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Today's consumer is increasingly concerned about health, body care, and problems related to aging, but does he have the means to answer his questions? On one hand, scientists must be aware that, in contrast to other fields of science, the public already has strong opinions as to what nutrition means and what foods are good for maintaining health. On the other hand, it is apparent that more than in the past consumers will select foods on the basis of what they have been taught, rightly or wrongly.

Further, the 20th century has brought a growing expression of "self," from a biological, behavioral, and social point of view. The sense of the individual is more important than that of belonging to a group. It is therefore not surprising to observe that individuals are more selective in their food choice and more critical toward nutrition.

The individual becomes the center of attention and the future demands of the consumer will be more and more concerned by services. It seems therefore that substantial economic growth of individualized countries will be observed in the realm of nonmaterial goods. Because nutrition is not just a way of eating to fulfill physiological needs but a whole "art de vivre," these general considerations will undoubtedly be important factors in shaping future research in nutrition and related sciences.

However, scientific success will also depend very much on the expression of "non-self," in that academic and industrial research groups will have to collaborate more closely. For the academic scientist, research funding will depend on some of his ideas ultimately having an economic value. Industry will look more to the academic world for solutions because the value of "gray matter" is ever increasing in the total cost of products.

The dual expression of "self" and "non-self" has been captured by Claude Bernard in these words: "Art is Me, Science is We!"
ROLE OF RESEARCH

There has been much debate on the relative value of targeted—in contrast to nontargeted—research and on the relative meaning of basic and applied research. In the field of biomedical research—which has some relevance to nutrition—it has been shown that basic research pays off in terms of key discoveries almost twice as well as other types of research (1). The relationship between scientific research and the practical world represents a constant problem. If science is to preserve a certain autonomy—a crucial factor for innovation—and at the same time affirm its ability to have a true impact on present and future reality, the tension will continue.

In Europe, current human nutrition thinking is determined by a number of research teams, bodies, and agencies (Fig. 1) (2). To complete the diagram, European nutrition foundations and scientific organizations, such as the International Life Sciences Institute (ILSI Europe), should also be included. While the coordination of all the different aspects is beyond the capacities of any individual group or agency, it is

FIG. 1. Who determines current human nutrition thinking in Europe? [From Gorr'ley TR (2).]
obvious, as a general principle, that the information pool is central in the interactions between the different groups involved. The information pool can only be filled by reliable scientific data, and this alone could justify conducting scientific research in nutrition with increasing intensity.

NUTRITION SCIENCE

Several revolutions were necessary to cope with the problem of food supply to guarantee the development of mankind. Our food habits result from long-lasting processes influenced by many factors, such as the sociocultural environment, economic considerations, and climatic conditions. During this century, one has seen the fading of the traditional pattern of food consumption due to the constant movement of goods, popularity of tourism, higher purchasing power, changes in life-style, improvements in agrobusiness, and so on.

The science of nutrition is also undergoing profound changes. While all nutrients essential to man appear to be known, a great deal of research is still necessary to understand better their interrelationships and their behavior in complex food systems. If, years ago, nutritionists were primarily interested in the cause and effect of providing essential nutrients in sufficient amounts ("one disease, one nutrient, one function"), the focus is now on the relationship between food and health. Thus research in nutrition has far from exhausted the fields of discovery. In the food industry, the scientific discipline relevant to its needs is largely seen as food science. Unfortunately, nutrition is thought to be in the sphere of the consumer and of the regulatory bodies and relevant to the consumption of food products, rather than to their creation.

Nutrition should be viewed as a global field taking its roots in cellular metabolism with application to the whole body and involving psychology, sociology, and economics. Successful research in nutrition will only be achieved by harnessing all interested parties (scientists, industrialists, and consumers).

By nature, nutritional sciences are integrative. Many factors contribute to the complexity of research in nutrition, which itself involves most of the disciplines in life sciences. One such factor is the difficulty of assigning a single discipline to the central role in nutrition research (and even the life-style of the eater) (3). Another factor is that research must take the total diet into account, as no single food component is the sole basis for good health and well-being.

FUTURE RESEARCH IN NUTRITION

Initially, formulation of nutritional questions requires a dual "macro and micro" approach. Epidemiology may lead to interesting and plausible associations, the validity of which must be explored at the cellular level, while a sequence of events observed at the subcellular level may need to be moved up to a higher level of biological organization (cell, organ, man, and ultimately society) to evaluate its
significance. The key to future research will be the ability of investigators to move from one level of biological organization to another (4). Success is idealistic because this dual approach depends very much on improving the use of epidemiology. Not only are human epidemiological studies expensive and time-consuming, but we do not know how to deal with data based on small sample size. Moreover, too many analyses are based on a "worst-case" situation.

A "balanced" diet is a prerequisite for general good health. It has become the motto of the epidemiologist, nutritionist, dietitian, social worker, and medical practitioner. "Well-balanced" nutrition means "an adequate consumption of food aiming at satisfying the requirements of the body in energy and nutrients." However, at present, the optimum in nutrition is still impossible to define for lack of sufficient knowledge. For planning better nutrition, it is necessary to increase our knowledge in the following subjects (5):

- the nature of indispensable nutrients
- the quantity of nutrients to be provided
- the optimum chronological timing for providing nutrients
- the bioavailability of nutrients when eaten in isolation or in a complete meal

Other questions will gain major importance in the future such as (1) nutrient regulation of gene expression; (2) nutrition in the causation and prevention of chronic diseases; (3) food production; and (4) communication about nutrition and nutrition research (6).

Due to the development of tools for examining biological problems at the molecular level, there is now a potential for exploring nutrition with greater sophistication, sensitivity, and complexity than has previously been possible. The availability of these techniques should accelerate progress in the understanding of nutrient-dependent metabolic interactions (7).

The future science of nutrition will not only maintain its "static" role in providing essential nutrients to the consumer, but will also have to assume a more "dynamic" function by contributing to the prevention of diseases. This creates new and exciting possibilities in the three classes of prevention:

- **Primary prevention.** Actions to promote health as undertaken prior to the development of disease.
- **Secondary prevention.** Detection of disease in its early (asymptomatic) stages and intervention to avert its expression.
- **Tertiary prevention.** Intervention after the development of a clinically manifest disease in order to reverse or avert its progression.

In view of the ever increasing cost of curative medicine the role of prevention will intensify, and nutrition is an integral part of a well thought out and well organized prevention program. As a result, health claims for food products will receive more attention. Implicit claims are nonspecific because the connections between the content of foods and specific diseases are not stated. They leave room for uncertainty.
They require little laboratory work because they rely mainly on "traditional beliefs" and "common knowledge." Specific claims will become more frequent and must be strongly regulated. They will require expensive laboratory and clinical research to obtain hard data, and will have to be made in the context of the overall diet.

One function of nutritionists is to predict the needs of both the food industry and the consumer in the light of new consumer attitudes, new environmental concerns, and new technology. Indeed, changes in life-style will have profound implications on the future of nutrition research. The modern life-style associated with health awareness will enhance sensitivity to the real value of food, i.e., nutritional adequacy as well as pleasure and convenience (8).

The technological progress of the agribusiness has been remarkable during the past few years although it has been overshadowed by spectacular advances in electronics and medicine. To cite a few examples, one can name the introduction of new plant varieties, the mastering of efficient microbial strains in the milk industry, aseptic filling, and the use of microwaves.

The food industry will soon have to integrate the products of the new biotechnology. To give a few examples: microorganisms can be modified to improve their performance in food fermentation processes; the nutritive value of cereals can be increased by raising their lysine content; plants can be multiplied in vitro and cellular fusion produces new hybrids; genetic engineering will produce plant varieties more resistant to pests or modified to improve food processing; and finally, it is not unrealistic to imagine new opportunities through transgenic animals.

However, all these developments must take the environment into account. As pointed out by J. Franz, "in the next ten years, environmentalists will become more insistent on the theme 'modern technology owes ecology an apology.' Any apology will probably come with a high price tag. The successful companies will be those that learn how to make an apology unnecessary by the development of environmentally friendly products. This will require some rethinking about how we can carry out the research/discovery process in a more efficient manner" (9).

Few, if any, foods now sold are genetically engineered (10). However, nutrition research will soon be deeply involved in considering raw materials in composite products derived by genetic engineering. The seed market will progressively change, with the introduction of genetically designed plants having modified nutritive and physicochemical properties.

It is not the purpose of this chapter to examine the relationship of diet to the occurrence of chronic diseases. This has been examined by many national bodies, and dietary recommendations have been issued for specific countries. Among them, a wealth of information on current knowledge and future research can be found in the first Surgeon General's Report on Nutrition and Health (11) and the report of the US National Research Council (12). While aiming at improving the diet of Americans, these reports will certainly help food companies around the world improve their own products.
COLLABORATION

Success in achieving better nutrition will also depend on establishing a better collaboration between industry and academia. In industry, there is always the temptation to make a choice on the basis of a short-term cost/benefit analysis including some estimates of the probability of success. While this approach is justified, industrialists must not forget that financial support must also be given to research scientists to investigate subjects for which the benefit of research cannot yet be entirely assessed (13), in industrial research facilities, in universities, and in specialized institutes. However, in the future, new schemes for collaborating with academia will need to be worked out because it is becoming increasingly difficult to define research contracts that satisfy both parties.

Transgovernmental projects are also attractive when available to the food industry. While this may lead to inflated costs simply due to the complexities of coordination, communication, and travel, the saving in harmonization and standardization may be worth it.

EDUCATION

Planning for better nutrition is intimately linked with education; that is, better education of both scientists and consumers.

Education of Scientists

Qualification requirements of scientists in nutrition will increase because nutrition research encompasses many disciplines. Indeed, there is a growing inventory of scientific knowledge needed for nutrition research. Nutrition research will keep pace only if nutritionists can assimilate and utilize advances in quantitative biology, information management, and data sharing. On the one hand, one cannot escape the conclusion that future nutrition research will require highly specific skills and knowledge (14); on the other, planning for better nutrition also includes identification of promising young researchers and their training as generalists, particularly in Europe. Governments, academia, and industry should all provide means to train a new generation of nutritionists as generalists who can take a balanced view.

Academia will have to provide stronger and more attractive programs in nutrition. Many young students in industrialized countries are losing interest in science and are choosing more financially profitable activities. Moreover, there is also a strong case for the belief that science is in need of redemption (15).

Education of Consumers

Sound nutrition is to a large extent a problem of communication and education. The public has a considerable individual and direct interest in nutrition research.
FOOD RESEARCH AND INDUSTRY

During the last ten years, the word "nutrition" has been launched into the headlines more than in preceding decades (16). Consumers are bombarded with advice and often do not have the means to separate the wheat from the chaff. This is aggravated by the current uncertain state of knowledge in many areas of nutrition, a situation poorly understood by the general public who expects experts to know everything but simultaneously accuses them of knowing nothing.

The nutrition community has too often been unable to present a common front on issues. Some nutritionists still hold back from recommendations to the general public (17). However, it must be recognized that nutrition is a complex field of study, and it would be an error to suppose that nutritionists can always produce adequate notions about complex issues. This is particularly evident in the relationship between diet and complex chronic diseases where scientific knowledge is far from complete.

In the past, nutritionists have been keen to underline what should not be done, what foods should be avoided, and what pleasures forgone. More positive approaches must be presented to the public. It is striking to observe that out of the seven Dietary Guidelines for Americans, as published by the US Department of Agriculture and the US Department of Health and Human Services, three recommendations started with the word "avoid." A more positive message has been issued in the last edition. Understanding consumer fears and how to deal with them is vital to today's food scientists, but sound education cannot be based on fear.

CONCLUSION

On the health and nutrition front, many researchers do not anticipate blockbuster breakthroughs but see a series of small and gradual changes (18). Others consider that nutrition is at the threshold of its Golden Epoch (19). Evolution? Revolution? While biotechnology may bring us revolution (more in processes than in products), trends are more in the nature of evolution with small increments. The days are over when new vitamins and other essential nutrients await to be discovered. However, undoubtedly, evolution will be seen in the field of lipids, thanks to the availability of polyunsaturated fatty acids such as γ-linolenic acid and stearidonic acid, and in mucosal immunology, a discipline which is generating much interest in nutrition research.

Nutritionists should not forget that "nutrition is both a science and a practice" (20). "The goal of nutrition is to apply scientific knowledge to feed people, to feed them adequately, and to feed them all. ... By its nature, nutrition is a set of scientific disciplines whose end is action" (17). The food industry should not forget that it must provide the customer not only with visible elements such as satisfaction and services, but also with invisible elements such as health and security. If this is properly understood by scientists, "a good diet will never be a mortification diet."

REFERENCES


**DISCUSSION**

*Dr. Ashwell:* I should like to take up your point about getting better brains in nutrition research. I should imagine that very few of us present today were trained as nutritionists. My hypothesis is that those who are getting the top jobs in nutrition are not trained in the subject. As a woman I hate to say this but I think one of the great problems is that food is associated with women and women are not associated with the higher levels of scientific thinking! If you look at the people doing nutrition courses, 80–90% are women. Nutrition courses have an image of a mother in the kitchen. We must make nutrition research much more trendy to be attractive to the best brains. After all we can put a man on the moon, but we still cannot measure food intake. There are so many basic questions to answer about mechanisms.

*Dr. Horisberger:* I fully agree. Our research center has attracted good scientists, but good scientists are needed elsewhere too. It is sometimes difficult to have the best brains working on applied problems.

*Dr. Walter:* A highly neglected group in Switzerland is the doctors. I wonder whether we should be trying to give young doctors a better grounding in nutrition than we are at the moment so that they can really advise their patients properly.
Dr. Horisberger: The level of nutrition knowledge among young doctors is still insufficient in Switzerland as in many other countries. The industry should somehow contribute to improve this situation.

Dr. Fischler: Although there has been general agreement among us that we should develop better ways of communicating nutrition to the public, I don’t think we have agreed on what the message should be. It reminds me of the Woody Allen joke: “The answer is no. What was the question again?” I have the feeling about nutrition that when we express advice and recommendations we cannot do any better than offer choices or give unsubstantiated or trivial advice. On the one hand we have constraining guidelines that seem controversial after a while, and on the other hand we have the type of message that Dr. Ashwell has told us we should be putting across, but which I for one am not totally happy about. In France, organizations that communicate this kind of information are funded with public money and whenever I participate in discussions in those committees I feel very uncomfortable spending taxpayers’ money on advising national television to tell people to make sure they have a well varied diet. I don’t think this is enough and I don’t think it is relevant. One of the major problems is food safety and it is frankly shocking that in a technological society like ours food poisoning should be on the increase. I don’t recall much about this in nutritional guidelines.

Dr. Ashwell: One of the problems is that there is often very little time or space to get the message over. If you have 20 seconds on TV to say something there is not much you can get over other than the simplest of messages, and what better simple message than “variety, interest, and moderation”? 