Samples were taken on four successive days when different meals were served. The schools included town schools, schools in mining areas and country schools. There was no significant difference between schools in the composition of the waste. One school, in a mining area, had no waste on any of the days. The results are shown in Table 9.

These results were compared with analyses of plate waste from lunches in 60 households of different classes, for which the averages were protein 1·1, fat 2·0 and carbohydrate 1·9 per cent. Plate waste is less in the home, probably because of insistence that the food is eaten, consideration for the cook's feelings and consideration of the tastes of the family. This does not imply that the food is better or of greater nutritive value.

Observations of the same kind were made in the Domestic Science College where lunch is served to all students and in a Government canteen where the College lunch is served. The results are shown in Table 10.

TABLE 9

COMPOSITION OF PLATE WASTE FROM SCHOOL MEALS: PERCENTAGE OF AMOUNT SERVED

School	Type of community	Number of meals	Percentage wasted of amount served		
			Protein	Fat	Carbohydrate
A	Town	120	3·3	3·3	2·5
B	,,	127	5·3	6·9	0·5
C	Mining	95	12·3	5·3	0·5
D	Town	103	7·8	5·0	0·2
E	Country	53	10·8	11·5	7·5
F	Town	140	5·1	5·1	0·5
G	Mining	77	8·0	7·2	0·2
H	Small country	28	9·2	5·6	0·7
I	,, ,,	33	6·8	12·5	0·2
		Average	7·6	6·9	1·4

This shows the effect of different tastes. Women eat less fat than men and are, like children, fonder of carbohydrate foods. Sweets and puddings are well consumed.

Railway Station Forces Canteen. The plate waste in a forces canteen, as a percentage of each food served, was as follows: stew 10, sausages 6, beans (small white variety but soft) 30, rolls 6, buns 0, cakes 0, biscuits 5, cheese 3, potatoes 4, sandwiches 2, milk 12.

TABLE 10

COMPOSITION OF PLATE WASTE FROM A COLLEGE LUNCH IN COLLEGE AND IN A GOVERNMENT CANTEEN AS PERCENTAGE OF AMOUNT SERVED

Place and meal	Number of meals	Percentage of amount served wasted on plate		
		Protein	Fat	Carbohydrate
College, early lunch	102	10·7	10·2	0·9
,, late ,,	280	11·0	4·5	2·2
Canteen lunch ..	35	6·5	3·2	11·4

The beans were obviously not worth serving. The men do not like beans unless they are served with tomato sauce. The milk loss is surprisingly high and arises from wastage of coffee when men have no time to finish it between trains. The waste of rolls and sausage is lower in the mobile canteen because, although men will leave food on plates, they will not throw it on a station platform.

A peculiar deposit of waste, 2 lb. of fat, was found in the steam trap of a canteen. This loss of fat by steam distillation may account for the lack of flavour of food cooked in steam ovens.

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Summary and Conclusions

The losses of nutrients in the cooking and plate waste of milk, eggs, fish and meat and the losses in the storage and preparation of vegetables have been studied. Records are presented also of waste in school and other canteens.

The waste in boiling milk is about 10 per cent. Scrambling is the most wasteful method of cooking eggs. Thermostatically controlled pans would reduce the waste in cooking eggs.

The filleting of fish in shops would ensure more economic use of the whole fish.

Plate waste of meat may be as high as 30 per cent. of cooked meat. Fat should be removed from plates before vegetables are served, or it should not be served. Imported meat has a higher plate waste than home fed.

Plate waste in school canteens includes 7 per cent. of the protein and 7 per cent. of the fat served. In a college canteen the waste of protein was 11 per cent. and of fat 5 to 10 per cent. In a Government canteen 6 per cent. of protein and 3 per cent. of fat served were wasted.

The wastage of vegetables is greatly increased by wilting in storage. Marketing methods are in great need of improvement. Some system of local market gardens should be adopted so that consumers in large towns could buy their vegetables fresh. Schools and institutions should have their own gardens.

I would like to thank the School Feeding Department, Ayr, for permission to do this work, the Institutional Department in College and my own students in College for their assistance.

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Loss of Nutrients in Cooking

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Introduction

Scattered through the literature are many papers dealing with the losses suffered by foodstuffs during cooking. Most of these deal with the more readily estimated of the inorganic constituents and vitamins, some by analysis of one or two substances in a variety of foods, others by detailed study of one or two closely related foods. It is difficult to find, or to build up, any general view of the subject, partly because of the very great differences in chemical and anatomical structure between the various classes of foodstuffs, partly because the substances which are, or may be, lost are of such varying chemical nature, partly because of the variety of cooking methods which involve differing physico-chemical processes, partly because cooking losses may be qualitative as well as