Picowave processing can safeguard your food

Those who would delay or prevent the use of this technology are condemning millions to unnecessary illnesses and even death! Researcher Niel E. Nielson reports.

After more than 30 years of investigation, to a depth of understanding unprecedented in food processing and food safety, the Food and Drug Administration issued regulations in April 1986 enabling the use of electromagnetic energy at picometer (one-trillionth of a meter) wavelengths in the processing of foods. The safety of use of this technology has been confirmed by *every* established, recognized, professional organization and regulatory agency knowledgeable in matters of food safety and the other disciplines concerned with use of this technology. *No* other food processing technique enjoys this level of support for its safety (certainly such long-used processes as broiling, toasting, and baking at high heat don't, because it is now believed that these processes can produce carcinogens). *No* other food processing technique has been so thoroughly investigated! *No* other food processing technique offers the potential for immediately (as its use becomes widespread) reducing the several thousand deaths that result annually from "food poisoning," and the thousands of cases of distress and incapacitation that occur annually as a result of "food poisoning."

Extremely well qualified scientists from many professional and governmental organizations have concluded that use of picowaves in the processing of foods would not, in any way, increase risks for consumers or significantly reduce vitamin content in foods.

In spite of this there have recently been:

1) a number of questionable, unacceptably supported, publications questioning the safety of using electromagnetic energy at picometer wavelengths in the processing of foods;

2) organizations formed by persons who wish to capitalize (in several ways) upon the lack of understanding of the technology by that segment of the public which is distrustful of governmental agencies and/or the scientifically based institutions (both in and out of government) and which chooses to believe unsupported sources of information, and

3) newly formed groups and organizations that have gone to legislatures, boards of supervisors, city councils, and so on, with half-truths, with long-since-discredited scientific works, with quotations from "authorities" who have already been discredited, and with publications by authors not recognized by the respected scientific community—all with the intention of impeding or stopping the use of picowave processing of foods.

In spite of the overwhelming support by the most respected of scientists and organizations throughout the world for use of this picowave food processing technology, the groups that would obstruct use of this technology have "sold" some elected officials and state legislators and even convinced some legislators, city, county, and state officials, and others, to sponsor bills, resolutions, and ordinances to create impediments to or even to block the use of this technology. Apparently there are officials and legislators so totally ignorant of the recognized scientific institutions and the processes they employ in reaching a collective position on matters in which they are expert, that they have "bought" the unsupported allegations of the antinuclear activists. In light of the overwhelming scientific and regulatory agency support for use of this technology, the efforts to impede the progress of the use of this picowave processing of foods are at least misguided. In light of the illness, death, and financial loss that could be

avoided or reduced by widespread use of this technology, the actions of opportunists with any scientific training of significance, who would influence others to prevent its use, are irresponsible.

It is the widespread and authoritative conclusion of the very cautious, established, recognized scientific community, and the regulatory agencies, that use of this picowave processing technology on foods will *not* increase risks for consumers. In addition, there is widespread belief in this knowledgeable, established scientific community that there is strong scientifically undeniable evidence that widespread use of this picowave processing technology will enable very significant improvements in the quality of life for all of mankind.

This author would think that those who have in good faith supported the leaders of the opportunistic anti-food irradiation organizations trying to prevent use of thi wave processing technology would be very angry at being so badly deceived by those leaders.

In congressional testimony given on Nov. 18, 1985, before the subcommittee on Operations, Research and Foreign Agriculture of the House Committee on Agriculture, this author described just how these opportunists and obstructionists use the scientific community's own very thorough and open practices and procedures to twist information contained in scientific publications to suit their own purposes. These opportunists use the classic approaches of half-truths, omissions, out-of-context quotations, and fail to cite any pertinent work except that which they can use to their own advantage, or fail to cite discrediting subsequent work or reviews. In short, these opportunists who would impede or prevent the use of this picowave processing of foods are at least dishonest, and their actions, even if only partially successful, will bring unconscionable, unnecessary grief, distress, and even death to citizens of the United States and other nations.

The purpose of this paper is to substantiate the foregoing, to highlight the important considerations in this involved and sometimes complex subject, and to give some guidance on where to find authoritative information to any reader who is seriously interested in finding more information on any aspect of this subject and in honestly trying to find the truth.

The term 'food irradiation'

For purposes of clarification and accuracy, it must be pointed out that the obstructionists worked very hard to have the FDA require the use of the expression "food irradiation" instead of "picowaved" in the regulations and the labeling, and were successful in having the FDA change the regulations already signed by then-Health and Human Services Secretary Margaret M. Heckler in 1986. They have done the public, as well as the FDA, a very obvious disservice, as this paper will make very clear.

Niel E. Nielson

The author was born in 1929, has a degree in Physical Sciences, and has spent most of his professional career as part of, or as Chief Operating Officer of, organizations and efforts to bring new scientific developments into practical use. For more than 20 years, he has been involved in providing the public sector with the means to use electromagnetic energy at wavelengths of one-trillionth of a meter (picowaves) for purposes of improving public health and the quality of life for all mankind.

The expression "food irradiation" is an overly broad, unnecessarily alarming name for the application of any specific type or wavelength of radiation to food. Its literal definition includes every form of radiation being applied to food, including effective but safe types (such as electromagnetic energy at picometer wavelengths, which is the principal focus of the regulations), ineffective types (small amounts of visible light), and including dangerous types (exposing foods to high-energy neutron radiations).

Many more knowledgeable authorities use the expression "picowave processing of foods" because of its accurate definition of the type and wavelength—electromagnetic energy (that is, waves) at picometer (one trillionth of a meter) wavelengths.

It is important to point out that picowaves can be generated not only by radioisotopes but also by electronic devices called linear accelerators that have added conversion devices. The accelerator is like a giant version of the "gun" in a television set's picture tube, and the conversion device is like the TV screen which converts the electron energy to light.

There is not much doubt that this electronic technique for picowave generation will be by far the most widespread in large-scale food processing plants of the future. Now, radioisotopes cobalt-60 and cesium-137 are the most prevalent source of picowave energy. A significant fraction of all medical disposables and personal hygiene items, for example, is sterilized with picowaves using these radioisotopes as the source of energy, today. The disadvantages of these radioisotope sources are that they are very limited in availability,

they must be disposed of when their usable lifetime is ended, and they have to be replenished at least annually. In addition, the wavelengths of cobalt-60 and cesium-137 emissions are fixed and can't be varied. Thus, electronically generated picowave energy can be considerably more effective in processing pallet loads of goods, since that energy can be produced with much shorter wavelengths.

Most important, the use of linear accelerators to generate picowaves removes one of the main arguments of the antinuclear obstructionists who make an issue of the use, handling, transportation, storage, production, and disposal of radioactive materials used to produce picowaves in their effort to stop the use of this technology in the processing of foods. Since this author and most of the processors of the future will be involved only in the use of electronically generated picowaves, this argument will be invalid.

Those who would obstruct or prevent use of this picowave processing technology on foods are saying that they have all of the right answers, and that the *recognized* technical and scientific community, worldwide not only doesn't know what it is talking about, but also is trying to deceive and poison the world. Obviously, these recognized scientists and institutions are not incompetent, and it is totally irresponsible of any group to even suggest that such scientists and organizations would advocate use of a technology about which there were any remaining concerns for safety of the consumer. It must be obvious that the objectives of those who would try to prevent use of this technology are suspect and must be questioned.

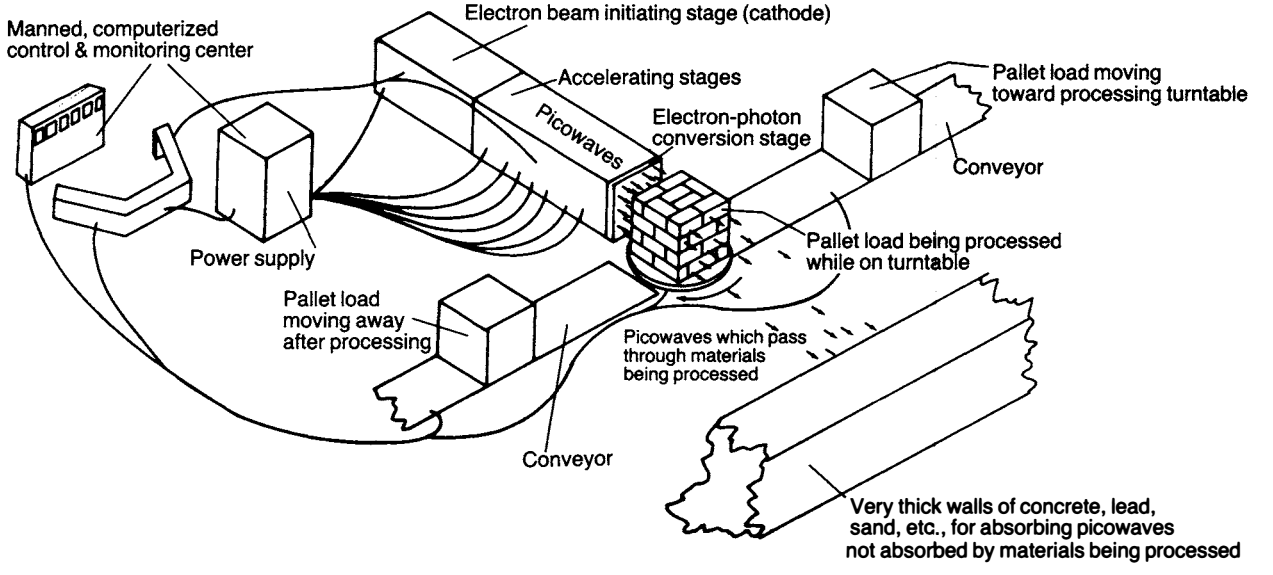
What are the facts?

Here are some of the facts about the use of picowave technology in food processing that are supported by a great many responsible agencies and individuals throughout the world (see box on page 22):

1) *There are no repeatable, verifiable, acceptable studies concluding that there will be an increase in risk for consumers from eating foods processed with picowaves!*[1]

There is one specific example that is constantly repeated by the antinuclear obstructionists who allege that picowaved foods increase risks, despite the fact that this particular example has been discredited by the scientific community. This example concerns conclusions drawn in several publications (1975 and 1978) on three studies by scientists of the India National Institute of Nutrition (Vijayalaxmi, Sadasivan, and Bhaskaram) which contended that abnormal white blood cells (chromosomal changes—polyploidy) resulted from a small number of badly malnourished children, monkeys, and rats, being fed irradiated wheat. These National Institute of Nutrition (NIN) studies were proven to be incorrect, mutually contradictory, and unacceptable by investigations conducted by a government-convened Committee of Indian Scientists and by officials from WHO, FAO, and IAEA. Of special significance is that the NIN researchers reported a normal chromosomal condition for the children fed the irradiated wheat, and an abnormal situation for those children fed the

FIGURE 1
Principal elements of the picowave processing centers



Source: Niel E. Nielson.

non-irradiated wheat.[2]

2) *There is no scientifically supportable reason (whether by experimentation or by well-supported theory) to believe that there will be any greater (if as much) destruction of vitamins and nutrients to result from processing foods with the doses of picowave defined in the FDA's regulations than will result from use of various common practices.* Examples of such common practices include letting fruit juices be exposed to light from essentially any source for a few minutes, heating essentially any food (whether in ovens, pans, or pots), boiling essentially any food, heating processes necessarily employed in many fumigation practices and procedures, or letting fruit dry/cure in sunlight. In other words, picowave processing will not do as much to reduce the the nutritional content of foods as is now being done by common cooking, canning, or disinfestation processes.[3]

3) *Both the obstructionists and the knowledgeable scientific community know that there is no absolutely safe food known to exist. Therefore, in spite of the obstructionists' devious writings suggesting that the picowave processing of foods should be proven absolutely safe,* they know that the proof they purport to want can never be realized. Anyone who has taken the time to study this subject of food safety will have studied the excellent, updated publication by the National Academy of Sciences "Toxicants Occurring Naturally in Foods" (ISBN 0-309-02117-0) and will have already concluded that the proving of absolute safety in foods is an impossible objective.[4]

Further insight into this food safety question can be realized by reading the publication resulting from congressional hearings on the subject. The Senate Agriculture Committee held hearings on this subject of food safety in 1979 and published "Food Safety: Where are We?" in July 1979.[5] This document should be studied by anyone interested in establishing a true perspective in matters of food safety.

From another viewpoint, annually there are significant numbers of people who are made ill, seriously ill, and even killed as a result of complications resulting from ingesting bacteria and microbes in foods.[6] In the briefest of summaries, the United States enjoys some of the safest food in the history of mankind, but it is not *absolutely* safe, and probably never will be. Those who would obstruct use of this picowave food processing technology fail to tell those who will listen to them about the truth and perspectives in food safety, and hope to block the use of the technology by having an uninformed populace insist upon *absolute* safety.

4) *Another focus of those who would obstruct use of this picowave processing technology on foods concerns "experts" who advocate long-term feeding studies (that is, those more than 20 years) using human beings.* Obviously, there would be no way, in a free society, of having such rigorous controls and tests on thousands of individuals for large fractions of their lives. This condition, therefore, could never be met.

FIGURE 2
Electromagnetic waves

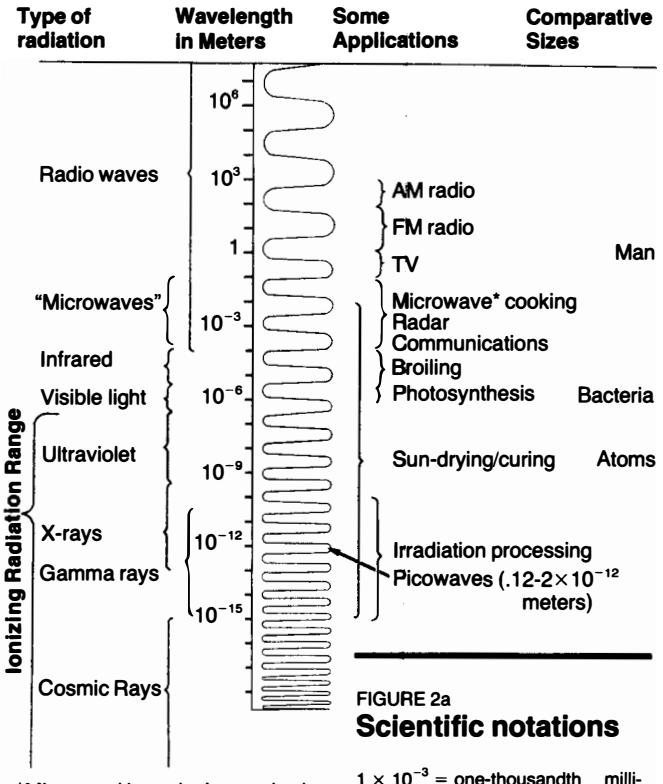


FIGURE 2a
Scientific notations

1×10^{-3} = one-thousandth milli-
1×10^{-6} = one-millionth micro-
1×10^{-9} = one-billionth nano-
1×10^{-12} = one-trillionth pico-

Source: Niel E. Nielson.

Furthermore, the credentials of the "experts" used by these obstructionists are suspect. For example, one of the antinuclear "experts" most frequently quoted is one Dr. John Gofman, who has advocated these multi-year studies. Here is how Judge Patrick F. Kelley of the U.S. District Court in Kansas characterized Gofman in a 150-page decision that he wrote after 42 days of testimony by 53 witnesses, 5,400 pages of trial transcripts, and 10 months of study: "This Court does find that Dr. Gofman's dramatic conflict with all of the world's experts creates a bias in him which destroys his credibility as an expert witness in radiation cases. His obsession blinds his objectivity."

5) *There are no Unique Radiolytical Products (URPs) produced by picowave processing of food to be ingested by consumers, if by unique is meant that they are not already contained in the air, food, and water we routinely ingest.* The allegation that the obstructionists often make is that there are such URPs—unique chemical forms being produced by picowave processing of foods.

The FDA, years ago, defined URPs as products that are not in the foods prior to "irradiation." This FDA definition of URPs has caused them many hours of explanations, since there are no chemicals produced in foods by "irradiation" that are not already being ingested by mankind, routinely, either because they are naturally found in some foods, or because they are the result of chemical changes caused by cooking, preservation, drying, or curing.

Anyone knowledgeable in food safety matters knows that it is impossible to put any significant amount of energy into foods without causing chemical changes in the foods. *All* forms of energy, all cooking, all drying/curing, and so forth, cause very significant chemical changes in foods, including "destruction" of vitamins. With picowave processing, very small amounts of energy are put into the foods, with the result that very small amounts of vitamins are changed.[7] The amount of chemical change is almost always in direct proportion to the amount of energy put into the foods.

The energy equivalent to that allowed to be put into foods within the FDA's "food irradiation" regulations[8] is extremely small when considering any other processing of foods (that is, 100 kilorads = 1 kilogray is approximately equivalent to one-half BTU: One BTU is the energy required to raise one pound of water one degree Fahrenheit). It is easy to see that, among the other ionizing food processes, pasteurizing milk subjects foods to more than 200 times as much equivalent energy, as picowave processing at 100 kilorads does. Baking foods at 350°F subjects foods to more than 600 times as much energy; microwave cooking subjects the interior of the foods to more than 200 times as much energy to achieve the same degree of microbial kill; and charbroiling subjects the surface of the foods to much more than 1,000 times as much energy. It is easy to understand why processing with picowaves produces far fewer chemical changes than does any of the other ionizing heat-employing processes.

Another perspective can be realized by calculating the theoretical number of molecules in foods that would be affected by 100-kilorad doses of picowaves. A prominent researcher in radiation chemistry and physics at the University of California at Davis calculates that 100 kilorads would cause ionizations in only 1 molecule in 10 million. In contrast, all of the heat-employing processes have to affect *every* molecule in the food.

The 'ionization' issue

Another issue distorted by the would-be obstructors to use of this technology concerns the fact that picowaves are "ionizing" energy. However, these obstructors fail to tell those who would listen to them that ionizations can be caused by *any* energy source, including heat and many chemicals. Ionizing radiations that cause significant chemical changes in foods begin at the longest of the ultraviolet wavelengths. These are the wavelengths that are closest to the visible light spectrum, but just a little too short for the human eye to see—close to one-millionth of a meter in wavelength. They go through all of the successively shorter wavelengths of electromagnetic energy, including the shortest of the ultraviolet wavelengths (0.013 millionths of a meter), the industrial and medical x-rays (approximately 200 trillionths of a meter in wavelength), and into the shortest portion of the safely usable electromagnetic spectrum, the picowaves, which include x-rays and gamma rays at almost precisely 1 picometer wavelengths.

In terms of food processing with "ionizing radiation," one must realize that broiling over hot coals or under glowing elements, toasting, and sun drying and curing are excellent examples of processing foods with a great deal more "ionizing energy" than processing foods as the FDA's regulations would permit using picowaves.

We can gain perspective in the amounts of ionizing radiation already being applied to foods in the oldest, and most widespread, worldwide food preservation technique when we consider use of the Sun's ionizing radiations in the curing of foods after harvest. It is a fact that 5% of the Sun's rays that reach the Earth's surface are ionizing radiations in the ultraviolet spectrum. It is also a fact that during the warmer six months of the year (in central California) the amount of solar energy reaching the Earth's surface is something considerably more than 2,000 BTUs per square foot, per day.[9]

From these facts, it is easily calculated that foods absorb megarads (millions of rads) of ionizing radiation when left in the Sun for days for curing and drying (the ionizing ultraviolet radiation from the Sun kills the exposed microbes and causes the ionizations that result in the chemical changes). It is important to note that the "skins" of living plants and animals selectively "shield" the interiors from the harmful ultraviolet radiations, and thus foods processed with the Sun's ionizing ultraviolet radiations must be opened up or have the skins removed, in order to allow the ultraviolet to reach the interior of the foods.

To complete this understanding of "ionization": a) the term simply means the addition or subtraction of the number of electrons normally held captive to an atom or molecule; b) ionization of an atom in a molecule can result in the molecule's atoms dissociating from the molecule while they seek to return to their normal number of electrons held captive; and c) it is well established that up through (in energy levels) picowaves, the shorter wavelengths (higher energy levels of photons) do not cause different ionizations, simply more of them per photon.[10]

For all of these reasons, it should not be a surprise that after years of study of the chemistry of representatives of every major food group, before and after processing with picowaves, highly respected scientists found *no* chemical species that were not already in the air, food, and water that mankind routinely ingests.[11]

Those who would obstruct use of this technology, and

who would attempt to frighten the public with unfamiliar terminology, fail to tell the public about these true perspectives in "ionizing radiations" and to explain to those who will listen to them what ionizations are.

Because of more than 30 years of intense study and hundreds of millions of dollars invested in those studies and research by highly qualified scientists in academia, industry, and regulatory agencies worldwide, it is a fair statement to make that the scientific community knows more about the chemistry and microbiology of processing foods with picowaves than it does about processing foods with any other technology, including all of those commonly used by industry, commercial kitchens, and domestic kitchens. From all of this study and research comes the learned consensus among those truly knowledgeable in this field, that there is *no* reason to believe that there will be any increase in risk for consumers of foods processed with picowaves under regulations issued by FDA.

Decrease in illness and death

But there is more! In addition to knowing with the highest possible certainty that there is *no* reason to believe that there will be *any* increase in risk from eating picowave processed foods, it is also widely known in the scientific community knowledgeable on this subject that there is great promise held for *reducing* risks for consumers from food-borne disease (both serious and inconveniencing) and even for preventing thousands of deaths per year, in the United States alone, by routine processing of a great number of foods with this technology.

The USDA, the U.S. Centers for Disease Control, and others have published the results and statistics of studies of the incidence of infections resulting form eating foods containing the more frequently encountered disease-causing bacteria and parasites. The USDA has attempted to assign a dollar value to the cost to the nation's citizenry for the infections of these food-borne diseases, and the number is in the range of $1 to $10 billion annually, without taking into consideration the costs of the human suffering involved.

In terms of the diseases salmonellosis, campylbacteriosis, toxoplasmosis, and trichinosis, the statistics and projections can be summarized as follows:[12]

Mild cases=>4 million cases/year

More acute, or very serious=>140,000 cases/year

Deaths=>4,500 cases/year.

Three factors are important to understanding just how routine processing of foods with picowaves could materially reduce the incidence of disease and even death from a too high count of disease-causing bacteria and parasites in the foods, in the United States alone:

1) Most of the bacterial infections that occur are caused by organisims with 90% kill sensitivities of much less than 100 kilorads (1 kilogray) of picowaves (the upper limit for most foods as defined in the FDA regulations.)

Free food distribution in Washington, D.C. The already dwindling food supply is under further attack from groups spreading hysteria against picowave food processing, such as the one that circulated this leaflet (inset) in New Jersey, targeting a food irradiation plant. Are you gullible enough to let the anti-nuclear freaks ready a hungry future for your family?

Who is backing food irradiation?

Some of the institutions, organizations, and agencies which have gone on record with conclusions to the effect that there will be no increase in risk for consumers from "irradiated" foods include the following:

FDA: The U.S. Food and Drug Administration, and in this matter, especially, the Center for Food Safety and Applied Nutrition (formerly, the Bureau of Foods). FDA is part of the Public Health Service, a division of the Department of Health and Human Services, and under the Federal Food, Drug and Cosmetics Act, has jurisdiction on the applications of radiation to the processing of foods.

USDA: U.S. Department of Agriculture, especially the Food Safety Inspection Service (FSIS)

EPA: Environmental Protection Agency

NFS: National Fisheries Service, within the U.S. Department of Commerce

WHO: World Health Organization

FAO: Food and Agriculture Organization

IAEA: International Atomic Energy Agency

AMA: American Medical Association

CAST: Council for Agricultural Science and Technology

IFT: Institute of Food Technologists

ACSH: American Council on Science and Health

NAS: National Academy of Sciences

NSF: National Science Foundation

NIH: National Institutes of Health (another branch of FDA)

R&DA: Research & Development Associates

NFPA: National Food Processors Association

CFI: Coalition for Food Irradiation

AIF: Atomic Industrial Forum

CRA: Committee on Radiation Applications

ESNA: European Society for Nuclear methods in Agriculture

OSTP: The President's Office of Science and Technology Policy

ANS: American Nuclear Society

2) Most of the parasites (for example, trichinae and other worms) are made incapable of reproduction and thus incapable of causing problems in human beings with doses of much less than 100 kilorads of picowaves.

3) Most of the bacterial infections require some minimum number of infecting organisms to be present (that is, salmonella are believed to have to be in concentrations of approximately 10 cells per gram of food) before a normally healthy person's immune system cannot prevent discomfort or serious illness, or death.

4) Most food contaminations are in low enough concentrations (that is, number of cells per gram) that a greater than 90% kill of those bacteria present would reduce the incidence of disease by very significant numbers.

One conservative, highly respected European scientist and researcher in food irradiation makes the statement in a paper dated May 1986, "Extensive literature supports the conclusion that radiation treatment at doses that do not cause unacceptable changes in organoleptic qualities can effectively eliminate potentially pathogenic non-sporing bacteria from red meat, poultry and fishery products under normal commercial conditions for products which are marketed in both fresh and frozen stage."[13]

The FDA regulations issued on April 18, 1986 concerning food irradiation are extremely well supported by the scientific community, but still are drafted with an ultra-conservative approach to use of this picowave processing technology. The regulations will allow a reduction in the quantities of unwanted post-harvest chemical additions to the foods for insect disinfestation, but they still do not allow the higher doses or applications to meats, poultry, or fish and seafoods (although petitions for these are reportedly now in the works), which will be necessary for this technology to reach its full potential in terms of improvements in public health and in the quality of life.

Still another public health benefit, and reduction in risks for consumers from eating foods, comes from the ability to use this picowave food processing technology to control the post-harvest movement of insects from one region to another, thus reducing the need to disinfest the fresh fruits and vegetables by using chemical fumigants.[14] Further reductions in chemical additives such as nitrites to the foods could result from use of picowaves in preservation processing.[15]

Summary

From all of these studies and authoritative conclusions, by recognized scientists and institutions throughout the world, and the many references each of these publications makes, the following obvious conclusions can be drawn:

1) There will be no increase in risk for consumers as a result of eating picowave processed foods!

2) Those who would delay or prevent the use of this picowave processing technology on foods are condemning a statistically significant number of people in the United States (and in the many other nations of the world who use the FDA's food laws as their own) to unnecessary distress, ill-

nesses, and even death!

3) In order for *anyone* to *not* agree with the preceding two conclusions, they must believe that the established, most highly respected scientists and scientific institutions in the world are incompetent and do not know what they are talking about. Such a belief is obviously an absurdity, and thus it must be concluded that: These people who are working to obstruct or prevent use of this picowave processing technology on foods must have objectives which have nothing to do with real, actual improvements in public health, improvements in environmental health, and/or improvements in the quality of life for all of mankind, since all of these benefits are sure to be realized by widespread, expanded use of this picowave processing applied to foods!

Notes

1. See the World Health Organization, Food and Agriculture Organization, and International Atomic Energy Agency's joint publication, "Wholesomeness of Irradiated Food," WHO publication Technical Report Series 659, WHO, 1981. See also the U.S. FDA's Rules and Regulations publication in the *Federal Register,* Vol. 51, No. 72, "Irradiation in the Production, Processing, and Handling of Food"; Final Rule, April 18, 1986.
2. "Wholesomeness of Irradiated Foods: A Review," by Ari Brynjolfsson, Department of Biological Sciences, Massachusetts Institute of Technology, April 1985.
3. See the aforementioned FDA and WHO publications, and their several references.
4. See the aforementioned FDA publications of April 1986 and December 1988.
5. Stock No. 052-070-050232-3.
6. See the FDA's "Workshop on New Microbiological Concerns," April 8-9, 1986. A presentation abstract is available from FDA, Center for Food Safety and Applied Nutrition.
7. See the FDA's aforementioned April 18, 1986 and Dec. 30, 1988 publications in the *Federal Register*; see the WHO 1981 publication "Wholesomeness of Irradiated Food"; see "Nutritional Aspects of Food Irradiation: An Overview," by E.S. Josephson, M.H. Thomas, and W.K. Calhoun, MIT, Dec. 18, 1978.
8. See the FDA publication of April 18, 1986.
9. See ASHRAE *Handbook of Fundamentals,* and "Input Data for Solar Systems," a U.S. Department of Commerce National Climatic Center publication, 1978.
10. See "Preservation of Foods by Ionizing Radiation," E.S. Josephson and M.S. Peterson, eds., sections by Simic, M.G., Taub, I.A., and other sections, CRC Press, 1983. See also, "Wholesomeness of Irradiated Foods: A Review" by Ari Brynjolfsson, the aforementioned FDA publications, and the many references in all of these publications.
11. See "Chemiclearance of Food Irradiation Process: Its Scientific Basis," by A. Brynjolfsson, a reprint from "Combination Processes in Food Irradiation," published by IAEA, Vienna, 1981; "Radiation Chemistry and Radiation Preservation of Food," by Irwin A. Taub, *Journal of Chemical Education,* Vol. 58 No. 2, February 1981; "Radiation Chemistry of Major Food Components," by Elias and Cohen, Elsevier/North Holland Biomedical Press, ISBN 0-444-41587-4, as updated, original copyright in 1977.
12. See "Food Irradiation: New Perspectives on a Controversial Technology," by Morrison and Roberts, Economic Research Service, USDA, December 1985, prepared for the Office of Technology Assessment, the U.S. Congress.
13. J. Farkas, Central Food Institute, Budapest, Hungary, "Disinfection, Including Parasite Control of Dried, Chilled, and Frozen Food by Irradiation."
14. See EPA's RPAR listings and attendant reports.
15. See paper 8.2, "The Use of Irradiation to Reduce or Eliminate Nitrite in Cured Meats," by Eugen Wierbicki and Ari Brynjolfsson, U.S. Army Natick R&D Command, 25th European Meeting of Meat Research Workers, August 1979.