THE NUTRIENT VALUE OF MEAT BASED ON THE LIPIDS FOR BRAIN CONSTRUCTION

A re-evaluation of animal production

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ABSTRACT

1. It is not generally realised that meat is a particularly rich source of essential fatty acids which are found in the structural lipids of the cells.
2. The association of meat value exclusively with protein is probably wrong. New evidence will be presented which suggests meat may be of greater value for its content of essential structural lipids than its protein content. Protein is associated with body growth, but lipids with brain growth and the brain is the outstanding development of the human species.
3. If, as suggested, the structural lipids are important to the qualitative value of meat, then the idea that biosynthetic protein texturised to taste like meat can substitute for meat is false.
4. The above propositions indicate an urgent need for extending animal agriculture rather than the popular notion of replacing animals by cereals and leguminous crops because of their high protein value.
5. Whilst there is an urgent need for extending animal production there should also be a redefinition of the parameters of production to provide more nutrients and less non-essential fats which in excess are harmful to community health.

Proteins and Lipids

Meat as a food is very much more than protein and no matter how good the quality of a biosynthetic protein, it will not be a substitute for meat. Indeed, the real value of animal products may not be in their protein content, but in other nutrients; for example, vitamin B_{12} is present in animal products, but not in plants. Certain substances, such as iron, are present in plants but not readily available to the animal which eats the plants, but iron in meat is available. There is also the new evidence on the lipids. All cells are built with both protein and lipid and the balance of protein to structural lipid varies from tissue to tissue. Muscle has more protein than structural lipid, but the brain has more lipid than protein. The structural lipids of animal products are very different to those of plant products; indeed the activity of the structural lipids of animal products as precursors for brain structures has been found to be some ten to twenty times that of plant lipids (Sinclair and Crawford, 1972) and this alone could negate the idea of using protein as a simplification to food or calculate conversion efficiencies.

Protein and Growth: The contrast between the laboratory and comparative evidence

To compare one protein with another, experimentalists often use the growth curve in rats. Improvement of growth performance is generally considered to imply nutritional excellence, and reduction in growth rate nutritional poverty. This test is useful but nonetheless crude.

More recently, Miller and Payne (1968) showed that animals fed a high protein intake had a shorter life span. We found that Histidine supplementation to a normal guineapig diet improved growth rate and reproductive performance (Gale & Crawford, 1969), but long-term follow-up studies showed that the supplemented animals may have grown faster but they also died faster.

If we examine the comparative data it is evident that the large mammals like the cow and the rhinoceros grow with remarkable speed by comparison with the primates. This remarkable growth rate is accompanied by an accumulation of protein- and mineral-rich tissues, but little development of the lipid-rich brain with its peripheral developments of nervous tissue. It is in the slow-growing primates that we see the developments of the lipid-rich nervous system and it is interesting that in related "secondates" we find it is the herbivores (like the bovids, antelopes, horses and pigs) which have the small brains ($< 0.05\%$ of their bodyweight), and the carnivores which have the relatively large brain size (0.3%) together with the peripheral developments of the nervous system such as in the articulated claws and the night vision of the large cats.

The herbivore and carnivore

Until recently it has been assumed that the difference between the food structures of the carnivore and the herbivore was the high protein diet eaten by the carnivores, or that the herbivore existed on a diet poor in protein. There can be little doubt that a characteristic of the herbivore is a rapid rate of growth in terms of mineral-rich tissues like bone, and protein-rich tissues such as muscle: but the brain, unlike other tissues in the body, is not protein-rich, but lipid-rich. The brain in these large herbivorous mammals is very small.

Now if growth rate is an important criterion of protein quality, then the comparative evidence does not support the idea that the herbivore food structure is protein-poor. In fact, the opposite seems to be the case. We now know that the ruminant in particular has solved the problem of protein supply in a unique way by employing a spectrum of micro-organisms in the rumen to convert the vegetation.

Mammals cannot digest plant cellulose but the micro-organisms can. The fermentation process in the rumen provides protein-rich protozoa and bacteria which the ruminant then eats (Hungate, 1966). There is no oxygen in the rumen and the end product of energy metabolism by the micro-organisms is hydrogen instead of water, hence highly unsaturated molecules may act as hydrogen acceptors, but in so doing become saturated. Therefore, much of the poly-unsaturated lipid nutrients in the food is saturated in the rumen (Wilde and Dawson, 1966). The ruminants gain protein from their micro-organisms and also vitamin B_{12}. On the other hand, this is at the expense of a loss in polyunsaturated fats. Thus, the ruminant is an extreme adaptation to a high quality protein and low quality lipid food structure.

The ruminant herbivore is capable of producing substantial amounts of protein-rich muscle tissue, but the features associated with the central and peripheral nervous system, which are dependent on lipid considerations, are poorly developed: the brain to body weight ratio is small.

By comparison the carnivorous system involves a far higher degree of development in the central and peripheral nervous system; in other words, the carnivore does not illustrate development in the protein-rich tissues, but the lipid-rich. The primates reach an even greater peak of development.

By contrast to the secondates, the primates have a slower rate of growth, long gestation and lactation periods and exhibit substantially less muscle development, but a considerable advance in the brain. Again, within the large apes we can see the contrast between the massive, strictly vegetarian gorilla, by comparison with the smaller but larger-brained omnivorous ape, man.

In fact, the chemistry of the human species is, on a comparative basis, remarkable not from its protein content, but lipid characteristics. The structural lipids employed in cell construction are quantitatively the most important structural group in the brain and the second most important in all other soft tissues in the body. Hence, in species like the rhinoceros, the buffalo and gorilla, the preponderance of muscle tissue and bone emphasises the protein and mineral aspects of animal biology, whereas in the human primate, the development of central, peripheral nervous and vascular systems emphasises the lipid aspects.

Biochemistry can now explain these differences in animal species. We have proposed, on the basis of the comparative and experimental evidence, that whilst protein and minerals may be important for body and bone growth, lipids are important for brain growth.

In this context it is especially interesting that the essential plant lipids do not appear in the structural lipids of the brain. When animals eat plants they metabolise the essential plant lipids to long-chain polyunsaturated fatty acids and it is only these long-chain acids which are used in brain growth and not their essential fatty acid precursors in the lipids of plant origin. This means that meat and other animal products provide "preformed" and what are now known to be "more active" essential fatty acids of the kind which the brain actually uses in its growth.

These findings will be described in greater detail because they place a completely new interpretation on the nutrient role of meat and animal products.

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