

SECOND SESSION

Chairman—Dr G. I. Watson

To open this afternoon's meeting I would like to remind you of Archie Clarke-Kennedy of the London Hospital who was a great teacher and tutor in nutritional matters. He started his afternoon tutorials with, 'Watson, what have you had for lunch today; a certain amount of protein, a certain amount of carbohydrate and a certain amount of fat? What is happening to it at this moment?' We are now going to hear not only what happens to our food but also whether we are eating the correct foods.

THE NUTRITIONAL PROBLEMS OF THE AFFLUENT SOCIETY

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I would like to expose some myths from our established ideas on nutrition and suggest there is a basic error inherent in our present day "food structure". Secondly, I wish to examine the relevance of this basic error to some of our more important health problems, particularly cardiovascular disease, and show how this error may have even more serious implications.

May I suggest one important error is that our food and agricultural policies are based on the foundation of proteins and calories; this could be the wrong premise. I question this foundation on available facts rather than speculation: for example, of the large mammals, the human animal has the largest brain and the most extensively developed peripheral nervous system on a bodyweight basis. It was the brain and nervous system which has been largely responsible for the success of the human species.

Sixty per cent of the brain's dry weight is specialised and specific lipid, a significant proportion of which cannot be made by animals but must be found in the food chain. If you say that such constituents are not necessary because the animal can make them in a roundabout way from the vegetation or because the animal can use substitutes, then you are speculating. If you say these constituents are found in the food chain and then in animal membranes, you are dealing with fact.

The fact that the requirement for lipid has not been taken into account is illustrated by the table of recommended intakes for the United Kingdom which gives no recommended intake for the lipids involved in brain construction. This is surprising because these structural lipids which are used in the construction of the brain are also used to a lesser degree in every cell of the body. Although quantitatively they are the most important in the brain, they are the second most quantitatively important structural constituent of every single cell in the body.

There are many examples in which the public are being unconsciously trained into thinking in the narrow terms of protein. The myth that protein is the only important factor is used to make quite accurate claims on television that nuts have more protein than "even roast beef", that milk has as much protein as steak, that so many slices of bread are equivalent to a pound of meat, that some favourite brand of dog food is rich in protein, and that protein has been added to potato crisps.

We have been told by the press that protein can be manufactured from soya beans, bacterial, fungal and petroleum waste products and knitted into meat analogues. Within

this whole concept of new food developments there is no mention of the components used for brain construction. This oversight is simply due to the chronology of food technology lagging behind the advance of science.

Technology before science

I would like to touch on the historical background to emphasise problems between science and technology. Science can unravel the atom, but technology produced the bomb and harnessed its use for peaceful energy. In this example science preceded the technological application, but in the matter of food, technology preceded both the scientific and medical understanding of biochemistry and nutrition. Indeed, it was thanks to mistakes in technology that biochemistry arose as a subject.

In the nineteenth century, the introduction of the steam roller mill for bread manufacture took place at a time when there was very little understanding of the importance of food biochemistry. Stone grinding mills and querns soon gave way to the production of white bread, which pleased the rich and made little difference to their wide and diverse food structure, but upset the balanced diet of the poor. Professor D. Wilbraham, in his book *The Englishman's Food*, comments that this change in such a short space of time produced a loss of one third of the vitamin B₁ and one half of the daily iron requirements.

As dietary requirements became known, bread was supplemented with additives such as calcium, vitamins, and some minerals. The change in the technological applications of food production was reported to the Government in 1902 during the South African War. Sir William Taylor, Director General of the Army Medical Services, reported that 40–60 per cent of the army recruits from dense urban areas were being turned away as unfit for military service. This report sent a flutter of disbelief around Whitehall, but disbelief is no challenge for facts.

They had to lower the minimum statutory height requirement from 1.53 m. (5 ft. 3 ins.) to 1.5 m. (5 ft.), a doubly unpalatable action because in 1883 the minimum statutory height had already been lowered from 1.65 m. (5 ft. 6 ins.) to 1.53 m. (5 ft. 3 ins.). This was largely due to the prevalence of rickets and the diverse manipulations of the food structure. Rickets was said to be due to bad breeding, cramped living conditions, stress, overwork with long hours in the factory, dark conditions, poor air, poor lighting conditions, farinaceous and purified foods.

The final answer to the problem of rickets came when attention was focused on the necessary requirements for bone construction. There are some interesting analogies with these early contrasting views on rickets and present day confusion on the aetiology of cardiovascular disease.

African comparisons

Our entry into the field of food structures came about not through problems of our modern society, but because of an interest in African pathology. We were interested in endomyocardial fibrosis, a heart disease occurring in Africans in which a fibrous tissue invades the endocardium and myocardium. Why does the African have a type of heart disease concerning the heart muscle while in the European, it is the artery which is primarily affected?

I would suggest that in Africa, the so-called "protein" malnutrition is a matter of much more than simply protein. The child with kwashiorkor has a swollen stomach, enlarged liver, oedema and falling hair with loss of pigmentation. This condition is found in many of the African villages where the carbohydrate rich foods are deficient in a variety of factors besides protein.

In order to consider the broad nutritional principles operating in Africa, we produced experimental diets to mimic the diets of the population. These diets were fed to guinea pigs; a fibrous replacement in the myocardium occurred similar to reports by

Reid in South Africa and Stewart and Platt in England. When we examined the vascular tissue of these experimental animals, the pathologists reported foam cells which seemed indicative of a high fat diet. In fact these animals were receiving little or no fat!

As the high saturated fats which induce foam cell formation compete with the essential fats of lipids used in membrane synthesis, we thought it was possible that a lack of appropriate essential lipid could bear some resemblance to the excess of the wrong kind of fat. It was at that stage that we realised that animals need both protein and fat or lipid for cell construction.

Armed with this insight we then felt we should re-examine the European and African problems. In view of the different practices of food selection in Europe and Africa it is common to study European atherosclerosis and use the African as a "control". But it occurred to my rather naïve mind that if one community suffered from one type of heart disease while the other community suffered from a different heart disease, then it was possible that there was something wrong with both. The likelihood of the food structures being important in both instances is supported by much experimental evidence. Perhaps both food structures have simply developed in different directions, both contain inherent, important errors and we both now have different problems.

Essential and non-essential aminoacids

We first approached the question of nutrition and cardiomyopathy in Africa from the usual protein viewpoint, but approached it rather obliquely. We asked could we show any comparative relationship between the wide variety of mammalian species which eat completely contrasting foods? What could this tell us about the relationship between the food structure and animal morphology and the differences within the animal species?

We studied the different protein aminoacids of muscle in 15 separate species, including man, and found no difference in composition regardless of species or food structure. It was already known that essential aminoacids fall in the plasma of children with kwashiorkor and we found similar results in adults at risk to cardiomyopathy. Of special interest in the adult plasma aminoacids changes was the observation that leucine, an essential aminoacid, and quantitatively one of the most important for muscle tissue, was low in the plasma of the "at risk" African. In general there was a loss of essential and a gain in the non-essential aminoacids. Thus it might be argued that a reduced availability of important protein constituents could affect growth maintenance and repair of essential protein-rich organs like the heart.

Essential and non-essential fatty acids

Unlike the proteins, we found that the tissue fats were totally different from species to species. We also studied fat from beef muscle from the United Kingdom and that of the African buffalo which compares with what we eat today in this country and what we used to eat some time ago. These two animal species are both bovids and have a similar weight and size. We found that there is an incredible difference in the balance between essential and non-essential fatty acids in our domestic beef and in the meat of the animal free to select its own food. In effect, what you are eating is very different from what you would have eaten before domestication intensified animal production.

I will have to make a slight diversion into chemistry and I hope you will bear with me but it is very important to understand this point. There are two fatty acids essential to animals which occur in the vegetation, linoleic and linolenic acids. Linoleic acid is distributed predominantly in seed material while linolenic acid is mainly found in leaf material. This is a complementary pattern and a vegetation animal obtains both these acids by eating different aspects of the vegetation. Our own basic food structure starts with the use of bread which is a seed and with greens which are essentially leaf material,

thus providing both acids. Now what is interesting is that in any natural product, where you have protein you will also have one or other of the essential fatty acids because both protein and structural fats are used in cell construction. Animals cannot make these two polyunsaturated fatty acids. But they can insert extra double bonds and extend the chain length once they are provided with linoleic and linolenic acids.

The interesting feature about this story, which was not realised until quite recently, is that although two essential acids occur in vegetation, we find that in animal products, probably to meet the greater complexity of animal cells, these two acids are metabolised from 18 carbon acids with two and three double bonds to longer chain lengths of 20 and 22 carbon atoms with four, five or six double bonds; these long chain products are then incorporated into the phospholipids and used in cell structures. They are involved in enzymes and membrane function. There is a very complicated interaction between protein and lipid in the extremely complicated animal cell. The mitochondria, for example, is a tremendous labyrinth of membranes, made up of 70 per cent protein and 25 per cent lipid. The figures vary with cell type and subcellular fraction but a large proportion of this structural fat contains essential acids incorporated into phospholipids.

Different types of fat

What appears to have gone wrong is the belief of another myth that fat was fat, when in fact there are two quite different types of fat: (1) structural lipid, and (2) adipose tissue.

Structural fat (phospholipid) is rich in essential fatty acids, whereas adipose tissue might be described in colloquial terms as a "rubbish dump"; more precisely it is an energy store and in land mammals it contains very little of the highly unsaturated fatty acids of the phospholipid complexes.

If we now re-examine the difference between the meat of free-living and intensively reared animals we can see some important contrasts in the fat they provide. The carcass of intensively reared bovinds produces three times as much non-essential "rubbish fats" as protein, structural lipid and other solid nutrients. Free-living species produce three times more nutrient than non-essential fat.

Quite simply, we have slipped into eating grossly obese animals! The importance of this realisation of the true biological description of contemporary animal production is that the dominant fatty acids of our contemporary food structure are non-essential. If we ate animals free to select their own food, we should eat a pattern of essential lipid. That is, meat or muscle as a rich source of essential cell structural constituents. Intensively reared animals are reared for fat not meat. Unpalatable as it may seem, three times as much adipose or non-essential energy fat in beef and pigs is biologically abnormal. What you are eating is adipose tissue, you are eating obesity and you know perfectly well that obesity is wrong and harmful.

Fats and coronary thrombosis

There is a very real difference between the free-range animal and the intensively bred animal. If we agree that in principle, the feeding of saturated fats to animals demonstrates that the artery is sensitive to this manipulation, then in the contemporary domestic animal, we have the two elements of (1) destruction and (2) construction: with the destructive elements very much in the ascendancy. The free-living system provides the constructive elements.

Furthermore, the distinction between storage and structural fat was not appreciated by the technologists. Structural fats tend to be unstable and degenerate in storage and this was one of the reasons for the introduction in the 1930s of "high energy" diets. Pig fats were soft, with a tendency to rancidity. The higher the degree of polyunsaturation, the greater the instability of the fat. Fatten the animal in a way to produce saturated

adipose tissue, infiltrate this into the muscle tissue and the meat has a longer shelf life. Meat products such as cold prepared luncheon meat, sausages, meat pies and the convenience foods can also be padded with non-essential fat.

It is not difficult to appreciate that we have traded cell structural fats for non-essential fats in our present-day food structure. Even vegetable fats can be changed, hence selective hydrogenation can be used to remove the linolenic acid which tends to make the oil go cloudy. It would be possible to go into much greater detail but the bare facts are that there has been a tremendous change in the use of fats with a loss of essential and a gain in the non-essential.

Carbohydrates follow a parallel pattern and the Yudkin-Cleave hypothesis on coronary thrombosis narrowly defines the cause as being due to the use of sugar and purified carbohydrate. This notion is based on another myth, i.e. that only sugar and carbohydrate consumption has changed. This supposition is patently absurd as such changes as have occurred obviously affect the whole spectrum of nutrients essential for cell construction. If you move an object from A to B you do not only move the object but also alter the positions of A and B and everything else in relation to the object.

Purification obviously means removal of nutrients just as the production of obese animals for us to eat also means a loss of nutrients. An attempt can be made to overcome the loss, if the community grossly exceeds its calorie intake which by itself is harmful. There is considerable evidence that we do over-eat.

The importance of the alteration of our food structure can be shown from the examination of vegetation in which there are roughly similar amounts of linoleic and linolenic acids. The tissues of the herbivorous animal incorporate these two vegetable acids and their long chain animal derivatives which are used for cell and mitochondrial construction. On the other hand, the carnivore by eating animal products starts with lipids which are more complex than those found in natural vegetation and include the long-chain animal products.

In effect the carnivore exhibits a significant increase in the long chain polyunsaturated fats in its tissue lipids as a result of a simple progression along the food chain. Now the lipids used in brain construction are specifically the long-chain variety and if one thinks about the large herbivores and carnivores it becomes apparent that we are dealing with two entirely different concepts of animal life. The carnivores with their hunting abilities and highly developed vision have a more advanced central and peripheral nervous system than the herbivores with their passive herd instinct and simple feeding patterns. The periphery of the herbivore is a hoof as opposed to the articulated claw of the carnivore. The difference between these two types of animals can be expressed not only chemically on the basis of the specific long-chain fatty acids used in brain construction, but also morphologically in the obvious attributes of the central and peripheral nervous system.

Our degenerating food structure

In simple terms, the development of our own contemporary food structure has been based on protein and calories. The calories may be sugar, carbohydrates or fat but no attention has been given to the structural fats of lipids despite the early recognition of a distinction between structural and storage fats by the pathologists.

Yet structural lipid is essential for the proper growth and maintenance of membrane-rich tissues like those of the brain and vascular systems. Our own investigations have shown that the developing rat brain incorporates long-chain polyunsaturated acids much more effectively than the parent vegetable acids. We are only just beginning to understand some of the possible implications of lipids in the food chain.

It is remarkable that the human animal has a brain size of about two per cent of the body weight while the ox has a brain size of about 0.05 per cent. The brain is a lipid-

rich organ. It is the outstanding characteristic of the human animal, yet the lipid nutrients involved in its construction have been overlooked in contemporary food policies.

If my suggestions are correct, then there is a fundamental error in our food structure which sooner or later must produce some long-term consequences for the population. The specialisation of our structural fats distinguished the human from other animals. The continued deterioration in the materials used is likely to lead to degeneration. The most marvellous genetic plan is like an architect's blueprint and it will be worthless without the correct building materials.

Acknowledgement

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DEATH IN THE AIR WE BREATHE

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It is a terrible indictment of human attitudes that when air pollution was first noted in the Los Angeles area it was not because of its effects on human life and health but because of its effect on crops. Only when the lettuces became spotty, the oats were wilting, and there was a nasty bronze shine on the sugar-beet leaves did people stop and think. In other words, it was only when Popeye's spinach began to curl at the edges that people began to wonder what was happening to Popeye himself and also to take note of the smarting eyes, running noses and the shortage of breath that ordinary people were experiencing. Other people had also commented on the effects of atmospheric pollution on rubber, no doubt worrying about their precious motor-car tyres, but quite heedless of the fact that what rots rubber must certainly rot lungs.

Nor can we flatter ourselves that things have been any different in Britain. The gardens and parks in our industrial towns are largely furnished with privet, spotty laurels, rhododendrons and the so-called London Pride. These plants have very thick wax-coated leaves which can stand up to soot and regular rinsing in sulphuric acid, which are the chief pollutants in our atmosphere. Similarly the rose is particularly suitable as a national emblem and also as the emblem of our two industrialised northern counties, Lancashire and Yorkshire. Roses bloom very happily in these areas because they are preserved from fungal disease and blackspot by the high sulphur content of the atmosphere.

It is also significant that the cauliflower and cabbage, almost our national vegetables, are highly resistant to some forms of pollution. Long ago we should have considered whether we were soot-tolerant like the rhododendron or more like the cupressus species which thrive in clean country air. I am not being facetious in quoting these parallels because we need to emphasise that there are two main types of growth-air pollution which differ markedly in effects on plants, animals and man.

Major pollutants

The extreme forms of atmospheric conditions combined with wind, temperature, combustion, decay of organic materials and industrial processes can produce what is