Nutritional Consequences of Technology

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ABSTRACT

If one wished to gain a rapid insight into consumer attitudes about processing and technology, one would only have to consider that the title of this paper would immediately imply to many people that the negative consequences of technology are going to be emphasized. This simply means that technology has developed a perjorative connotation in the U.S., although its positive contribution to nutrition has been almost incalculable and one of the major negative consequences might simply be that fear of technology and modern food processing causes the consumer to make poor judgements. Unfortunately the consumer now expects food to act as a national eraser and wipe out disease. However, the facts must be considered rather than the expectations. If faced with an "all natural diet" (actually an undefinable term), the consumers would quickly realize some of the reasons why food is eaten. They would learn that their food choices are made on the basis of such things as: acceptability, availability, quality, cost, convenience and safety. Features which would be difficult to obtain in an "all natural diet". Further, such a diet might create nutritional deficiencies which are simply unheard of today. Perhaps it might be well to remember the Biblical story of Joseph who placed grain in storage for 7 fat years to prevent famine against 7 lean years. In a very literal sense, this should be the aim of technology and processing - to ward off death due to starvation by lengthening the functional life span of foods so that they may be used, rather than rotting in the fields, or spoiling on the shelves.

Aldous Huxley, the British novelist once stated that, "People always get what they ask for; the only trouble is that they never know, until they get it, what it actually is that they have asked for".

QUESTIONABLE JUDGEMENTS

This quotation is most pertinent to a discussion of nutrition and technology because one of the major nutritional consequences of technology has been the poor judgements that the consumer has made about food and nutrition due to an irrational fear of technology. We have seen the rise of a huge health and natural food industry, the growth of a tangled mass of governmental regulation and consumer paranoia due to a sense of impending doom prompted by a gross misunderstanding of science and technology along with a few notable failures which, although extremely serious, have often been given media coverage totally out of proportion to the actual or potential harm they might cause.

Why has the consumer "asked for this" now. Why are the demands for changes in technology so strident at this time, after all the world survived the Industrial Revolution with less fanfare about technology.

Edward W. Lawless (15) in his book Technology and Social Shock proposes an interesting explanation for this phenomenon:

"...public concern over technology is not entirely new. The successful science and technology of the eighteenth and nineteenth centuries not only generated much optimism for the future of mankind, but also led to tragic numbers of occupational injuries, sicknesses and deaths. In large measure, however, those were afflictions of the working classes, and the technological causes were readily understood; the hazards were regarded as acceptable, if not avoidable risks to the worker, and the rest of society was little concerned. In contrast, the nature of the hazards and the people who are concerned are now significantly different, because modern technologies can exert subtle influence far from the point of their use, and modern communications methods can make the discovery of an adverse effect know nationwide almost overnight. People thus learn that technologies, of which they may know little, pose hazards which they may only dimly understand. For the most part, they are dependent on the news media's descriptions of what the problem is and what is being done about it. They may have little confidence in their own ability to judge correctly the actual danger to themselves or how to avoid it. Thus the social shock can be very great."

Thus we have a situation where every new technological advance is viewed by the consumer with suspicion at best and fear at worst. This has resulted in a situation whereby consumers are asking for the familiar. Perhaps they know that "natural" is really not what its most ardent supporters claim, but at least it presents familiar risks which the consumer has previously decided upon as being acceptable or unacceptable. Lowrance (19) suggests that when a person is faced with a risk they must entertain two separate mental or social functions: to decide what the risk is; then to decide what to do about it. He goes on to point out that the term "risk" has several different meanings:
“One, in a somewhat stoic way, people simply endure the risk without complaining. They see no alternatives, and decide that for whatever reasons the hazard is just tolerable. A second meaning is that people know essentially what the risks are, but decide to accept them. Smoking is probably a very good example of that. At the other end of the spectrum are risks that we see as absolutely intolerable, such as chemicals or radiation that cause birth defects. In this case, it is more useful to speak of unacceptable risk, and we as a society or a subgroup of society decide to do something about reducing the risk. Of course, the ranking of a risk as acceptable or not is not an absolute line at all. Sometimes we worry about hazards that are not so risky as some others, and we probably let some hazards go unattended that we would worry more about if we really examined the statistics”.

It would seem that the consumer faced with making a decision about food which has been touched by technology often assigns it to the third category without examining the facts. This results in “getting what they asked for, without knowing what it is they asked for”. Perhaps this fear of technology might turn out to be the major negative nutritional consequence of technology.

**RISE OF NATURAL AND HEALTH FOOD INDUSTRIES**

One of the results of this situation has been the dramatic growth of the so-called “health and natural foods” industry. This is not a small, insignificant industry but an industry which has achieved some financial status. Barrett (3) recently presented some facts about the size of this industry which will be published in a forthcoming book (4). He estimates that the major food supplement, health food companies have sales of approximately $900 million per year and involve one million distributors selling person to person. To this figure we must also add 50,000 drugstores, 7,000 health food stores, 10,000 so-called “professionals” who prescribe and sell food supplements in their office and a publishing business which has produced some 3,000 books based on faulty nutrition concepts.

Magazines provide yet another aspect of this business. Barrett (3) estimates that Prevention magazine, published by Rodale Press, has a circulation of 2.4 million. Better Nutrition and Today’s Living are published by Syndicate Magazines in New York, which also has a 24-volume library of paperback books. These two magazines have circulations of about 500,000 each. They’re bought by health food stores and given away free to customers. Health Quarterly has a circulation of about 200,000. Let’s Live’s circulation is about 150,000, Bestways is about 130,000, and there is a new one called The Herbalist/New Health.

However, these numbers only account for the health food industry itself; what about some of our country’s largest and most respected food and household item companies? They have seen the sales figures and have also joined in to provide the consumer with what “they asked for”. Now we have “natural” shampoo, food, beer and even rat poison. D Con advertizes a new formula of natural ingredients for its poison. The logic behind this escapes me but perhaps this is what Huxley meant when he said that “they didn’t know what it was they were asking for”.

**GOVERNMENT INTERVENTION**

The second major result of these demands over the past 10 years has been an ever increasing involvement of the government in deciding how much and what we should eat. This activity culminated in chaos and confusion with the publication of the “Dietary Guidelines for American” by the U.S.D.A. and HEW (27), followed by the seemingly contradictory report by the Food and Nutrition Board of the National Academy of Sciences entitled, “Toward Healthful Diets” (10). The degree of concern such publications is evidenced by the fact that a symposium was held in April 1980 at the 64th Annual Meeting of the Federation of American Societies for Experimental Biology in Anaheim, California, aimed at discussing the confusion. The symposium was entitled “Nutrition Initiatives in the Federal Government”, and the proceedings are now available. (1).

**THE GOOD OLD DAYS**

Having examined some of the results of these demands, it might be instructive to look at the factuality of the data base to decide upon the wisdom of such changes.

Bettman (5) has written a very interesting book in which he describes life in the good old days and from which I have taken the following quotation:

“There is a benign nostalgia for the food of the Gilded Age, reinforced no doubt by the proliferation of old-fashioned cookbooks crammed with mouth-watering recipes. The cornucopia comes to mind as neatly symbolizing America’s blessed fertility which lured the half-starved Irishman across the ocean. Culinarily speaking, America appeared to be one gigantic, groaning board.

But the board in reality groaned only for a small minority of Americans. The country’s fertility notwithstanding, the masses were forced to subsist on a crude and scanty diet of which tea and bread were staples, supplemented now and then by a soup or stew of questionable origin. Ragpickers and fellow paupers ate what they could find in trash cans, and many people shopped for their dinner at the secondhand food market - a feature of large cities - where they could select from leftover groceries and castoff trimmings and bones from butcher shops.

With lack of hygenic standards, the established purveyors in the slum districts-from street vendor to corner grocer-sold food that would not today be considered fit for human consumption.
Nostalgia even for the food of most rural Americans cannot survive the light of truth. While to a degree substantial, their diet was very simple, monotonous and often far from healthful.

HEALTH OF AMERICANS TO-DAY

The next obvious question to be asked is can the advent of technology into the field of food and nutrition be correlated to an increase or decrease in the situation which Bettman describes?

According to the annual report of the Health and Human Services Department (13), the following developments occurred over the past decade (1970-1980):

- Life Expectancy of the newborn climbed to a record 73.3 years, an increase of 2.7 years since 1970.
- The death rate from heart disease, though still the nation’s No. 1 killer, dropped nearly 20%. The death rate from stroke declined 33%.
- Fewer people under age 49 are dying of cancer—the result of reduced lung cancer in younger men and advances in treatment of breast cancer in younger women, Hodgkin’s disease and childhood leukemia.
- Infant mortality rates reached a new low—13 deaths for every 1,000 births—a 47% drop since 1965.
- The incidence of childhood infectious diseases has fallen so low that measles soon will be eradicated as an indigenous disease. By 1990, doctors believe that rubella, or German measles, also will be wiped out.

The report also lists some minuses.

- For one thing, the death rate is rising for the 40 million Americans of ages 15 to 24—the result of accidents, violence, and alcohol and drug abuse.
- Deaths from motor-vehicle accidents, after declining in the mid-1970s are up again. Traffic-death rates rose 4% in 1977 and 7% in 1978.
- Some experts also fear that there may be too much unnecessary surgery. One concern: 15% of all births are now by Caesarean section—triple the proportion of a decade ago.
- On the money side, the nation’s health bill now exceeds 212 billion dollars a year. Nursing-home costs have risen 20% each year since 1967.
- At the same time, blacks and the poor have higher rates of illness—and stay sick longer—than do whites and the rich. The mortality rate for black infants is twice the rate for whites. Poor families see dentists only half as often as people with higher incomes and have more problems with teeth.

Still, U.S. Surgeon General Julius B. Richmond said he was “unabashedly upbeat” on making the report. “The health of the American people,” he insisted, “has never been better.”

RISK PRIORITIES

It would seem that the consumer might be placing the relationship between technology and food in the wrong risk category. Perhaps it might be wise if they were to rearrange their priorities and look more closely at accidents, violence, alcohol and drug abuse. It is interesting to note that consumers decry the use of a tablespoon of sugar in a bowl of cereal as they sip on their third martini before dinner. As well, television, radio and newspaper advertisements tell us that we can only run 10 miles if we end the run with a certain type of beer. Other brands of beer have chosen to imply that certain sports are only played well when you bet their brand on the outcome, while still another tells the youth of our nation that it is the beer of the Olympics. Isn’t it incredible that with this type of advertising some consumer groups still ignore the risks of alcohol and concentrate instead on Saturday morning cartoon advertising or soft drinks. These same manufacturers promote their “natural” beers when they know full well that no food additive is as toxic as alcohol itself. These statements are not meant to support a ban on alcohol, or, heaven forbid, more regulation. However, the need for the consumer to reassess risk is critical, and it is important to point out that the dangers of alcohol are certainly not technology-related but are due to its abuse.

Lieber (18) has pointed out that alcoholism is now recognized to be a major, if not the major social problem confronting our society today. Of particular concern has been its steady growth. Indeed over the last three to four decades there has been a significant increase in alcoholism, with present statistics estimating 10 million alcoholics in the United States alone. In large American hospital systems, such as that of the Veterans Administration, the incidence of alcoholism and its medical complications is considered second only to cardiovascular disease.

In particular, the prevalence of cirrhosis of the liver has now reached such a magnitude that this complication of alcoholism represents, in and by itself, a major public health problem. We now recognize that 75% of all deaths attributable to alcoholism are due to cirrhosis of the liver. In the United States, cirrhosis has overtaken diabetes as the fifth cause of mortality; in large urban areas, it has become the third cause of all deaths in the active age group of 25 to 65 years. Although not all cirrhotic subjects are alcoholics, it is generally recognized that most patients with cirrhosis do admit to excessive alcohol consumption.

Lieber (18) also points out that although malnutrition can occur in the alcoholic, it is now evident that alcohol-related complications cannot be prevented by controlling the diet; it is also essential to control alcohol intake. Alcohol is also a good example of the dietary substances that can promote cancer (27). Reif (23) points out that for smokers who also drink, alcohol greatly amplifies the risk of cancer at the sites where both smoke and alcohol impinge: the mouth, the larynx and the esophagus. However, even for nonsmokers, the risk of cancer at these sites is two to three times greater for moderately heavy drinkers than for those who do not drink, yet this simple fact is rarely mentioned to the...
consumer. It must be remembered that to-day's consumers are extremely intelligent, but we must provide them with an adequate data base so that they can make appropriate decisions. For instance, in this inflation-ridden society we deal with today, we can hardly afford huge health costs entirely aside from the tragic social costs. Therefore it should be pointed out that if one considers the nutrition-related diseases, the cost due to alcohol abuse is some $20 billion per year, which is equal to that for all other nutrition-related diseases combined as shown in Table 1 (25). Recognizing the dangers of drinking in pregnancy and the risk to the newborn of fetal alcohol syndrome, Senator Strom Thurmond (R-S.C.) introduced a bill (S1543) the last week in July 1981 (26) that would require a health warning on the labels of alcoholic beverages that contain more than 24% alcohol. The bill, which would amend the Federal Alcohol Administration Act, was sent to the Senate Committee on Commerce, Science and Transportation for consideration. The proposed warning would read: "Caution: The Surgeon General has determined that consumption of alcoholic beverages during pregnancy can cause serious birth defects. Alcohol can also impair driving ability, create dependency or addiction and can contribute to other major serious health hazards.”

TABLE 1. The cost of poor nutritional status which contributes to some of the diseases in the United States. Briggs 1977, from Select Committee report (25).

<table>
<thead>
<tr>
<th>Disease</th>
<th>Cost (Billion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dental diseases</td>
<td>3</td>
</tr>
<tr>
<td>Diabetes</td>
<td>4</td>
</tr>
<tr>
<td>Cardiovascular disease</td>
<td>10</td>
</tr>
<tr>
<td>Alcohol</td>
<td>20</td>
</tr>
<tr>
<td>Digestive diseases</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>$40</td>
</tr>
</tbody>
</table>

**TECHNOLOGY AND SURVIVAL**

The U.S. is reported to have the greatest abundance of food in the history of the world. Without technology this most certainly would not be true. World-wide, population is growing, availability of conventional energy is decreasing and food supplies per person are dwindling. Unfortunately, it seems that an acceptance of the population problem is developing, which implies that things aren't all that bad: consider the following quotation from U.S. News and World Report (22).

“If you remember those alarming predictions that world population would grow three or four times the current number until the globe was packed with 14 to 16 billion humans - now the United Nations has a happier forecast:

The world's population will stabilize at 10.5 billion by the year 2110. With luck and good population-limitation campaigns, number could be 8 billion.

Big increase still will be in poor countries of Asia and Africa, with 60% of world population in 2110. Feeding them will be a major problem”.

However, I want to assure you that things are all that bad with 10.5 billion people. Not only for feeding but for energy. Hafele (11), when considering the energy problems with 8 billion people (not 10.5) in the year 2030, stated that it will be neither easy nor automatic to sustain the lives of this many people but it could be done. I would like to add that such sustenance will require some massive worldwide political, social and economic rearrangements.

The world cannot survive without technology. For instance, without pesticides we would be faced with losses of 50 to 80% of our crops worldwide. Problems with weeds alone are formidable. The Department of Agriculture recently estimated that about 10% of U.S. agricultural production is lost because of weeds. This loss amounts to more than $12 billion per year. An additional $6.2 billion is spent each year to control weeds. Thus the costs of weeds to agriculture add up to more than $18 billion annually (24).

It is essential that developing countries begin to incorporate technology. This does not mean a direct transfer of our technology, but it does mean utilizing technology in a manner appropriate to their culture, labor force and social mores. This must be done because now the world rests its hunger problems on only a few producing areas. These areas use technology but a poor harvest could be disasterous, as the FAO warns (14):

“FAO experts warn, the only hope of averting a disastrous world food crisis in 1981 is a good harvest in the main producing areas. Six years after the World Food Conference and its pledge to eliminate hunger, world food security is once again in jeopardy.”

Without processing and technology we would always have fat and lean seasons and years. Certainly we would all agree that food freshly picked, rushed to the kitchen and eaten immediately is the most nutritious and has the highest quality. However, try, a vine-ripened tomato grown in Boston in January!

Losses due to processing exist and cannot be ignored or discounted. However, the aim of technology should be to decrease the losses while increasing quality. Both home-preparation and industrial procedures may have an adverse effect on vitamins, particularly if care is not taken (9). Also, certain minerals, like iron, may be made either more or less available by processing procedures (6, 16). Other processing procedures improve certain nutritional characteristics in some foods as shown in Table 2. Of course, the fortification of foods is a tremendous technological success story and has been discussed by Clydesdale (7) along with the added convenience technology has provided.

**THE QUESTION OF SAFETY**

Aside from agricultural production, technology and modern food processing has probably had its greatest impact on the safety of today's food. Sodium arsenite and
Change in basic composition
control and crop spraying at the turn of the century
other arsenic compounds were commonly used for weed
control and crop spraying at the turn of the century (24).
Toxic compounds were used to color foods and
samples and found
Health Commission of New
were mistrusted and there were stories of canned meat
devolved a classic definition of food:

TABLE 2. Nutritional characteristics of foods improved by
processing (20).

<table>
<thead>
<tr>
<th>Component</th>
<th>Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elimination of compounds that destroy or bind vitamins</td>
<td>Ascorbic acid oxidase in tomato juice</td>
</tr>
<tr>
<td></td>
<td>Thiaminase in clams</td>
</tr>
<tr>
<td></td>
<td>Avidin in egg white</td>
</tr>
<tr>
<td></td>
<td>Peroxides in vegetable oils</td>
</tr>
<tr>
<td>Elimination of anti-enzymes that interfere with digestion</td>
<td>Antitryptic factor in beans and egg white</td>
</tr>
<tr>
<td>Addition of essential nutrients</td>
<td>Enriched flour</td>
</tr>
<tr>
<td>Addition of protective minerals</td>
<td>Iodine to salt</td>
</tr>
<tr>
<td></td>
<td>Flouride to drinking water</td>
</tr>
<tr>
<td>Change in basic composition</td>
<td>Polyunsaturated vegetable oils in margarine</td>
</tr>
<tr>
<td></td>
<td>Liquid vegetable oils replacing more saturated fats in animal products (milk, meat)</td>
</tr>
<tr>
<td></td>
<td>Reduction in cholesterol intake - low cholesterol egg products</td>
</tr>
</tbody>
</table>

Consumers must learn that use of additives is not new
in the twentieth century. When humans first learned
that fire would cook and preserve their meat and that salt
(sodium chloride) would preserve it without cooking, they
began to use additives. Food colors were used in ancient
Egypt. In China, kerosene was burned to ripen bananas;
the reason this method succeeded, although the Chinese
did not know it, was that the combustion produced the
ripening agent, ethylene. Flavoring and seasoning were
arts in many ancient civilizations, and as a result, spices
and condiments were important items of commerce.
Columbus sailed for the Indies in search of food
additives—that is, spices. As our knowledge of food
preservation and technology has increased, our use of
additives has also increased (9).

Scientists are really not smart enough to invent all the
additives. Historically, they observed that certain foods
didn’t spoil and upon analysis and trial and error they
found the ingredient which was responsible. They added
this ingredient to another food and achieved the same
effect. Thus a food additive was born.

**FOOD ADDITIVE USAGE**

It is interesting to look at the use of food additives in the
U.S. to gain perspective on our consumption. The per
capita consumption of food additives has been calculated
to be about 140 lb a year, which upon initial examination
seems very high. Let’s look at the kinds of additives that
make up this 140 lb. The most widely used food additives
is a natural product, a single chemical of high purity that
is produced in abundance. This additive is sucrose—that is,
ordinary cane or beet sugar, and each person in North
America consumes an average of 102 lb of it per year.
The second most widely used additive is sodium chloride
(ordinary table salt), of which we use about 15 lb per
year. After salt comes corn syrup, about 8 lb, and then
dextrose (a simple sugar), 4 lb. Note that the 139 lb had
dwindled to 10 lb if we exclude sugar, salt, corn syrup,
and dextrose from our list. Following these are about 33
different additives, which account for 9 lb a year. Of
these 33, 18 are used either as leavening agents or to
adjust the acidity of food. Yeast, sodium bicarbonate,
citric acid, black pepper, mustard, and the much abused
but innocent monosodium glutamate (MSG) are among
the most often used of these 18.

We hope that you are beginning to realize why we are
not concerned about food additives. Our list is now down
to 1 lb, which is spread over the same 1800 other
additives we use. The median level of use of these is about one-half a milligram per additive per year—the weight of one grain of salt per year (12).

Weigh these facts against the benefits of additives, including cost, and you have a risk/benefit equation. Consider that additives save money. If additives were removed from bread, margarine, processed meats and processed cheese, it would increase costs to the consumer by a factor of $2,332,000,000, a sizable figure (2). I do not mean to imply that a cost saving or a cosmetic change should even be weighed against safety, it should not. If any food is deemed to contain or cause disease when consumed at a reasonable level it should be taken off the market. However, when extremely high dosage levels are required to produce a questionable effect, then perhaps the benefit side of the equation should be considered.

SANITY OR STARVATION

In conclusion, I would like to point out that when one sees a reference to the fact that the health of the American public is being threatened by today’s processed food it implies one of two things: (a) in the good old days people lived longer with less disease and didn’t use or need processed food, (b) somehow the processing which was used back in the good old days was less dangerous that that used today. The first shows a total ignorance of history and the second a total ignorance of science and technology. The statements are wrong.

Nutrition means more than the nutrients in a food. It means the consumption of that food which implies year-round availability, safety, reasonable cost, convenience, quality, individual diet control, knowledge and life style. Remember that Americans have the opportunity to become the best-fed and healthiest people in history. However, like all good things, this requires individual responsibility and effort.

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REFERENCES


