

A PRACTICAL DIETARY REGIME FOR DECREASING THE SERUM-CHOLESTEROL LEVEL

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A close association has been shown to exist between the serum cholesterol and the development of atherosclerosis and coronary heart disease,¹⁻⁴ and it has been demonstrated that the serum-cholesterol level can readily be lowered by dietary means.⁵⁻⁷ These observations have led to the hope that the use of an appropriate diet will provide a practical method for inhibiting the development of coronary heart disease. In man, the benefit of a cholesterol-decreasing regime in relation to this disease has not yet been established. In fact, the natural history of coronary heart disease is so variable that it is unlikely that the influence of any prophylactic or therapeutic procedure can be assessed in less than 10 years of carefully controlled clinical study. Hence there is at present no indication for introducing major changes in the eating habits of the community as a whole. Nevertheless the practitioner may be confronted with certain special cases in which he may not feel content to adopt a 'wait and see' attitude to the question of decreasing the serum-cholesterol level. This sort of problem has often been presented to us and is illustrated by the following case histories:

Case 1

European male aged 40 years, a shopkeeper. He stated that for the past 6 months, whenever he was engaged in strenuous activity such as fixing his motor engine or hurrying up a hill, particularly after meals, he experienced a tight, burning pain in the middle of his left chest accompanied by a sensation of numbness in his left arm. These symptoms were promptly relieved by rest. He

had no other complaints. There was no family history of cardiovascular disease or of diabetes mellitus. Examination showed him to be a heavily built, thick-necked male with a slight tendency to obesity (height 5 feet 9 inches; weight 210 lb.). There was no evidence of xanthomatosis but there was a marked arcus cornealis. No evidence of organic disease was detected clinically. An electrocardiogram taken at rest showed no abnormality, but when it was repeated after effort there were marked changes consistent with myocardial ischaemia. His serum-cholesterol level was 324 mg. per 100 ml. The patient spontaneously informed us that he was a big eater and that he was particularly fond of fatty meat, gravies, eggs, butter and cheese; he then asked us whether he should modify his diet.

Case 2

A European male aged 27 years. This man was a hard-working business executive. He had no symptoms at all. His mother died of a 'coronary thrombosis' at the age of 61; his father died from the complications of a gastric ulcer at the age of 58. He had 3 brothers, one of whom died at the age of 37 of 'coronary thrombosis'; another, aged 43 years, had survived an attack of 'coronary thrombosis'; the third brother, aged 29, was quite well. He also had 3 sisters, one of whom, aged 45 years, had had a 'coronary thrombosis'. There is no family history of diabetes mellitus or of xanthomatosis. He was a thick-set, short-necked healthy-looking young man, 5 feet 9 inches tall and weighing 165 lb. There was no abnormality on clinical examination. His serum-cholesterol level was 304 mg. per 100 ml. He was seeking medical advice on how to ward off the coronary attack which he was sure he was going to get.

In cases such as these, in whom the risk of coronary heart disease is great, we believe that there is justification for

prescribing a cholesterol-decreasing regime. We explain to the patient that the evidence for using this regime is incomplete but that it is recommended in the reasonable anticipation that its theoretical virtues will eventually be confirmed. The indications for this regime are as follows:

1. Patients with clinical evidence of coronary heart disease who have serum-cholesterol levels above 275 mg. per 100 ml.
2. Individuals with a strong family history of coronary heart disease and with serum-cholesterol levels above 275 mg. per 100 ml.
3. Cases of essential (familial or idiopathic) hypercholesterolaemia.
4. Patients with intractable angina pectoris or cardiac failure in whom artificial myxoedema is induced.
5. Cases of diabetes mellitus with hypercholesterolaemia, which does not respond to the conventional management of the underlying disease.

The figure of 275 mg. per 100 ml. as the 'upper limit of safety' has been arrived at somewhat arbitrarily and may require revision in the light of future experience. It is based on the mean level of the serum cholesterol in cases of coronary heart disease as recorded in several large surveys,⁸⁻¹¹ and in our own studies. It should be recalled that the serum-cholesterol level is liable to considerable fluctuation in active men on ordinary diets, and that serial estimations are necessary in order to determine an individual's 'characteristic' level and his response to a therapeutic programme.⁷

A number of different dietary regimes have been found to lower the serum-cholesterol level. Originally a reduction of the total fat intake was recommended,¹² but to achieve an adequate response very strict fat restriction must be enforced,⁷ which will be irksome for the patient, difficult to maintain, and liable to produce unpleasant side-effects.^{1, 13} Next, it was shown that formula-type diets in which all the fats were highly unsaturated effectively decreased the serum-cholesterol level;^{14, 15} such diets, however, are highly artificial and cannot be adapted for ordinary domestic use. Recently it has been shown⁷ that the serum-cholesterol level may satisfactorily be decreased by supplementing ordinary diets with about 50 g. of a highly unsaturated fat daily. The use of this procedure in practice is limited by the fact that the consumption of about 4 tablespoons of oil daily is not pleasant and may lead to an undesirable gain in weight; it should, therefore, be reserved for experimental purposes only.

We believe that the type of diet which will prove to be most satisfactory for general use is one in which saturated fats are moderately restricted and partly replaced by unsaturated fats. It combines the virtues of the 3 experimental regimes just mentioned and has the particular advantage of being readily adaptable to conventional domestic practice; and it can easily be adapted to achieve simultaneous weight reduction if this is desired. The purpose of this communication is to describe the constitution of such diet. Firstly, common South African foodstuffs are listed in relation to the quality and quantity of fat which they contain. Secondly, a series of sample menus is presented to illustrate the principles of this regime and to give some idea of the variety of dishes which it includes; these menus are not meant to be a prescribed programme for the patient to follow sedulously.

We should like to record that it was only after careful consideration and much hesitation that we decided to publish the details of this regime. On the one hand, we wished to meet the many requests from our colleagues for guidance in the

planning of cholesterol-decreasing diets. On the other hand, we did not want to produce an unhealthy preoccupation with dietary details in our coronary patients or to sponsor a new type of food faddism. Having decided to publish these recommendations, we trust that they will be applied only under medical supervision and in properly selected cases. We are particularly anxious that they shall not be misinterpreted by the lay public and used to gratify the desires of dietary cranks.

In the following statement foodstuffs are classified according to their fat content:

Foods Rich in Saturated Fats

(a) *Dairy Products.* Eggs, butter, milk, cream, ice cream and cheese should be avoided as far as possible. It must be noted that many cakes, puddings and similar dishes contain large amounts of these foodstuffs and should be eaten sparingly. Skimmed milk and skimmed-milk cheese may be eaten freely. Egg white is free from fat and may be used in puddings, meringues, marzipan, nougat, etc.

(b) *Meats:*

(i) Bacon, ham, pork, mutton, lamb and tongue are particularly rich in saturated fat and they are best avoided.

(ii) Lean cuts of beef, young poultry and veal contain less fat and, provided that the visible fat is trimmed away and no fat is added in their cooking, they may be eaten in moderation.

(iii) Breast of chicken, liver, kidneys and tripe contain little fat and may be eaten *ad libitum*.

(c) *Cooking Fats.* Lard and dripping should not be used. Margarines, shortenings and other solid cooking fats vary in their degree of saturation; whenever possible they should be replaced by natural cooking oils.

(d) *Pastry.* Commercial pastry is usually made with saturated fat and is best avoided. With the exception, however, of the 'flaky' variety, most pastries can be made with unsaturated fats (oils), and home-made products of this sort may be eaten freely.

(e) *Chocolates.* These contain butter, egg, cocoa butter, etc. and should only be eaten on special occasions.

Foods Rich in Unsaturated Fats

(a) *Vegetable Products*

(i) *Cooking and salad oils.* Sunflower-seed oil and maize oil are the most highly unsaturated vegetable oils available in South Africa. They may be used freely in frying and roasting, in making pastry, and as salad dressings. Refined sunflower-seed oil is palatable and odourless and can be used with confidence by the most fastidious cook. Olive oil and peanut oil are less effective than sunflower-seed oil and maize oil in lowering the serum-cholesterol level.

(ii) *Vegetables.* Avocado pears and olives are rich in unsaturated fats and may be eaten freely.

(iii) *Nuts.* With the exception of coconuts and cocoa beans, nuts are generally rich in unsaturated fats and need not be restricted. Note that most brands of peanut butter are made from crushed peanuts and are not artificially saturated fats; they may be consumed freely.

(iv) *Cereals.* Whole-grain cereals (including whole-wheat bread, Provita, etc.) are rich in unsaturated fats and are recommended.

(b) *Marine Products*

Marine animal fats in their natural form are all highly unsaturated and may be eaten in liberal quantities. Sardines, herring, pilchards, kippers, snoek and salmon contain the most fat; most other fish are largely free from fat.

Foods Largely Free from Fat

Apart from those already noted, the following foodstuffs contain very little fat of any sort:

- (a) Fruit of all kinds: fresh, stewed or preserved.
- (b) Vegetables, except olives and avocado pears.
- (c) Gelatin desserts, fruit jellies, etc.
- (d) Macaroni and similar products not made with egg.
- (e) Rice.
- (f) Sweets—but not toffees or chocolates.

(g) Fruit and alcoholic beverages; synthetic or naturally flavoured mineral waters.

SAMPLE MENUS

A daily schedule of sample menus for a week's meals is set out in Table I. A number of recipes are shown in the Appendix at the end of this article.

showed that it was not the cholesterol content of these eggs which raised the serum-cholesterol level and it was demonstrated that when the eggs were fried in sunflower-seed oil their increasing effect on the serum-cholesterol level was abolished.¹⁸

This experiment has been quoted to illustrate a major

TABLE I. SAMPLE MENUS (excluding beverages)

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Breakfast	Corn flakes	Tomato juice	Grape fruit	Melon	Cereal	Stewed fruit	Fruit juice
	Fried kipper	Sweet corn	Sardines on toast	Porridge (with skim milk)	Fried bread	Pilchards with tomato sauce	Baked beans
Tea	Cucumber, tomato and lettuce sandwich	Anchovy toast	Date sandwich	Snoek sandwich	Ryvita with spiced skim-milk cheese	Peanut-butter sandwich	Sardine and tomato sandwich
Lunch	Cold consommé	Avocado pear	Fried fish with chip potatoes and green salad	Devilleed grilled kidneys	Pickled fish with chutney	Fried liver and onions	Tinned salmon
	Chicken casserole with mushrooms and rice	Macaroni with skim-milk cheese	Apple snow*	Potato salad*	Frozen fruit ice	Coleslaw	Mealie 'on the cob'
	Cranberry sherbert*	Fruit salad		Fresh fruit		Fruit jelly	Watermelon konfyt
Tea	Angel food cake*	Water biscuit with marmite	Skim-milk-cheese cake*	Date sandwich cake*	Ginger-nut biscuits	Bread and jam	Cornflake macaroon*
Evening Meal	Pea soup	Chicken soup	Asparagus soup	Vegetable soup	Mushroom soup	Mulligatawny soup	Sea-food hors d'oeuvres with olives
	Crayfish mayonnaise	Sweet potato	Fried veal and rice	Grilled sole	Asparagus	Fried mushrooms	Grilled steak, peas and cauliflower
	Baked apple	Tripe and onions	Pineapple fritters	French salad	Baked herring	Fish cakes with mashed potatoes	
		Orange ice		Marshmallow Ice cream*	Meringue with mock cream*	Fruit tapioca pudding	Strawberries with castor-sugar or marsala

* See recipe in appendix

DISCUSSION

The dietary programme which has been described includes a wide variety of foods and should be acceptable to nutritionists, dietitians and patients. The sample menus by no means exhaust the gastronomic potential of this regime and, within the prescribed limits, an enthusiastic housewife should be able to plan many satisfying meals for her hypercholesterolaemic spouse; with a little ingenuity she should, on occasion, be able to produce elaborate repasts which will gratify the wishes of the most fastidious.

The growing interest of food technologists can be expected materially to facilitate the preparation of cholesterol-decreasing diets.¹⁶ Already in Sweden Malmros *et al.*⁶ have reported the successful use of diets containing ice cream and cheese made from milk in which the butter fat has been replaced by corn oil. With the help of South African manufacturers we are exploring the possibility of modifying standard hydrogenation processes in order to develop margarines and shortenings with increased amounts of unsaturated fats. In the field of animal husbandry there is also considerable scope for research of this sort; it is well known that the degree of saturation of body fats of animals is partly determined by the degree of saturation of their diet fats and, by modifying the diet of ruminants and poultry, it may be possible to some extent to 'unsaturate' their body fat.¹⁷ We have attempted a pilot experiment of this sort, in which we fed hens with a diet rich in sunflower seeds; in this way we were able to 'unsaturate' their egg-yolk lipids from 72 to 100. When these 'unsaturated' eggs were fed to 2 human volunteers, however, we were unable to detect any difference in their action on the serum-cholesterol level. Further investigation

problem in connection with the dietary regulation of the serum-cholesterol level: what characteristic of a dietary fat determines its effect on the serum-cholesterol level? It was first thought that 'vegetable fats' as a class lowered the serum-cholesterol level whereas 'animal fats' increased it, but this was quickly disproved when it was shown that coconut oil and hydrogenated vegetable oils increased the serum-cholesterol level while marine animal fats decreased it.¹⁹ Ahrens *et al.*¹⁵ have suggested that the degree of saturation of a fat (as measured by its iodine value) is responsible for its effect on the serum-cholesterol level; the more unsaturated the fat, the greater is the reduction in the serum-cholesterol level which it produces, while the more saturated the fat, the greater is its increasing effect on the serum-cholesterol level. Our own observations in the above experiments with hens' eggs and in several other feeding trials have failed to confirm that there is a direct linear relationship between degree of saturation and effect on the serum-cholesterol level.²⁰ Keys *et al.*²¹ also do not accept the 'degree of saturation' theory and they have suggested that gram for gram, the increasing effect of saturated fatty acids on the serum-cholesterol level is twice as powerful as the decreasing effect of the polyunsaturated fatty acids. In terms of this theory, 2 g. of linoleic acid are required to 'neutralize' 1 g. of saturated fatty acid; but in some of our experiments²² we have shown that 100 g. of sunflower-seed oil containing only 65 g. of linoleic acid completely neutralizes the cholesterol-increasing effect of 100 g. of hydrogenated coconut fat, almost all of which consists of saturated fatty acids.

Next there is the theory of Sinclair²³ and Kinsell *et al.*,²⁴ who believe that the cholesterol-decreasing effect of

unsaturated fats is due to their content of a few 'essential fatty acids' of precise physico-chemical structure, particularly linoleic acid and arachidonic acid. Kinsell *et al.*²⁴ have shown that linoleic acid in doses of at least 40 g. daily does lower the serum-cholesterol level and they cite this as evidence in favour of the 'essential fatty acid' theory. They have not, however, investigated the effect of the 'non-essential' geometrical and linear isomers of linoleic acid; until this is done, the specific importance of natural linoleic acid will remain unproven.

The chain length of its component fatty acids must also be taken into account when considering the effect of a dietary fat on the serum-cholesterol level. Thus Ahrens *et al.*¹⁵ have reported that butter, which is rich in short-chain saturated fatty acids, will increase the serum-cholesterol level more than cocoa butter, which has a similar degree of saturation but fewer short-chain fatty acids. It is unlikely, however, that chain length is important with respect to decreasing the serum-cholesterol level; short-chain polyunsaturated fatty acids do not occur in nature.

Finally, reference must be made to the work of Beveridge *et al.*²⁵ who hold that at least part of the cholesterol-decreasing effect of corn oil is due to a factor in its unsaponifiable (non-fatty acid) fraction, probably beta-sitosterol. They base their conclusions on the results of a large number of short, highly artificial feeding trials and their results are at variance with those of Ahrens *et al.*¹⁵ who found that removing most of the unsaponifiable fraction from corn oil did not interfere with the cholesterol-decreasing action of the latter. They are also at variance with our observations in 3 patients in none of whom could be cholesterol-decreasing effect of pilchard oil or sunflower-seed oil be reproduced by feeding with only the unsaponifiable fraction of these fats.

It is clear, therefore, that much investigation is still required before a directive can be given to food technologists about which factors to include or exclude from their products. The prospects are still remote of finding a cholesterol-decreasing 'philosopher's stone' of which a tiny dose will be effective without dietary restriction. In the present state of knowledge we believe that the dietary regime which has been outlined above is the most convenient way of lowering the serum-cholesterol level. It is anticipated that the effects of this diet will develop slowly, and the sharp falls in the serum-cholesterol level which occur in acute feeding experiments should not be expected. The practitioner and his patient will need to exercise considerable patience and perseverance, but we must repeat the warnings which we have given before.²⁶ The patient must not be allowed to become obsessed with attention to meticulous dietary details not to inflict his dietary conventions on his family or friends. He should be protected from developing a morbid interest in his serum-cholesterol level, and his enthusiasm for unsaturated fats should not allow him to indulge in them to the extent of producing obesity. Only in cases of marked hypercholesterolaemia in whom an adequate fall in the serum-cholesterol level is not produced by prolonged adherence to this diet is it necessary to prescribe daily draughts of highly unsaturated oils. It should be noted that none of the presently available commercial preparations of 'linoleic acid' is as concentrated as natural sunflower-seed oil or corn oil and an effective dose of these preparations is liable to present a considerable and expensive caloric supplement to the daily diet.

SUMMARY

1. Some tentative indications for the use of cholesterol-decreasing diets are presented; these particularly concern persons at risk of developing coronary heart disease in whom the serum-cholesterol level is regularly above 275 mg. per 100 ml.
2. It is suggested that in practice a conventional type of diet in which saturated fats are moderately restricted and partly replaced by unsaturated fats will be the most convenient method of reducing the serum-cholesterol level.
3. Common South African foodstuffs are listed in terms of the quality and quantity of fat which they contain and sample menus are provided to illustrate the composition of the recommended diet.
4. It is noted that the factor in dietary fats which determines their effect on the serum-cholesterol level has yet to be identified. Until this is achieved, no solution will be available to many of the practical problems which have arisen in connection with the production of foodstuffs suitable for a cholesterol-decreasing regime.

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APPENDIX

Angel Food Cake

1. Sift together 1 cup of sifted flour and 7/8ths cup of sugar.
2. Measure the following into a large bowl and mix until foamy: 12 egg whites, 1½ teaspoons cream of tartar, ¼ teaspoon salt, 1½ teaspoon vanilla, and ½ teaspoon almond extract.
3. Gradually add ¾ cup of sugar to this mixture and continue beating until stiff.
4. Fold in the flour-sugar mixture.
5. Pour into an ungreased tube tin and bake in a moderate oven for 45 minutes.

Apple Snow

1. Add a dash of nutmeg, a pinch of salt and a teaspoon of vanilla to 1½ cup of unsweetened stewed apples.
2. Beat 2 egg whites until stiff and then gradually add ¼ cup sugar, while continuing to beat.
3. Fold the beaten egg whites into the stewed apples.
4. Chill before serving.

Cornflake Macaroons

1. Beat 2 egg whites and a pinch of salt until stiff.

2. Fold the following into the beaten egg whites: 1 cup sugar, $\frac{1}{2}$ teaspoon vanilla, 2 cups corn flakes, 1 cup shelled peanuts, and 1 cup dates and sultanas.

3. Drop teaspoonsful of the mixture on to a greased and paper-lined cookie sheet, and bake in a moderate oven for 15-20 minutes.

Cranberry Sherbert

1. Dissolve 2 tablespoons gelatine in $1\frac{1}{2}$ cup boiling water.

2. Add: 1 cup sugar, 2 cups cranberry juice, and 3 tablespoons lemon. Stir until the sugar is dissolved.

3. Strain, cool and freeze.

Date Sandwich-cake

1. Use the same batter as for Angel Food Cake; place into 2 layer tins and bake at 350°F for about 35 minutes.

2. *Filling.* Heat $1\frac{1}{2}$ cups chopped dates with $\frac{1}{2}$ cup sugar and $\frac{1}{2}$ cup water until thick. Cool and add 1 tablespoonful lemon juice.

Fruit Tapioca Pudding

1. Combine the following thoroughly in a saucepan: $2\frac{1}{2}$ cups fruit juice and water, $\frac{1}{4}$ cup tapioca, $\frac{1}{2}$ cup sugar, and $\frac{1}{4}$ teaspoon salt.

2. Bring quickly to a full boil, stirring constantly. Avoid overheating.

3. Remove the thin mixture from the fire, and add $1\frac{1}{2}$ cups diced canned fruit and 2 tablespoons lemon juice.

4. Cool, stirring occasionally (the mixture thickens as it cools).

Marshmallow Ice Cream

1. Place the following in a double boiler and steam until melted: 20 marshmallows, 1 cup juice of canned pineapples, 1 dessertspoon gelatin dissolved in $\frac{1}{2}$ cup water.

2. Add 1 dessertspoon lemon juice; mix and set aside until slightly jellied.

3. Beat 2 egg whites with a pinch of salt until stiff and fold into the mixture.

4. Put into a freezing tray and freeze.

Meringue

1. Beat 4 egg whites with a pinch of salt and 4 drops of almond essence until moderately stiff.

2. Beat in $\frac{1}{4}$ teaspoon cream of tartar and 1 cup of sugar (a tablespoonful at a time).

3. Drop 1 teaspoon at a time on a paper-lined baking sheet and shape into shells. Bake in oven at 250°F till dry.

4. Fill with mock cream.

Orange Ice

1. Combine 2 cups sugar and 4 cups water in a saucepan; bring to a boil and boil for 5 minutes.

2. Cook slightly and add 2 cups orange juice, $\frac{1}{4}$ cup lemon juice and the finely grated rind of 2 oranges.

3. Cool, strain and freeze.

Potato Salad

1. Dice 10 boiled potatoes and sprinkle them with a little salt.

2. Heat 1 cup white vinegar with a dash of pepper and a dash of celery salt.

3. Sprinkle 2 tablespoons finely minced onions over the potatoes, and pour the hot vinegar over all. Toss several times when the potatoes have fully absorbed the vinegar, pour off the excess.

4. Cover the potatoes generously with olive oil (or sunflower-seed oil).

5. Embellish to taste with chives, capers, pickles, chopped parsley, beetroot, onions, green peppers, etc. Serve cool.

SKIM-MILK-CHEESE CAKE

(a) Pastry Shell

1. Sift together $1\frac{1}{2}$ cups sifted flour, $1\frac{1}{2}$ teaspoons sugar, and 1 teaspoon salt.

2. Add $\frac{1}{2}$ cup sunflower-seed oil and 2 tablespoons skimmed milk. Mix thoroughly with a fork.

3. Press the mixture evenly into a pie pan and flute its edges.

4. Fill with the desired filling and bake at 375°F until golden brown.

(b) Skim-milk-cheese Filling

1. Beat 2 egg whites until stiff.

2. Fold in: 1 lb. skim-milk-cheese, $\frac{1}{2}$ cup skim milk, 1 tablespoon lemon juice, 1 teaspoon custard powder, and 3 tablespoons sugar.

3. Mix well and pour into pastry shell.