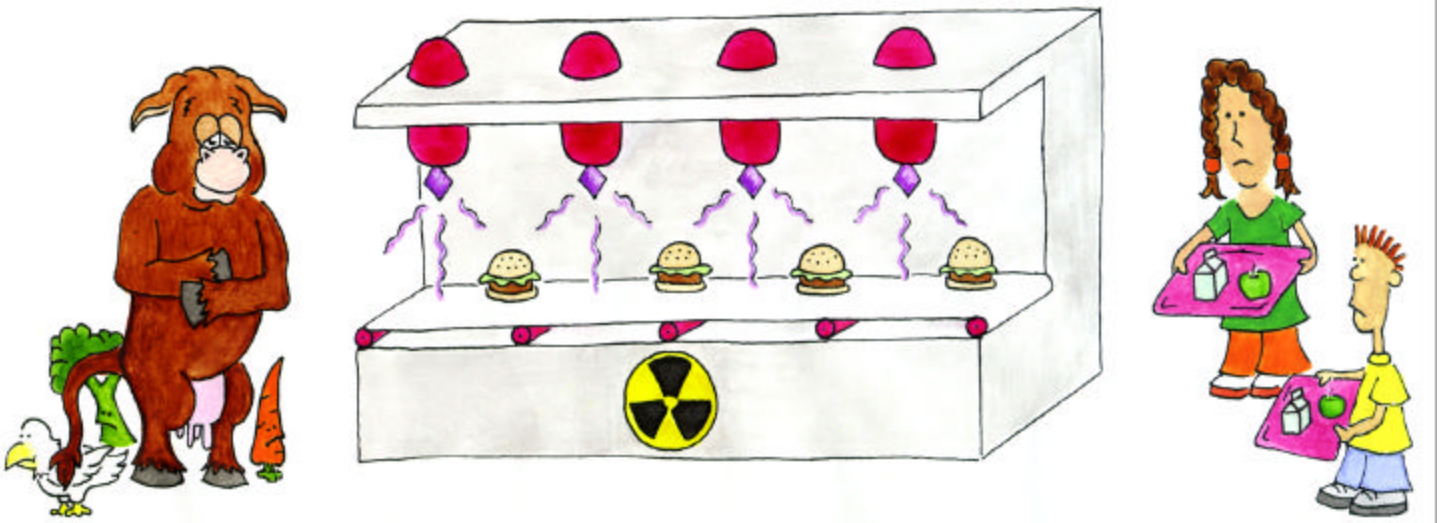


THE STOP FOOD IRRADIATION CAMPAIGN



SCHOOL LUNCH ORGANIZING KIT



Irradiated Food in School Lunches



Background

On May 29, 2003, despite thousands of comments from parents, teachers, students, and concerned citizens who overwhelmingly opposed the purchase of irradiated food for the National School Lunch Program, the U.S. Department of Agriculture (USDA) chose to include irradiated ground beef for federal nutrition programs. As of September 2004, irradiated ground beef is available to schools and costs 29-80 cents more per pound than non-irradiated ground beef. **However, school officials in each district can choose whether or not to purchase it for their schools.**

The possibility of irradiated food in schools began with the 2002 Farm Bill that was passed by Congress. The food irradiation industry was successful in inserting language into the bill that directs the Secretary of Agriculture not to prohibit the use of irradiated food in the National School Lunch Program. Previously, irradiated food had been prohibited from the program.

This provision attempts to accomplish legislatively what USDA could not achieve administratively in 2001. In the spring of 2001, the USDA issued revised specifications for commodity contracts for the National School Lunch Program that would permit the purchase of irradiated food for the program. A public outcry against the inclusion of irradiated food in the National School Lunch Program forced Secretary of Agriculture Ann Veneman to rescind the revised contract specifications.

Irradiation exposes food to high doses of ionizing radiation to kill bacteria. In the process, irradiation disrupts everything in its path, depleting vitamins and nutrients and causing the creation of new chemicals – some of which do not naturally occur in food and that the Food and Drug Administration (FDA) has never studied for safety. Research dating to the 1950s has revealed a wide range of problems in laboratory animals that ate irradiated foods, including premature death, cancer, stillbirths, genetic damage, organ malfunctions, stunted growth and vitamin deficiencies. Recent studies by the Federal Research Center in Germany found that one class of irradiation byproducts, called alkylcyclobutanones, caused genetic damage to human cells and promoted cancer development.

However, there is little research into the long-term health effects experienced by children who are exposed to toxic chemicals in foods. Nowhere in the world has there been a mass feeding of irradiated food to children over a prolonged period of time. Dr. William Au, a toxicologist at the University of Texas Medical Branch has argued that “the scientific community and regulatory agencies have very little knowledge regarding how children respond to insult from toxic chemicals. These concerns also apply to toxicological risk with respect to eating irradiated food.” This is significant, considering that children are more susceptible to toxic substances in their environment because they eat, drink and breathe much more than adults, pound for pound.

The USDA “encourages” schools serving irradiated ground beef to label it as irradiated and notify parents – but it does not require them to do so. This ignores parents, teachers, and

students' right to know what is being served in school lunches. In 2004, a California right-to-know law that would require public disclosure, parental notification, and school board approval prior to serving irradiated food in school lunches passed the CA legislature, but was vetoed by the Governor. Therefore, nationwide, parents and students can still be uninformed when irradiated food is served in school lunches.

Recently, there have been a few bright spots in the struggle against irradiated foods being pushed onto school children. In June 2004, Congress passed the Child Nutrition Act (CNA), which restricts school lunch use of irradiated food. Specifically, CNA states that irradiated food may be made available to school children only at the request of state and local school systems and that its use in school lunches cannot be mandated by the USDA; that irradiated food cannot be subsidized by the federal government; and that state and school food authorities are to be provided with factual information about irradiation, including notice that irradiation is not a substitute for safe food handling.

A number of states and schools are taking measures to keep irradiated food out of school lunches. As of September 2004, ten school districts, including Los Angeles and Washington DC, have outright banned irradiated food. Others, notably Seattle, have adopted strong directives discouraging the use of irradiated foods as part of a comprehensive healthy school lunch policy.

At the start of the 2004-2005 school year, only Minnesota, Nebraska, and Texas ordered irradiated ground beef for schools in their states. Ultimately, all three states withdrew their orders for irradiated ground beef, citing the product's high cost and the inadequate information provided by the federal government.

Fans of irradiation (including the USDA) have been disappointed that irradiated ground beef has been so slow to catch on in school lunches – and they will continue to promote it to schools across the country. The best way to make sure that irradiated food stays out of your local schools is to work with your school board to adopt a formal policy on this and other school nutrition issues. This packet gives you some ideas and resources to get you started.



This is the “radura,” the symbol for Irradiated Foods
*The radura is only required on products in grocery stores

Getting Started- Working with School Boards

Although the U.S. Department of Agriculture (USDA) has decided to purchase irradiated ground beef for the National School Lunch Program, they have left the decision of whether or not to serve it up to local food service directors and school boards. It is essential that you work in your community to build support and then take your concerns to your school board and food service director and ask for a ban on irradiated food in your school district.

Important facts about the National School Lunch Program:

Many schools get some portion of the food they serve from the National School Lunch Program. This program involves several levels of government. State departments of education purchase commodity products (which now include irradiated ground beef) from the federal government (USDA) and offer it through their statewide distribution system to individual school districts. If the state decides not to carry irradiated ground beef, local schools will not be able to receive this product through the National School Lunch Program – but they could purchase it on their own from another source.

- 1) Over 91% of the thousands of comments submitted to the USDA on this issue were opposed to the agency's proposal to purchase irradiated food for school lunches.
- 2) In January 2004, USDA started to offer irradiated ground beef for school lunches. During the summer of 2004, we called all 50 states to find out if they planned to carry irradiated ground beef in their state's commodity distribution program. Many of the states told us that there was not enough demand for the product to justify carrying it. In 2004, the three states that ordered irradiated food pulled out because of high cost and inadequate information.
- 3) The boxes of irradiated meat arriving at schools will be labeled. But, labeling in the cafeteria or parental notification is NOT required. The USDA will "encourage" schools using irradiated meat to let parents know. Urge your schools to properly label irradiated meat and send home notification if they will be serving it.
- 4) Initial bids by suppliers of irradiated ground beef have been 29-80 cents more per pound than non-irradiated ground beef. This should serve as a financial disincentive for cash-strapped schools to spend extra money on an unnecessary, potentially harmful food item.

Working with your school board to keep irradiated food out of school lunches:

Step 1: Do your homework. Call the food service director for your school system and ask if they are serving any irradiated foods. (This is the first thing many people will want to know when you talk to them about the issue.) If the answer is no, that doesn't mean you're finished – it just means that you want to get your school board to make the current policy a permanent one, by passing a resolution or policy. If the answer is yes, you should also ask the food service director if they label the irradiated foods or notify parents.

Step 2: Build broad-based support by working with other parents, teachers, and students! This is important, and probably the most time-consuming step. The more members of the community who are concerned about irradiation in school lunches, the better chance you will have of getting action from the school board!

A good way to get people to feel invested in this issue is to invite people to a meeting. Give your group a name, educate folks on the issue, and designate outreach tasks for people. It is better to have many members help you with the work so you don't burn out!

Ways to build support:

- Share information with family, neighbors, and friends
- Talk with the local PTA and share information with them about irradiation.
- Have community members who support this moratorium sign a petition (sample enclosed.) A petition is a great way to get names and contact information for folks you can call to come to the school board meeting. Take petitions to your children's sporting events or other extracurricular activities and talk with the parents there. Get a table at local fairs, festivals, picnics, school functions, etc.
- Write a letter to the editor of your local paper about the problems with irradiation, your local effort, and how to become involved. (Be sure to include your contact information.)
- Find out if there are other efforts to improve school nutrition happening in your school or district already, and then work with those concerned parents and officials to include a ban on irradiated foods.
- Hand out information to parents when they drop off or pick up their kids from school.
- Ask to speak at PTA and other parent groups' meetings
- Get your kids and other students involved! The students are the ones who will be eating irradiated meat if it is purchased by the district, so they have an interest in this. Reach out to student groups and clubs and have them circulate a petition among the students, write a letter to the food services director, and attend the next school board meeting where you will be presenting. Call the student newspaper and get them to write an article on this issue and attend the school board meeting.

Step 3: Legislators can be sensitive to this issue. Meet with staff at your representative and Senators' offices to urge them not to support irradiated food in school lunches, and to correct the damage done by the 2002 Farm Bill (which opened the door for USDA to buy irradiated food for school lunches.) If your legislators are on your side, it will help to motivate the school board.

Step 4: Once you have support behind you, determine the date of the next school board meeting and try to get on the agenda.

Step 5: Send background packets to all school board members before the meeting.

Background packets could include:

- Cover letter from your group explaining the situation
- Top 10 Problems with Food Irradiation
- Questioning Food Irradiation
- Dr. Au Statement
- Broken Record Executive Summary
- What's in the Beef Report

Step 6: Have two or three people speak at the board meeting for 2-3 minutes each. Be sure to call the folks who signed your petition and ask them to attend the meeting and get students to come as well! Have everyone involved in your campaign wear an identifying sticker or ribbon so the school board realizes how broad the support is.

(Contact Public Citizen for stickers.) **The more people there to show support, the better the results will be.**

Topics presented could include:

- Background on food irradiation: Effect on nutrients, creation of new chemicals
- Politics of Irradiation: Poor FDA approval process, lack of long-term studies
- Labeling: None required in schools!

Emphasize that parents have a right to know what their children are eating, and irradiated food does not have to be labeled in schools. Emphasize that irradiated meat is more expensive and not worth the extra money, especially considering the questions about health impacts. **Do not accuse the school of serving irradiated food to children.** School boards may be very sensitive and it is more important to have them willing to work with you on this issue.

Step 6: Present a resolution (sample enclosed) and request a moratorium on the future use of irradiated food in the district.

Step 7: Be sure to keep in contact with the board to keep up the pressure for follow through. Periodic appearances at meetings, petitions, and letters to the editor in local papers are all tools that can help you keep the issue on their agenda.

Contact Us: Public Citizen's Food Program
215 Pennsylvania Avenue SE
Washington, DC 20003
(202) 454-5185
cmep@citizen.org
www.safelunch.org

Packet Contents

- Talking Points on Major Reasons for Opposing Irradiated Food in School Lunches
- Don't Let Your Child Eat Irradiated Food! (Parent outreach tool)
- Petition to District School Board (Parent/teacher/community outreach tool)
- Sample resolution to school board calling for a moratorium on irradiated food in the district
- Seattle Comprehensive Nutrition Policy News Release
- Top 10 Problems with Food Irradiation
- Sample State Bill Legislation- California Bill AB 1988 as introduced, and as amended
- Statement by Dr. William Au, toxicologist at the Department of Preventive Medicine and Community Health, University of Texas Medical Branch in Galveston
- Questioning Irradiation: A History of Research Into the Safety of Irradiated Foods
- What's In The Beef? Scientists Question the Safety of Irradiated Ground Beef
- Broken Record Executive Summary

Talking Points on Major Reasons for Opposing Irradiated Food in School Lunches

- Irradiated food has not been proven safe to eat. There has not been enough long-term, comprehensive research on the health effects of consuming irradiated food. Some of the research that has been conducted revealed a wide range of health problems in laboratory animals that ate irradiated food, including premature death, fatal internal bleeding, a rare form of cancer, stillbirths and other reproductive problems, genetic damage, and organ malfunctions and nutritional deficiencies.
- New research from Europe on alkylcyclobutanones, one class of unique chemicals created during the irradiation process, has further indicated the need for caution. The Food and Drug Administration (FDA) and U.S. Department of Agriculture (USDA) have never publicly addressed this new toxicity information. Yet, these European studies establish that substances unique to irradiated food cause cellular and genetic damage and promote colon tumor formation in rats. The European researchers, the most prominent scientists actively working in this area now, “suggest that caution should be exercised before any risk to consumers by exposure to these compounds is denied.”
- Irradiation depletes food of vitamins- sometimes significantly. It can destroy up to 80 percent of vitamin A in eggs and 48 percent of beta carotene in orange juice. Moreover, some vitamins undergo accelerated losses in storage if the food has been irradiated, thereby compounding the problem.
- Even greater caution is necessary to protect children. There is an appalling lack of research into the long-term health effects experienced by children who are exposed to toxic chemicals in foods. The only controlled study of children, published in 1975 in the American Journal of Clinical Nutrition, found that a diet of irradiated food had mutagenic effects. No studies on children have been done since, primarily for ethical reasons because of the dangers seen in early studies. Dr. William Au, a toxicologist at the Department of Preventive Medicine and Community Health, University of Texas Medical Branch in Galveston, has argued that the lack of understanding regarding the ill effects suffered by children who consume toxic chemicals in foods extends to “the toxicological risk with respect to eating irradiated food.”
- Low-income families are the most likely to consume a high percentage of their daily food intake from the school meal programs (breakfast, lunch, and snack.) Not only are these children a more susceptible population because they may be undernourished, they are the most in need of a healthy meal. It is reprehensible to use our most disadvantaged children to create a market for a technology that consumers have rejected in grocery stores around the country.
- Irradiation is considered a food additive because of the chemical byproducts created during the process. Before legalizing a food additive for human consumption, the FDA is required by federal regulations to follow current testing protocols in order to

establish "a reasonable certainty in the minds of competent scientists that the substance is not harmful under the intended conditions of use." However, the FDA never conducted sufficient testing of irradiated food, something the irradiation industry does not want to see rectified. In spring 2002, a Congressman representing San Diego, home of irradiation company SureBeam (now defunct), killed a budget proposal to provide the FDA with \$500,000 to do additional testing.

- Irradiation merely masks problems in meat processing that result in contaminated meat. It is a mistake to accept food irradiation as a solution to food contamination problems. Poor sanitation and improper slaughter and processing practices in meat and poultry plants must be fixed, otherwise all consumers remain at risk.
- School food systems face additional food safety challenges. A USDA report entitled "Food Distribution 2000: Transforming Food Distribution for the Next Millennium" reports that food poisoning from school meals is caused by uneven flow of commodities and unpredictable delivery which leads to storage problems, lack of information and an inadequate communication system in food recall situations, and deteriorating food storage and preparation facilities that create hazards as food is prepared. These problems will not be solved by irradiation.
- Proposed changes that could strengthen inspection and testing in the meat industry have been languishing in the USDA. However, the agency has opposed legislation that would strengthen the current inspection program.
- Current regulations do not require meals prepared with irradiated food to carry identifying labels. This effectively eliminates parents' right-to-know what their children are eating at school.

Irradiated Food Resources

The Center for Food Safety, www.centerforfoodsafety.org
No Cobalt 4 Food, <http://www.nocobalt-4-food.org/>
Healthy Kids Minnesota, <http://www.geocities.com/healthykidsmn/index.html>

Healthy School Lunch Resources

Community Food Security Coalition, http://www.foodsecurity.org/farm_to_school.html
Food Routes, <http://www.foodroutes.org/farmtoschool.jsp>
Seattle School Nutrition Policy, <http://www.seattleschools.org/area/news/x40903nr.xml>
Stonyfield Farm, Menu for Change <http://www.stonyfield.com/MenuForChange/>



What's in your child's lunch?



Don't Let Your Kid Eat Irradiated Food!

On May 29, 2003, despite thousands of comments from parents, teachers, students, and concerned citizens that overwhelmingly opposed the purchase of irradiated food for the National School Lunch Program, the U.S. Department of Agriculture (USDA) chose to include irradiated ground beef for federal nutrition programs. As of September 2004 irradiated ground beef is available for federal nutrition programs and costs 29-80 cents more per pound than non-irradiated ground beef. **However, school officials in each district can choose whether or not to purchase it for their schools.** We need your help to convince our district officials to ban irradiated food!

Dr. William Au, a toxicologist at the University of Texas, has argued that “the scientific community and regulatory agencies have very little knowledge regarding how children respond to insult from toxic chemicals. These concerns apply to toxicological risk with respect to eating irradiated food.” This is worrisome, since children are more susceptible to toxic substances in their environment because they eat, drink and breathe much more than adults, pound for pound.

Why Should You Be Concerned?

- Irradiating food causes the creation of known toxins and unique chemicals. Research has shown numerous health problems in lab animals that ate irradiated food, including reproductive problems, genetic damage and promoting cancer development.
- Only one study on the effects of irradiated food consumption on children has ever been conducted. A chromosome abnormality called polyploidy – associated with leukemia and direct exposure to radiation – was detected in malnourished children who ate recently irradiated wheat. Not enough long-term, comprehensive studies have been done.
- *Irradiated food served in schools does not have to be labeled!* This obstructs your right-to-know what your child is eating.
- Irradiation masks filthy and inhumane meat processing, where meat is often contaminated with feces and other filth.
- Irradiating food depletes essential vitamins and nutrients in food.

How Can YOU Help Keep Irradiated Food Out Of [DISTRICT NAME]?

- Contact [GROUPNAME] at [CONTACT INFORMATION] for more information or to get involved.
- Contact [DISTRICT NAME] food services director, [DIRECTOR NAME], and school board members [LIST SCHOOL BOARD MEMBERS AND NUMBER HERE] and let them know that you reject the idea of serving irradiated food to your children.

[GROUP NAME]
[CONTACT INFORMATION]
www.safelunch.org

A Resolution in Support of Keeping Food Safe for All Students

Submitted by: [Group or Individual Name]

WHEREAS: Each day, [DISTRICT NAME] school district students trust that the foods they eat in cafeterias are wholesome and safe; and

WHEREAS: The school board is charged with the responsibility of ensuring the safety of foods provided at schools within the [DISTRICT NAME] school district for human consumption; and

WHEREAS: Despite the fact that much of the research done on irradiated foods is over twenty years old and expressed the need for more long-term research on the unique radiolytic products created in irradiated food, current US laws regulating the production and retail of irradiated foods are still based on these studies and the FDA has never studied the long-term effects of consuming irradiated food; and

WHEREAS: Recent research in Germany, using more technologically advanced techniques and equipment, has led to the belief by many scientists, here and abroad, that irradiated foods are unsafe; and

WHEREAS: Current federal laws do not require irradiated foods served in schools to be labeled as such, and because schools are increasingly being targeted by the food irradiation industry through such programs as the National School Lunch Program, there is increasing likelihood that children may consume unsafe foods without their knowledge or the consent of their parents; and

WHEREAS: Current federal laws do not require certain irradiated food ingredients to be labeled, there is likelihood that the school district may be unknowingly purchasing irradiated foods.

FURTHER RESOLVED : The [DISTRICT NAME] school district shall not purchase any food products that can be reasonably believed to have been processed using any form of ionizing radiation (irradiation).

September 3, 2004

News Release

**Seattle School Board Approves
Comprehensive Suite of Nutrition Policies
*Sales of Sodas and Junk Food Banned on School Campuses***

The Seattle School Board has unanimously approved a comprehensive and far-reaching set of nutrition-related policies designed to provide students with healthy food and beverage choices during the school day. Specifically, the policies will ban sales of all foods containing high levels of sugar and fat, improve the quality and appeal of school meal programs, and prohibit contracts with beverage vendors for "exclusive pouring rights."

These policies are amongst the strongest in the country, and confirm the Board's commitment to eliminating barriers to learning by creating a healthy nutrition environment in all 100 schools.

"These policies make it clear that we are determined to provide our students with healthy food options," said School Board Vice-President Brita Butler-Wall. "We are committed to providing an environment at each school that maximizes students' ability to learn and succeed. That includes ensuring that foods and beverages sold at schools are healthy and nutritious."

The new policies require all foods and beverages sold and distributed during the school day to meet nutrition guidelines and follow certain portion sizes. This provision will go into effect immediately at elementary and middle schools, and beginning February 1, 2005 at high schools. Exclusive 'pouring rights' contracts will be prohibited, and the current exclusive contract with Coca-Cola will be phased out within one year. The policies also give direction to the school meal program and others to offer fresh, local, organic, non-genetically-modified, non-irradiated, unprocessed food, whenever feasible.

Butler-Wall praised Shelley Curtis, Nutrition Director for the Children's Alliance, for leading the research team that developed the policies over a six-month period. The nutrition sub-committee of the School Board relied on the expertise of more than 60 health and nutrition experts and community members. In adopting these policies, Seattle leads the way on a new state law requiring districts to adopt nutrition policies by 2005.

The new and amended policies include:

Policy [E11.00, Food Service](#) , and Procedure [E11.01, Breakfast and Lunch Program](#)

Policy [E13.00, Food Sales](#) , and Procedure [E13.01, Distribution and Sales of Competitive Foods](#)

Procedure [C30.01, Advertising and Commercial Activities](#)

The [report of the nutrition committee](#) is available on the District's Web site at <http://www.seattleschools.org/area/board/committees.xml> and School Board Policies are available at <http://www.seattleschools.org/area/policies/index.dxml>



The Top 10 Problems With Irradiated Food

Food irradiation companies, food industry groups and even federal government officials have insisted for nearly a half-century that Americans who eat irradiated foods have nothing to worry about.

They say irradiated foods are nutritious, wholesome and taste just like regular food. They say research demonstrates that irradiated foods are safe for human consumption. They say that irradiation facilities are safe. They say that irradiation causes no adverse economic impacts.

Here are 10 reasons why they're wrong.

1) Research dating to the 1950s has revealed a wide range of health problems in animals that ate irradiated foods, including premature death, a rare form of cancer, stillbirths and other reproductive problems, mutations and other genetic damage, organ malfunctions, stunted growth and vitamin deficiencies.^{1,2,3,4}

2) Irradiation masks filthy conditions in slaughterhouses and food processing plants, which cause meat to be contaminated with foodborne pathogens. Irradiation can kill most bacteria in food, but it does nothing to remove the feces, urine, pus and vomit that often contaminate beef, pork, chicken and other meat.^{5,6}

3) Irradiation uses ionizing types of radiation – electron beams, gamma rays and X-rays – that disrupt the chemical composition of everything in its path. Many new chemicals called “radiolytic products” are formed by irradiation –

some of which do not naturally occur in food, and that the FDA has not adequately studied for safety. One type of chemical, called 2-ACBs, was recently found to promote the cancer-development process in rats, cause genetic damage in rats, and cause genetic and cellular damage in human and rat cells.^{7,8,9,10}

4) Irradiation destroys and disrupts vitamins, protein, essential fatty acids and other nutrients in food – sometimes significantly. It can destroy up to 80 percent of vitamin A in eggs and 48 percent of beta carotene in orange juice, but the FDA nonetheless legalized irradiation for these products.^{11,12}

5) In legalizing and endorsing food irradiation, the U.S. Food and Drug Administration and the World Health Organization, respectively, ignored a vast amount of research suggesting that irradiated foods are not safe for human consumption.^{13,14}

6) Because it can increase the shelf life of food and utilize centralized facilities, irradiation may further encourage the globalization and consolidation of the food production, distribution and retailing industries. Due to these existing trends, agriculture operations have moved outside the U.S., multitudes of family farmers and ranchers have been forced out of business, product diversity has been reduced, and local economies in developing nations have been disrupted.

7) Irradiation can exacerbate the problems faced by family farms because it could open the floodgates to low-cost, imported food. Irradiation facilities have been constructed in many countries that export large amounts of fruit, vegetables and meat, including Argentina, Australia, Brazil, Chile, Mexico and New Zealand. Brazil, already major meat exporter, is being touted as the “fruitbasket of the world.”

8) Irradiation can change the flavor, odor and texture of food – sometimes disgustingly so. Pork can turn red, beef can smell like a wet dog, and fruit and vegetables can become mushy.^{15,16,17}

9) Irradiation facilities can create air pollution, worker safety and environmental hazards. Smog-forming ozone is released from facilities that use electron-firing linear accelerators. Several deaths and numerous injuries have occurred at irradiation plants throughout the world. Dozens of accidents and acts of misconduct have been reported. In 1988, after more than 30 Nuclear Regulatory Commission violations – including throwing radioactive garbage into the trash – the president of a New Jersey irradiation company was charged with numerous federal crimes, including conspiracy to defraud the NRC. The president, who threatened to fire workers who did not lie to NRC investigators, was sentenced to two years in prison.¹⁸

10) Soon, some irradiation plants may use cesium-137, a highly radioactive waste material left over from the production of nuclear weapons. This material is dangerous and unstable. In 1988, a cesium-137 leak near Atlanta led to a \$40 million, taxpayer-funded cleanup.¹⁹

Notes

- ¹ *A Broken Record: How the FDA Legalized - and Continues to Legalize - Food Irradiation Without Testing it for Safety.* Washington, D.C.: Public Citizen, Cancer Prevention Coalition, Global Resource Action Center for the Environment, Oct. 2000.
- ² Kesavan, P.C., Swaminathan, M.S. “Cytotoxic and mutagenic effects of irradiated substrates and food material.” *Radiation Botany*, 11:253-181, 1971.
- ³ Schubert, J. “Mutagenicity and cytotoxicity of irradiated foods and food components.” *Bulletin of the World Health Organization*, 41:873-904, 1969.
- ⁴ Spiher, A.T. “Food Irradiation: An FDA Report.” *FDA Papers*, Oct. 1968.
- ⁵ Nestor, F. and Hauter, W. *The Jungle 2000: Is America's Meat Fit to Eat?* Washington, D.C.: Government Accountability Project, Public Citizen, Sept. 2000.
- ⁶ Piccioni, R. “Food irradiation: Contaminating our food.” *The Ecologist*, 18:2:48-55.
- ⁷ Delincée, H. and Pool-Zobel, B. Genotoxic properties of 2-dodecylcyclobutanone, a compound formed on irradiation of food containing fat. *Radiation Physics and Chemistry*, 52: 39-42, 1998.
- ⁸ Delincée, H. et al. Genotoxicity of 2-dodecylcyclobutanone. Food Irradiation: Fifth German Conference, Karlsruhe, November 11-13, 1998.
- ⁹ Delincée, H. et al. “Genotoxicity of 2-alkylcyclobutanones, markers for an irradiation treatment in fat-containing food – Part I: cyto- and genotoxic potential of 2-tetradecylcyclobutanone.” *Radiation Physics and Chemistry*, 63:431-435, 2002.
- ¹⁰ D. Burnouf, H. Delincée, A. Hartwig, E. Marchioni, M. Miesch, F. Raul, D. Werner (2001), Etude toxicologique transfrontalière destinée à évaluer le risque encouru lors de la consommation d'aliments gras ionisés - Toxikologische Untersuchung zur Risikobewertung beim Verzehr von bestrahlten fetthaltigen Lebensmitteln - Eine französisch-deutsche Studie im Grenzraum Oberrhein, Rapport final d'étude Interreg II, projet N° 3.171. BFE-R-02-02, Federal Research Centre for Nutrition, Karlsruhe, Germany.
- ¹¹ FDA Memorandum, from Kim Morehouse, Ph.D. to William Trotter, Ph.D. April 11, 2000.
- ¹² FDA Memorandum, from Antonio Mattia, Ph.D. to William Trotter, Ph.D. Nov. 2, 1999.
- ¹³ Op. cit, Note 1.
- ¹⁴ *Bad Taste: The Disturbing Truth About the World Health Organization's Endorsement of Food Irradiation.* Washington, D.C.: Public Citizen, October 2002.
- ¹⁵ Webb, T. et al. *Food Irradiation: Who Wants It?* Rochester, Vermont: Thorsons Publishers, 1987.
- ¹⁶ Huang, S. et al. “Effect of electron beam irradiation on physical, physicochemical and functional properties of liquid egg during frozen storage.” *Poultry Science*, 76:1607-15, 1997.
- ¹⁷ Wong, Y.C. et al. “Comparison between irradiated and thermally pasteurized liquid egg white on functional, physical and microbiological properties.” *Poultry Science*, 75:803-808, 1996.
- ¹⁸ “Executive convicted in radiation spill.” *North Jersey Advocate*, Oct. 30, 1986.
- ¹⁹ “Last radioactive capsules taken from DeKalb plant.” *Macon Telegraph*, Nov. 20, 1990.



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Sample State Legislation- California Bill

The following two pieces of legislation are the introduced and amended versions of California State Bill AB 1988. As introduced, the bill included a ban on serving USDA irradiated ground beef in California schools, as well as regulations on irradiated beef served in schools from other sources. The amended version of the bill essentially required school board approval, public disclosure, and parental notification before irradiated beef could be served in CA schools. The amended version passed the California House and Senate in 2004, but was vetoed by the Governor. This legislation could be adapted for passage in any state!

ASSEMBLY BILL

No. 1988

Introduced by Assembly Member Hancock

February 13, 2004

An act to add Section 38086 to the Education Code, relating to schools.

LEGISLATIVE COUNSEL'S DIGEST

AB 1988, as introduced, Hancock. California Safe School Lunch Act.

Existing law authorizes the governing board of a school district to establish food services in the schools under its jurisdiction.

This bill would establish the California Safe School Lunch Act, which would prohibit the State Department of Education from accepting irradiated ground beef for the purposes of the National School Lunch Program. The bill would prohibit a school from selling irradiated foods, unless specified conditions regarding those sales are met.

Vote: majority. Appropriation: no. Fiscal committee: yes. State-mandated local program: no.

The people of the State of California do enact as follows:

1 SECTION 1. The Legislature finds and declares all of the
2 following:

3 (a) In May of 2003, the United States Department of
4 Agriculture approved irradiated ground beef to be purchased for
5 donation to the National School Lunch Program, which provides
6 schools with surplus commodities and provides subsidies to

1 schools based on the number of low-income pupils served by each
2 school. These subsidies are to be used to provide pupils with free
3 or reduced price meals, depending on the income status of the
4 family of the pupil. In California, 2.4 million pupils eat school
5 lunch daily. Of those, 69 percent receive free lunches, 9 percent
6 receive reduced-price lunches, and 22 percent participate in the
7 paid meal category.

8 (b) Extensive research dating back to the 1950s has found that
9 irradiation destroys essential vitamins and minerals, including
10 vitamins A, B2, B3, B6, B12, C, E, K, Thiamine, and Folic acid.
11 Amino acids and essential polyunsaturated fatty acids may also be
12 affected. It is not uncommon for irradiated foods to sustain a loss
13 of 20 to 80 percent of these vital vitamins and minerals. Irradiation
14 also results in the formation of known toxins and carcinogens in
15 food, including benzene, methanol, methyl ethyl ketone, and
16 toluene. Additionally, irradiation forms a class of chemicals,
17 called “unique radiolytic products.” A subset of these chemicals,
18 called cyclobutanones, has been linked to tumor growth in rats,
19 and has cytotoxic and genotoxic properties.

20 (d) There has been no research on the health impacts of
21 consuming irradiated foods over a long period of time. Moreover,
22 there is a lack of consumer acceptance for irradiated foods. If
23 irradiated beef is served in the National School Lunch Program,
24 children would be the first population to ever consume this food
25 as a substantive part of their diet, with no knowledge on the
26 possible long-term health impacts.

27 (e) Proper nutrition of children is a matter of highest state
28 priority, and malnutrition among children from low-income
29 families constitutes one of the most critical child health problems
30 in the state. The State of California should not knowingly provide
31 schools with food that is nutritionally deficient, particularly when
32 more nutritious options are available.

33 SEC. 2. Section 38086 is added to the Education Code, to
34 read:

35 38086. (a) The Commodity Distribution Unit of the
36 California Department of Education may not accept irradiated
37 ground beef from the United States Department of Agriculture, to
38 distribute to schools participating in the National School Lunch
39 Program, the Summer Food Service Program, the Commodity



1 Supplemental Food Program, or any other nutrition programs in
2 which that school participates.

3 (b) Schools choosing to serve irradiated food shall do all of the
4 following:

5 (1) Provide to pupils and their parents or guardians all of the
6 following information regarding irradiated foods:

7 (A) The purpose of radiation used on foods.

8 (B) The effects of radiation on the nutritional value of foods.

9 (C) Potential adverse health consequences of irradiated foods.

10 (2) Provide pupils with alternative, nonirradiated food options
11 during every meal and ensure that nonirradiated food items are not
12 commingled with irradiated foods items.

13 (3) Ensure that menu items containing irradiated foods are
14 clearly labeled with the phrase “treated with irradiation” or
15 “treated by irradiation.”

16 (4) Ensure the prominent display of signs in school cafeterias
17 indicating that irradiated food is being served.

18 (c) Notwithstanding Article 3 (commencing with Section
19 33050) of Chapter 1 of Part 20, compliance with this section may
20 not be waived.



Assembly Bill No. 1988

Passed the Assembly August 25, 2004

Chief Clerk of the Assembly

Passed the Senate August 24, 2004

Secretary of the Senate

This bill was received by the Governor this _____ day of
_____, 2004, at _____ o'clock __M.

Private Secretary of the Governor



CHAPTER _____

An act to add Section 38086 to the Education Code, relating to schools.

LEGISLATIVE COUNSEL'S DIGEST

AB 1988, Hancock. Schools: Irradiated foods.

Existing law authorizes the governing board of a school district to establish food services in the schools under its jurisdiction.

This bill would prohibit a school from serving irradiated foods, unless specified conditions regarding those sales are met.

The people of the State of California do enact as follows:

SECTION 1. The Legislature finds and declares all of the following:

(a) In May of 2003, the United States Department of Agriculture approved irradiated ground beef to be purchased for donation to the National School Lunch Program, which provides schools with surplus commodities and provides subsidies to schools based on the number of low-income pupils served by each school. These subsidies are to be used to provide pupils with free or reduced price meals, depending on the income status of the family of the pupil. In California, 2.4 million pupils eat school lunch daily. Of those, 69 percent receive free lunches, 9 percent receive reduced-price lunches, and 22 percent participate in the paid meal category.

(b) Proper nutrition of children is a matter of highest state priority, and malnutrition among children from low-income families constitutes one of the most critical child health problems in the state. The State of California should seek to provide schools with food that maximizes nutritional benefits to pupils.

SEC. 2. Section 38086 is added to the Education Code, to read:

38086. (a) Before a school may serve food that is required by subsection (c) of Section 179.26 of Title 21 of the Code of Federal Regulations to be labeled as irradiated, the governing board of the school district shall do all of the following:



(1) Take formal action permitting the use of irradiated foods as described in this subdivision.

(2) Make all of the following information available in any appropriate form to pupils and their parents:

(A) The purpose of irradiation use on foods.

(B) The effects of irradiation on the nutritional value of foods.

(C) Objective and balanced scientifically peer-reviewed research on the use of irradiation on foods.

(3) Ensure that menu items containing irradiated foods are clearly labeled with the phrase “treated with irradiation” or “treated by irradiation.”

(b) Notwithstanding Article 3 (commencing with Section 33050) of Chapter 1 of Part 20, compliance with this section may not be waived.



Susceptibility of children to environmental toxic substances

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Abstract

Our understanding of toxicity of environmental substances is based mainly on investigations using adult human populations and matured animals. Therefore, the scientific community and regulatory agencies have very little knowledge regarding how children respond to insult from toxic chemicals. However, certain scientific data indicate that children are more susceptible to toxic exposure than adults because they have proportionally more intake of food contaminants, active developmental processes, multiple exposure pathways and susceptible socio-behavioral activities. More emphasis should therefore be focused on addressing the information gap for improving the health of our children.

Introduction

Traditionally, our understanding of toxicity of environmental substances is based on human experience and from studies using experimental animals. The knowledge is therefore generated mainly from studies involving adult human populations (workers) or matured animals. As a result, protection and regulatory standards that are developed from these data are used universally for adults and children. However, concerns have been raised that there can be profound differences between children and adults from exposure to toxic substances. Chemical exposures during childhood or in utero could increase health problems such as cancer during childhood or later in life (National Research Council, 1993; Quang and Woolf, 2000). This concern is supported by the reported increases in rates of brain cancer in children and of testicular cancer in young adults (Charnley and Putzrath, 2001). It becomes clear that the regulatory policies that are developed based on observations in adults are not adequate in protecting children. This led to the signing of the executive order by former president Clinton, Protection of Children from Environmental Health Risk and Safety Risks (Executive Order, 1997). In response to the Executive Order, several regulatory and public health agencies have set up specific programs to address children's environmental health issues.

Health consequences from exposure to toxic chemicals

Numerous studies have been conducted to elucidate how toxic environmental chemicals induce cancer. Therefore, environmental cancer will be used as a model in this

commentary to provide a general explanation on the development of health problems from exposure to environmental toxicants.

Upon exposure to a chemical carcinogen, the chemical is absorbed, distributed and metabolized in various tissues and organs in the body. From the metabolic process, metabolites are produced which may be more reactive than the original chemical or may be inactive. Differences in an individual's ability to metabolize chemicals contribute significantly to variations in toxicological responses to hazardous chemicals. Many of these variations have recently been shown to be due to the inheritance of variant chemical metabolizing genes (Au et al., 2001). The toxicological effects may range from the expression of DNA damage, chromosome aberrations, gene mutation and perturbation of cell proliferation. These effects are known to be some of the initial events in the development of cancer (Greenblatt et al., 1994; Bonassi and Au, 2002).

Children specific activities

Children are more active than adults. As a result, they drink more water, breathe more air and eat more food per pound of body weight compared to adults. Therefore, they are proportionally exposed to more toxic chemicals from the environment and from materials they ingest than adults, making them susceptible to toxicants. Furthermore, children have unique activities and behavior that may increase their susceptibility. The hand-mouth behaviors of toddler put them at risk of ingestion of a variety of contaminated materials. Children are less aware of standard hygiene such as the avoidance of contaminated food and their dietary preferences may cause them to consume a proportionally large amount of a particular type of food. Children are less likely than adults in reading information labels on food products and warning labels. Children have their own social activities. Some activities may involve the consumption of large amount of certain dietary ingredient that can cause overt toxicity, leading to the need for emergency care. An example is the abuse of nutmeg, an aromatic chemical, by a 13-year-old female who ended up in an emergency room in New York (Sangalli and Chiang, 2000). Nutmeg is used as spice for food preparation and, based on conventional assessment, one would not expect the consumption of nutmeg is of health concern.

Age as a susceptibility factor

The embryos, fetuses and children undergo tremendous developmental changes and most of these changes are absent in the adult. These changes involve complex and integrated activities that lead to the expression of unique processes such as differentiation, organogenesis, morphogenesis, rapid and controlled cell division and developmental stage-specific gene activities. How these developmental changes alter children's response to toxicological insult in comparison to adult remains to be elucidated (Faustman et al., 2000). However, in some rare occasions, the age-dependent susceptibility phenomenon has been documented. The carcinogenic activity of diethylstilbestrol is a good example. The standard rodent cancer bioassay would not have predicted the in utero carcinogenic effects of this chemical. Other supportive evidence is from the cancer incidence among the Japanese atomic bomb survivors. The incidences

for leukemia and breast cancer are much higher for those who were exposed to the atomic bomb fall-out at a younger age than those at an older age (Upton, 1984). In the methyl isocyanate accident in Bhopal, India, children are disproportionately affected, as documented in increased seizures, coma and lethality (Mehta et al., 1990). Fetuses and children are much more sensitive to the toxicity of environmental toxicants than adults, as demonstrated in the Minamata Bay, Japan, methylmercury contamination problem (Powell, 1991; Koos and Longo, 1976). It should also be stated that, in some cases, children are less susceptible than the adults.

Contaminants in food can be accumulated in the mother and passed on to the embryos and fetuses via the placenta. In addition, infants are further exposed to the contaminants via the human milk. Certain man-made chemicals that have long-half lives, e.g. polychlorinated biphenyls and organochlorine pesticides, are present in higher concentrations in milk of mothers from industrialized countries than from under-developed countries (Przyrembel et al., 2000).

Physiological differences

Besides differences from adult in the intake of chemicals, physiological differences in the absorption of chemicals via the gastrointestinal track have been documented. For example, young children absorb approximately 50% of ingested lead compared to 10% among adults (Royce, 1992). Detoxification of hazardous chemicals is a critical event in the defense against their toxic effects. However, infants are deficient in such defense mechanism, as most chemical metabolizing enzyme activities evolve within a few days to weeks after birth (Linakis, 1998).

Conclusions

The scientific community and regulatory agencies have very little knowledge regarding how children respond to insult from toxic chemicals. However, certain scientific data indicate that children are more susceptible to toxic exposure than adults because they have proportionally more intake of food contaminants, active developmental processes, multiple exposure pathways and susceptible socio-behavioral activities. Therefore, a national committee has previously stated that “an uncertainty factor up to ten-fold ... be consider ... when data from toxicity testing relative to children are incomplete.” (National Research Council, 1993; Landrigan et al., 2001). The recommendation was adopted by the 1996 Food Quality Protection Act with respect to pesticides. In addition, test for prenatal developmental toxicity and the 2-generation reproductive study protocol are recommended for pesticides (Kimmel and Makris, 2001). The Executive Order in the US offers a tremendous stimulus towards a concerted effort in addressing children-specific susceptibility to environmental and ingested toxicants. Since developing countries have significantly more children in the populations than developed countries, the consideration of children susceptibility should be a global concern. These investigations may range from standard toxicological studies to molecular studies on genetic susceptibilities. The investigations should target exposure from environmental contamination and exposure through the food chain. From vigorous evaluation of the

toxicology of chemicals and understanding children's susceptibility, regulatory agencies will be able to set better guidelines for protecting children's health.

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Questioning Food Irradiation

A History of Research Into
the Safety of Irradiated Foods

Public Citizen

Critical Mass Energy and Environment Program

Washington D.C.

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Questioning Food Irradiation

The scientific community is in agreement that food irradiation is among the most thoroughly researched technologies of the 20th century. Where there is no agreement, however, is whether “treating” foods with high doses of ionizing radiation to kill pathogens and extend shelf-life poses health risks to the people who eat these products.

Food irradiation research began in 1921, when a U.S. Department of Agriculture scientist discovered that X-rays killed the *Trichinella spiralis* bacteria commonly found in pork. Two years later, the results of the first animal feeding studies to evaluate the safety and wholesomeness of irradiated foods were published.

In the 80 years since, dozens of foods – bananas, ground pork, onion powder, papayas, beef stew, potatoes, clams, chicken, apricots and many others – have been irradiated and fed to numerous types of animals, mainly rats, mice, dogs, monkeys and hamsters.

At least six experiments involving people – including one involving children – have been conducted.

Virtually every biological assessment of test subjects has been made: animal fetuses have been dissected, biopsies have been taken, DNA and chromosomes have been examined, red and white blood cells have been counted, enzyme levels have been measured, and so on.

Over these eight decades, dozens of studies have drawn into question the safety and whole-

someness of irradiated foods. A wide range of health problems have been observed in animals – and, in a few cases, people – who ate irradiated foods.

Whether the food was “treated” with gamma rays, X-rays or near-speed-of-light electrons, many adverse health effects have been

observed, including but not limited to premature death, mutations and other genetic damage, fetal death and other reproductive problems, residual radioactivity, immune system dysfunction, fatal internal bleeding, a rare form of cancer, organ damage, blood disorders, tumors, nutritional deficiencies and stunted growth.¹

Here are some noteworthy examples:

- A chromosome abnormality called polyploidy – which has been associated with leukemia

and direct exposure to radiation – was detected in children who ate recently irradiated wheat.²

- Polyploidy and a blood disorder were detected in men and women who ate a diet containing a variety of irradiated foods; and elevated red blood cell counts were detected in

Many adverse health effects have been observed in animals fed irradiated foods, including premature death, mutations, fetal death and other reproductive problems, residual radioactivity, immune system dysfunction, fatal internal bleeding, a rare form of cancer, organ damage, blood disorders, tumors, nutritional deficiencies and stunted growth.

Questioning Food Irradiation

men and women who ate irradiated potatoes.³

- The carcinogenesis process was promoted in rats fed a chemical called cyclobutanones, which are formed in certain irradiated foods, and which do not occur naturally in any food.⁴

- “Considerable amounts of radioactivity” were detected in the liver, kidney, stomach, gastrointestinal tract and blood serum of rats fed irradiated sugar.⁵

- Rats fed irradiated beef died from internal bleeding; others fed irradiated beef suffered “general incoordination, spastic hopping gait and sometimes complete loss of movement with dragging hindquarters. Those most severely affected often became completely prostrated a short time before death.”⁶

- In U.S. Army tests, more dogs and rat pups died, and dogs gained less weight than those fed unirradiated foods; and a rare form of cancer developed in rats.⁷

- Rats fed a variety of irradiated foods gave birth to more dead offspring.⁸

- Mice fed recently irradiated food led to embryonic⁹ and fetal deaths,¹⁰ and shorter lifespans.¹¹

- Fruit flies grown in an irradiated medium were born with a variety of mutations.¹²

Additionally, human blood cells exposed to irradiated food components have undergone genetic damage, including “grossly damaged” chromosomes¹³ and “considerable inhibition of mitosis and chromosome fragmentation.”¹⁴

Many researchers who have observed health problems in animals that ate irradiated foods have said that these problems could not be attributed to consuming irradiated foods. Instead, researchers have often made unsubstantiated claims that these health problems were due to dietary factors or experimental anomalies.

In many other cases, researchers who documented health problems in their raw data simply failed to discuss these problems in the summaries and conclusions of their reports. Abnormalities in reproductive performance, blood counts, enzyme levels, organ function, weight gain and other measurements have been recorded, only to be ignored in summaries and conclusions.

This phenomenon led prominent Swedish

radiobiologist and chemist Göran Löfroth – a pioneering DDT researcher – to tell U.S. federal government health officials in 1968: “In my studies of the literature, I have often found a credibility gap between observed parameters and the recurring conclusions that there is no apparent toxic hazard involved in the ingestion of irradiated food.”¹⁵

By downplaying and ignoring raw data suggesting that irradiated foods may not be safe for human consumption, scientists from a wide variety of universities, institutes, organizations and agencies have deprived government officials, the food industry, food scientists and, ultimately, the American people of the complete picture of the potential health problems associated with these products.

By misrepresenting raw data, these scientists have ignored seemingly minor health problems that, in the long term, could result in more serious effects – particularly if multiple problems work in combination, or if problems fester unnoticed for months or years.

This concern was raised in 1968, when then-FDA Associate Commissioner Daniel Banes cautioned members of Congress: “Our knowledge 8 or 10 years ago about the teratogenic [birth defect-causing] effect of drugs – for example, thalidomide and its effects on the embryo – was sketchy. In fact, it was practically nonexistent. The questions we ask now about the effects of drugs on the reproductive process and on metabolic systems and the biochemistry of the body are far more subtle and far more advanced. I submit, sir, that the same situation obtains with respect to irradiated food.”¹⁶

Furthermore, irradiation results in the formation of dozens of chemical compounds, many of which have toxic properties. The scientific record of these chemicals goes back 50 years. During this time, many chemicals known or suspected to cause cancer and birth defects, and chemicals that can damage the central nervous system, have been detected in irradiated foods. Among these are benzene, toluene, methyl ethyl ketone, octane, acetone, ethanol, hexane, heptane and pentane.¹⁷ “Safe” levels for these chemicals in irradiated foods have yet to be determined.

Questioning Food Irradiation

Recently, chemical byproducts formed in irradiated foods called cyclobutanones (or 2-ACBs) were shown to promote the carcinogenesis process in rats, and to cause genetic damage in rats and in human cells. Cyclobutanones have never been found to occur naturally in any food.¹⁸

These findings, coming in four consecutive experiments since 1989, contributed to the European Union's decision in Dec. 2002 against expanding irradiation for several additional types of food, including shrimp, cereal flakes and frog legs. The findings have also delayed a proposal by the Codex Alimentarius Commission - which sets food-safety standard for more than 160 nations - to allow any food to be irradiated at any dose, no matter how high.

In conclusion, the researchers wrote:

[S]ince our results point toward toxic, genotoxic and even tumor promoting activity of certain 2-ACBs, we strongly recommend to carry out further research, including confirmation of our results by other laboratories, to elucidate a possible risk associated with the consumption of irradiated fat-containing foods... Numerous questions still remain to be answered, and much research is left to be done, before a qualified risk assessment can be performed.¹⁹

These findings are particularly disturbing, given that 2-ACBs have been found in numerous foods that contain fat, including beef, chicken, pork, eggs, cheese, fresh- and salt-water fish, salmon, shrimp, mangoes and papayas. The types of fat from which 2-ACBs derive - such as oleic, palmitic and stearic acids - are contained in nearly all foods.

In one study, researchers found 2-ACBs in chicken that was irradiated 13 years earlier.²⁰ 2-ACBs are so easily detected and can be formed at such low radiation doses that they are often used as chemical "markers" to determine whether food has been irradiated. The European Union, for example, has officially adopted this technique to determine whether fat-containing foods have been irradiated.²¹

In addition to concerns related to 2-ACBs, many other warnings have been issued by researchers during the past 50 years.

Among them:

- "An increase in concentration of a mutagen in food by irradiation will increase the incidence of cancer... It will take four to six decades to demonstrate a statistically significant increase in cancer due to mutagens introduced into food by irradiation... When food irradiation is finally prohibited, several decades worth of people with increased cancer incidence will be in the pipeline."²²

- "The thalidomide disaster might have been prevented if an easily performed investigation of possible cytotoxic effects in plant cells had been made. It must be acknowledged that any compound causing [cellular] damage must be considered a potential hazard to any living cell or cell system - including man."²³

- "Irradiating can bring about chemical transformations in food and food components resulting in the formation of potential mutagens... It is now realized, especially since the thalidomide episode, that [older testing] protocols do not detect the more subtle population hazards such as mutagens and teratogens... In view of the serious consequences to the human population which could arise from a high level of induced mutations, it is desirable that protocols for irradiated food should include *in vivo* tests on mammals for possible mutagenicity."²⁴

- "Numerous studies have been carried out to ascertain whether cytotoxic effects occur when unirradiated biological test systems are cultured or fed with irradiated media or food. Adverse physiological (growth retardation and inhibition), cytological (mitotic inhibition and chromosome aberrations) and genetical (forward and reverse mutations) effects have been observed in a wide range of test systems, ranging from bacteriophages to human cells."²⁵

Despite a vast body evidence that irradiated foods may not be safe for human consumption, and despite numerous warnings from researchers, food irradiation has been endorsed by the World Health Organization (WHO), the United Nations' Food and Agriculture Organization (FAO), the International Atomic Energy Agency

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(IAEA) and the Codex Alimentarius Commission. And, the process has been legalized in more than 50 countries.

In particular, the WHO has played a role in abandoning the original research agenda it co-drafted in 1961, which urged experiments into whether irradiated foods are toxic or radioactive; whether they could cause cancer, mutations or nutritional deficiencies; and whether the scientific expertise even existed to answer these fundamental questions.

The process by which the U.S. Food and Drug Administration (FDA) has legalized food irradiation has also been flawed. The FDA has legalized irradiation for several major classes of food – including fruit, vegetables, pork, chicken, beef and eggs – despite numerous shortcomings:

- Since 1983, FDA agency officials have knowingly and systematically ignored federal regulations and their own testing protocols that must be followed before irradiated foods can legally be approved for human consumption.
- Since 1986, FDA officials have legalized irradiation for major classes of food while relying on nearly 80 studies that the agency's own expert scientists had dismissed as "deficient." (The FDA legalized the irradiation of eggs in July 2000, for instance, based on three "deficient" studies, one of which was conducted in 1959.)
- None of the seven key studies that FDA officials used to legitimize their first major approval of food irradiation in 1986 met modern standards. (One of them had actually been declared "deficient" by FDA toxicologists; three others had never been translated into English.)
- FDA officials have systematically dismissed evidence suggesting that irradiated food can be toxic and induce genetic damage. Much of this evidence resulted from government-funded research submitted to the FDA and members of Congress as early as 1968.
- FDA, U.S. Army and other federal officials have consistently misled Congress about the potential hazards of food irradiation, and about the reasons that past research initiatives have failed to demonstrate that irradiated food is safe for human consumption.²⁶

Following a rapid expansion of food irradiation in the U.S., the European Parliament

voted in December 2002 against expanding the list of foods that could be irradiated in the 15-nation European Union, pending additional scientific evidence regarding the safety of irradiated foods. Shrimp, frog legs, cereal flakes and several other foods were proposed for addition to the current list, which is limited to spices and seasonings. The EP went so far as to reject a proposal to collaborate with the WHO on research into the safety of irradiated foods.

Further, the EU – citing concerns over 2-ACBs – formally opposed a Codex proposal to remove its 10 kGy maximum dose and allow any food to be irradiated at any dose, no matter how high.²⁷ France, Germany, Japan, the Netherlands, Poland, Sweden, South Korea and the United Kingdom also opposed the proposal. Under this pressure, a key Codex panel in December 2002 abandoned the proposal.²⁸

The decision is significant, to say the least: Codex sets food-safety standards on behalf of more than 160 countries representing more than 90 percent of the world's population. And, Codex standards are enforceable under World Trade Organization (WTO) rules.

If the full Codex Commission ratifies the committee's decision to abandon the proposal and maintain the 10 kGy dose cap, any decision by a WHO member nation to irradiate foods above 10 kGy could be challenged before a WTO tribunal. And, food companies desiring to irradiate their products above 10 kGy may face limitations as to the types of food they could irradiate, or how long irradiated foods could stay on the shelves, be stored, or be shipped.

In retrospect, the 40-plus-year history of analyzing the safety and wholesomeness has been compromised to the extent that a complete reassessment is required in order to protect Americans, as well as millions of people throughout the world where food irradiation is legal, from health risks. This reassessment should take the form of published, peer-reviewed research in the areas of toxicology, food science, radiation chemistry, nutrition and other relevant fields.

Taken together, the well-documented health hazards of irradiated foods; the flawed processes by which food irradiation has been

Questioning Food Irradiation

legalized and endorsed by U.S. and international agencies; the recent caution exhibited by the European Union and the Codex Alimentarius Commission; and the myriad unanswered questions related to this technology, make any proposal to legalize or endorse additional types of food for irradiation, to expand use of irradiation, or to broaden the production and distribution of irradiated foods is ill-advised.

Additional proposals should be withheld, pending the conclusion of research into the toxic properties of 2-ACBs, as well as chemicals known or suspected to cause cancer and birth defects – such as benzene, toluene, ethanol and methyl ethyl ketone – and chemicals that can damage the central nervous system, such as acetone, pentane, heptane, nonane, and ethyl mercaptan.

Notes

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- ¹⁰ Anderson, D. et al. "Irradiated laboratory animal diets: Dominant lethal studies in the mouse." *Mutation Research*, 80:333-345, 1981.
- ¹¹ Bugyaki, L., A.R. Deschreider, J. Moutschen, M. Moutschen-Dahmen, A. Thijs, and A. Lafontaine. "Do irradiated foodstuffs have a radiomimetic effect? II. Trials with mice fed wheat meal irradiated at 5 Mrad." *Atompraxis* 14:112-118, 1968.
- ¹² Swaminathan, M.S. et al. "Mutations: Incidence in *Drosophila melanogaster* reared on irradiated medium." *Science*, 141:637-638, 1963.
- ¹³ Shaw, M.W. and Hayes, E. "Effects of irradiated sucrose on the chromosomes of human lymphocytes in vitro." *Nature*, 211:1254-1255, 1966.
- ¹⁴ Kesavan, P.C. and Swaminathan, M.S. "Cytotoxic and radiomimetic activity of irradiated culture medium on human leukocytes." *Current Science*, 16:403-404, 1966.
- ¹⁵ Kesavan, P.C. and Swaminathan, M.S. "Cytotoxic and mutagenic effects of irradiated substrates and food material." *Radiation Botany*, 11:253-281, 1971.
- ¹⁶ "Status of the Food Irradiation Program." *Hearings before the Subcommittee on Research and Development of the Joint Committee on Atomic Energy, Congress of the United States*. July 18/30, 1968. Washington, D.C.: U.S. Government Printing Office.
- ¹⁷ "Evaluation of the health aspects of certain compounds found in irradiated beef." *Life Sciences Research Office, Federation of American Societies for Experimental Biology, Bethesda, Maryland*. Prepared for U.S. Army Medical Research and Development Command, Fort Detrick, Frederick, Maryland, Contract No. DAMD-17-76-C-6055. August 1977. Supplements I and II, March 1979.
- ¹⁸ Stevenson, H. "Identification of irradiated foods." *Food Technology*, 48:141-144, 1994.
- ¹⁹ Burnouf, Op. cit.
- ²⁰ Crone, A.V.J. et al. "Detection of 2-dodecylcyclobutanone in radiation-sterilized chicken meat stored for several years." *International Journal of Food Science and Technology*, 27: 691-696, 1992.
- ²¹ EN 1785. Foodstuffs - Detection of irradiated food containing fat - Gas chromatographic / Mass spectrometric analysis of 2-alkylcyclobutanones. European Commission. <www.europa.com>
- ²² Tritsch, G.L. "Food irradiation." *Nutrition*, 16:698-701, 2000.
- ²³ Lofroth, G. "Toxic effects of irradiated foods." *Nature*, 211:302, 1966.
- ²⁴ Schubert, J. "Mutagenicity and cytotoxicity of irradiated foods and food components." *Bulletin of the World Health Organization*, 41:873-904, 1969. (Co-sponsored by the U.S. Atomic Energy Commission and the Food and Drug Administration.)
- ²⁵ Kesavan 1971, Op. cit.
- ²⁶ *A Broken Record: How the FDA Has Legalized – and Continues to Legalize – Food Irradiation Without Testing It for Safety*. Washington, DC: Public Citizen, Global Resource Action Center for the Environment, Cancer Prevention Coalition, October 2000.
- ²⁷ *European Community Comments on CL 2001/34-FAC of the Codex Secretariat. (Proposed Draft Revision to the Codex General Standard for Irradiated Foods, ALINORM 01/12A, paragraph 85 and Appendix VII.)* 4 December 2001.
- ²⁸ Letter from Alicia O. Lustre, Chair, International Consultative Group on Food Irradiation, to David Byron, Food and Agriculture Organization of the United Nations, 18 November 2002.

Questioning Food Irradiation

Following are many of the dozens of studies conducted since the 1950s that raise questions about the safety of irradiated foods. Most of these studies were conducted at or funded by public agencies, universities and institutes. The excerpts are taken directly from the text of the studies.

Health Problems in Humans [I]

Fifteen children suffering from severe protein-calorie malnutrition...receiving freshly irradiated wheat developed polyploid cells and certain abnormal cells in increasing number as the duration of feeding increased... Though the biological significance of polyploidy is not clear, its association with malignancy makes it imperative that the wholesomeness of irradiated wheat for human consumption be very carefully assessed.

- Bhaskaram, C., and G. Sadasivan. "Effects of feeding irradiated wheat to malnourished children." *Amer Journ Clin Nutr*, 28:130-135, 1975.

Health Problems in Humans [II]

[After eating gamma-irradiated potatoes for 14 weeks], it was evident that the haemoglobin values were significantly higher *during* the period than *before*. The values were also significantly higher *during* than *after*. An additional comparison of the values *before* with the values *after* shows that a small effect still remains.

- Jaarma, Maire. "Studies of chemical and enzymatical changes in potato tubers and some higher plants caused by ionizing radiation, including studies on the wholesomeness of γ -irradiated potato tubers and effects on some carbohydrates *in vitro*." *Biokemiska institutionen, Kungl. Universitetet i Stockholm*, 1967.

Health Problems in Humans [III]

Ten young men served as test subjects for this study, [and were fed] pork loin which had been ground ... and subjected to gamma radiation... It is apparent...that there may very well be differences in the digestibility of the foodstuffs from irradiated or non-irradiated meat, and in the ability of protein in irradiated or non-irradiated meat to maintain nitrogen balance.

- Plough, I.C. et al. "An evaluation in human begins of the acceptability, digestibility and toxicity of pork sterilized by gamma radiation and stored at room temperature." U.S. Army Medical Nutrition Laboratory, Fitzsimons Army Hospital, Denver. Report No. 204, May 1957.

Health Problems in Humans [IV]

Thirteen young men served as test subjects, [and were fed] an irradiated food diet...of 8 different food items... The excretion of indophenol-reducing substances was significantly higher ($p < .005$) during the irradiated food periods... Irradiation decreased the thiamine and ascorbic acid content and increased the "browning reaction" derivatives, fat soluble carbonyl compounds, and thiobarbituric acid reactants.

- Bierman, E.D. et al. "Short-term human feeding studies of foods sterilized by gamma radiation and stored at room temperature." U.S. Army Medical Nutrition Laboratory, Fitzsimons Army Hospital, Denver. Report No. 224, July 1958.

Chromosomal Aberrations in Human Blood Cells [I]

Irradiated sucrose solutions...were extremely toxic to human lymphocytes. Mitoses were inhibited... Degenerated mitoses were observed and the chromosomes were grossly damaged. The chromatin [DNA]

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material was clumped or the chromosomes appeared shattered or pulverized... In contrast, treatment with unirradiated sucrose at the same concentration had no apparent effect on the mitotic rate and the chromosomes were not visibly damaged.

- Shaw, M.W. and Hayes, E. "Effects of irradiated sucrose on the chromosomes of human lymphocytes in vitro." *Nature*, 211:1254-1255, 1966.

Chromosomal Aberrations in Human Blood Cells [II]

Leukocyte cultures from four different healthy human males [underwent] a considerable inhibition of mitosis and chromosome fragmentation. [Additional] research would be extremely prudent.

- Kesavan, P.C. and Swaminathan, M.S. "Cytotoxic and radiomimetic activity of irradiated culture medium on human leukocytes." *Current Science*, 16:403-404, 1966.

A Summary of Problems

Numerous studies have been carried out to ascertain whether cytotoxic effects occur when unirradiated biological test systems are cultured or fed with irradiated media or food. In such studies, adverse physiological (growth retardation and inhibition), cytological (mitotic inhibition and chromosome aberrations) and genetical effects (forward and reverse mutations) have been observed in a wide range of test systems, ranging from bacteriophages to human cells... The available data suggest that [a variety of free radicals] may act as the toxic and mutagenic agents.

- Kesavan, P.C. and Swaminathan, M.S. "Cytotoxic and mutagenic effects of irradiated substrates and food material." *Radiation Botany*, 11:253-281, 1971.

A Thalidomide Warning [I]

The thalidomide disaster might have been prevented if an easily performed investigation of possible cytotoxic effects in plant cells had been made. It must be acknowledged that any compound causing [cellular] damage must be considered a potential hazard to any living cell or cell system – including man.

- Lofroth, G. "Toxic effects of irradiated foods." *Nature*, 211:302, 1966.

A Thalidomide Warning [II]

Irradiating can bring about chemical transformations in food and food components resulting in the formation of potential mutagens, particularly hydrogen peroxide and various organic peroxides... It is now realized, especially since the thalidomide episode, that [older testing] protocols do not detect the more subtle population hazards such as mutagens and teratogens... In view of the serious consequences to the human population which could arise from a high level of induced mutations, it is desirable that protocols for irradiated food should include *in vivo* tests on mammals for possible mutagenicity.

- Schubert, J. "Mutagenicity and cytotoxicity of irradiated foods and food components." *Bulletin of the World Health Organization*, 41:873-904, 1969. (Co-sponsored by the U.S. Atomic Energy Commission and Food and Drug Administration)

A Cancer Warning

An increase in concentration of a mutagen in food by irradiation will increase the incidence of cancer... It will take four to six decades to demonstrate a statistically significant increase in cancer due to mutagens introduced into food by irradiation... When food irradiation is finally prohibited, several decades worth of people with increased cancer incidence will be in the pipeline.

- Tritsch, G.L. "Food Irradiation." *Nutrition*, 16:698-701, 2000.

Toxic Chemicals Formed in Irradiated Food Containing Fat [I]

When food containing fat is treated by ionizing radiation, a group of 2-alkylcyclobutanones is

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formed... To date, there is no evidence that the cyclobutanones occur in unirradiated food... *In vitro* experiments using rat and human colon cells indicate that 2-dodecylcyclobutanone (2-DCB)...is clearly cytotoxic and genotoxic... [M]ore experiments than these preliminary ones are required.

- Delincee, H. and Pool-Zobel, B. "Genotoxic properties of 2-dodecylcyclobutanone, a compound formed on irradiation of food containing fat." *Radiation Physics and Chemistry*, 52:39-42, 1998. (Co-sponsored by the International Consultative Group on Food Irradiation.)

Toxic Chemicals Formed in Irradiated Food Containing Fat [II]

In this study, *in vivo* experiments were conducted on rats, which received two different doses of 2-DCB by way of pharyngeal probe... Slight but significant DNA damage was observed in the experimental group that received the higher concentration of 2-DCB (14.9 mg/kg body weight). Further studies are needed to clarify the relevance of these results to an evaluation of risk from the consumption of irradiated foods.

- Delincée, H. et al. "Genotoxicity of 2-dodecylcyclobutanone." *Food Irradiation: Fifth German Conference, Report BFE-R-99-01, Federal Nutrition Research Institute, Karlsruhe, Germany, 1998.*

Toxic Chemicals Formed in Irradiated Food Containing Fat [III]

To date, there is no evidence that 2-alkylcyclobutanones [2-ACB's] occur in unirradiated food, and therefore, it is advisable to determine the toxicological potential... [Human colon tumor cells were incubated with 2-tetradecylcyclobutanone, one particular ACB.] After prolonged incubation times, (1-2 days) at higher concentrations (>50iM), cytotoxicity did appear.

- Delincée, H. et al. "Genotoxicity of 2-alkylcyclobutanones, markers for an irradiation treatment in fat-containing food – Part I: Cyto- and genotoxic potential of 2- tetradecylcyclobutanone." *Radiation Physics and Chemistry*, 63:431-435, 2002.

Unique, Toxic Chemicals Formed in Irradiated Food Containing Fat [IV]

[U]sing an experimental colon carcinogenesis model in rats, 2-ACB's [2-alkylcyclobutanones], when tested at a high concentration, potentiate the effect of an inducing carcinogen on the long term. This was revealed by the increase of colonic neoplastic lesions and the development of a higher number of colon tumours with larger size... This suggests that, in this experiment, 2-ACB's, although they do not induce carcinogenesis, *per se*, rather promote the colonic carcinogenesis process. Finally, it was shown that small fractions of 2-ACB's had been stored in rat adipose tissues and excreted in faeces of the treated rats. This indicates that most of the 2-ACB's is metabolically transformed or stored in other organs...[I]n our opinion further investigations...will help to elucidate a possible risk associated with the consumption of irradiated fat-containing foods.

- Marchioni, E. et al. "Toxicological study to assess the risk associated with consumption of irradiated fat-containing food." (Summary) *International Consultative Group on Food Irradiation, Dec. 2001.*

Radioactivity in Organs and Excrement of Rats

Considerable amounts of radioactivity were present in the liver, kidney, stomach, gastrointestinal tract, and blood serum of rats [fed irradiated sucrose solutions]... Radioactivity was present in urine and feces samples.

- De, A.K. et al. "Biochemical effects of irradiated sucrose solutions in the rat." *Radiation Research*, 37:202-215, 1969.

Fatal Internal Bleeding in Rats [I]

A significant number of rats consuming irradiated beef died from internal hemorrhage within 46 days, the first death of a male rat coming on the 11th day of feeding. This rat became sluggish on the 8th day of the regimen and started refusing food. He continued [to be] morbid during the next two days, did

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not eat any food, lost weight and appeared anemic. He was found dead on the 11th day. Post-mortem examination showed hemothorax, the blood had not clotted; there was bleeding also in the epididymis.

- Metta, V.C. et al. "Vitamin K deficiency in rats induced by feeding of irradiated beef." *Journal of Nutrition*, 69:18-21, 1959. (Co-sponsored by the Surgeon General of the U.S. Army)

Fatal Internal Bleeding in Rats [II]

Hemorrhagic death had occurred in all males fed irradiated diets by day 34... There is evidence to suggest that inefficient absorption of vitamins, i.e. vitamin K, from the intestinal tract may contribute to a deficiency state.

- Mellette, S.J. and Leone, L.A. "Influence of age, sex, strain of rat and fat soluble vitamins on hemorrhagic syndromes in rats fed irradiated beef." *Federation Proceedings*, 19:1045-1048, 1960. (Co-sponsored by the Surgeon General of the U.S. Army)

Fatal Vitamin E Deficiency in Rats

A considerable number of the second litter of the experimental group [of rats that ate irradiated beef] died... Symptoms observed were marked edema of the face, ruffled hair coat, general incoordination, spastic hopping gait, and sometimes complete loss of movement with dragging of the hind quarters. Those pups most severely affected often became completely prostrated a short time before death... In no case were these symptoms noted in the control group... The probability [is that the pups] were suffering from the characteristic muscular dystrophy syndrome (commonly referred to as nutritional muscular dystrophy) known to result from a marginal vitamin E intake.

- Poling, C.E. et al. "Growth, reproduction, survival and histopathology of rats fed beef irradiated with electrons." *Food Res*, 20:193-214, 1955.

Prenatal Deaths in Mice [I]

Freshly irradiated diets produced elevated levels of early deaths in [mice fetuses]... The increase in early deaths would suggest that the diet when irradiated has some mutagenic potential.

- Anderson, D. et al. "Irradiated laboratory animal diets: Dominant lethal studies in the mouse." *Mutation Research*, 80:333-345, 1981.

Prenatal Deaths in Mice [II]

Feeding of mice for two months before mating with 50 percent of the standard complete diet irradiated with [gamma rays] provokes a significant increase of embryonal deaths,... probably to be interpreted as a dominant lethal mutation associated with gross chromosomal aberrations, such as breaks repeatedly found to be induced by irradiated materials.

- Moutschen-Dahmen, M. et al. "Pre-implantation death of mouse eggs caused by irradiated food." *Inter Journ Rad Biol*, 18:201-216, 1970.

Chromosomal Aberrations in Monkeys

The increased incidence of cells with numerical aberrations in animals which received a diet containing freshly irradiated wheat... must be considered significant.... Also, the disappearance of these cells, following the replacement of freshly irradiated wheat with unirradiated wheat, clearly indicates that the appearance of the abnormal cells was due to the ingestion of freshly irradiated wheat.

- Vijayalaxmi. "Cytogenetic studies in monkeys fed irradiated wheat." *Toxicology* 9:181-184, 1978.

Chromosomal Aberrations and Blood Disorder in Rats; Mutations in Mice

[A]n increase of chromosomal aberrations which was significant at the 5 percent level [was observed]... [Later experiments] demonstrated beyond a doubt that this effect is real, and running experi-

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ments also indicate an increase of intrauterine foetal death, possibly dominant lethal mutations in the mouse... [A] 15-20 percent decrease of the absolute lymphocyte numbers in the peripheral blood of the rat [was observed]... [T]he lymphopenia produced by irradiated food increased with increasing age of the rats.

- Lofroth, G. et al. "Biological effects of irradiated food. II: Chemical and biological studies of compounds distilled from irradiated food." *Arkiv. Zool.* 18:529-547, 1966.

Chromosomal Aberrations in Mice

Feeding of freshly irradiated wheat resulted in significantly increased incidence of polyploidy cells in bone marrow, aneuploid cells in testis, reduction in number of spermatogonia...as well as a higher mutagenic index... [S]ome toxic substance(s) may be formed during irradiation.

- Vijayalaxmi."Genetic effects of feeding irradiated wheat to mice." *Canadian Journal of Genetics and Cytology*, 18:231-238, 1976.

Chromosomal Aberrations in Rats

Feeding irradiated wheat to rats was associated with an increase in the number of polyploid cells in the bone-marrow... Irrespective of the protein content in the diet, animals which received irradiated wheat had polyploid cells in their bone-marrow.

- Vijayalaxmi and G. Sadasivan. "Chromosomal aberrations in rats fed irradiated wheat." *Inter Journ Rad Biol*, 27:135-142, 1975.

Chromosomal Aberrations in Hamsters

The proportion of [bone marrow] cells with polyploidy increased between 4 to 5 times the control level... When feeding of the irradiated diet stopped, the proportion of polyploid cells returned to the control level.

- Renner, H.W. "Chromosome studies on bone marrow cells of chinese hamsters fed a radiosterilized diet." *Toxicology*, 8:213-222, 1977.

Genetic Damage in Rats

Well-fed rats, when switched over to a diet of irradiated wheat, showed a higher mutagenic index than those given unirradiated wheat.

- Vijayalaxmi and K.V. Rao. "Dominant lethal mutations in rats fed on irradiated wheat." *Inter Journ Rad Biol*, 29:93-98, 1976.

Immune Dysfunction in Rats

Rats given diets containing freshly irradiated wheat showed significantly lower mean antibody titres to four different antigens, decreased numbers of antibody-forming cells in the spleen and rosette-forming lymphocytes... [T]he consumption of irradiated wheat is associated with changes in the immune status of the animal.

- Vijayalaxmi. "Immune response in rats given irradiated wheat." *British Journal of Nutrition*, 40:535-541, 1978.

Immune Dysfunction in Hamsters

The irradiated fish diet has apparently caused an even greater immunological response than unirradiated fish... [T]he possibility of a mutagen remaining undetected must be considered.

- Renner, H.W. et al. "An investigation of the genetic toxicology of irradiated foodstuffs using short-term test systems. III - In vivo tests in small rodents and in *Drosophila melanogaster*." *Food Chemistry and Toxicology*, 20:867-878, 1982.

Reproductive Dysfunction, Cancer, Stunted Growth in Mammals

A careful analysis by FDA of all [Army] data present (including 31 looseleaf notebooks of animal

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feeding test results) showed significant adverse effects produced in animals fed irradiated food... What were these adverse effects?... A decrease of 20.7 percent in surviving weaned rats... A 32.3 percent decrease in surviving progeny of dogs... Dogs weighing 11.3 percent less than animals on the control diets... Carcinomas of the pituitary gland, a particularly disturbing finding since this is an extremely rare type of malignant tumor.

- Spiher, A.T. "Food irradiation: An FDA report." *FDA Papers*, Oct. 1968.

Reproductive Dysfunction in Rats [I]

Very high losses of litter in the [first] and [second] generations [80 and 85 percent, respectively] in spite of a high fertility rate and normal size of litter in all dietary groups caused at first great difficulty. The suspicion that the animals had obtained too little vitamin E was certified correct.

- Reichelt, D. et al. "Long-term animal feeding study for testing the wholesomeness of an irradiated diet with a high content of free radicals." *Federal Research Institute for Food Preservation, Institute for Radiation Technology, Karlsruhe, Germany, 1972.*

Reproductive Dysfunction in Rats [II]

An impairment in the fertility of the male and an increased mortality in litters, which [researchers] believed was due to vitamin E destruction.

- DaCosta, E. and Levenson, S.M. "Effect of diet exposed to capacitor irradiation on the growth and fertility of the albino rat." *U.S. Army Medical Nutrition Laboratory, Fitzsimons Army Hospital, Denver. Report No. 89, 1951. Cited in Kraybill, H.F. and Huber, T.E. "The wholesomeness of irradiated food and its military implications." Paper to be presented at 63rd Annual Convention, Association of Military Surgeons, United States of America, Hotel Statler, Washington, D.C., Nov. 12-14, 1956.*

Reproductive Dysfunction in Mice [I]

Cytogenic examinations of the developing spermatogonia in 30 mice of each group revealed that cytogenetic abnormalities were significantly more frequent in the group fed irradiated flour than in the control group... [T]he incidence of litters [with non-viable offspring] was significantly higher in the group fed irradiated flour... [O]n the average the losses [of young mice] were about 35% higher in the test group than in the controls. The life span of mice fed irradiated flour was slightly shorter than in the control mice.

- Bugyaki, L., A.R. Deschreider, J. Moutschen, M. Moutschen-Dahmen, A. Thijs, and A. Lafontaine. "Do irradiated foodstuffs have a radiomimetic effect? II. Trials with mice fed wheat meal irradiated at 5 Mrad." *Atompraxis* 14:112-118, 1968.

Reproductive Dysfunction in Mice [II]

The mice raised on the irradiated diet exhibited some impairment in lactational performance.

- Luckey, T.D. et al. "Nutritional adequacy of a semi-synthetic diet sterilized by steam or cathode rays." *Food Research*, 20(2):180, 1955. Cited in Kraybill, H.F. "Problems in food processing by ionizing radiations with special reference to wholesomeness studies on irradiated foods." Paper to be presented at Fifth Annual Conference sponsored by Pennsylvania Public Health Association, Pennsylvania Health Council, Medical Society of Pennsylvania, Pennsylvania Department of Health, held at Pennsylvania State University, University Park, Pennsylvania, August 21, 1956.

Reproductive Dysfunction in Fruit Flies

The production of *Drosophila* offspring in cultures containing gamma irradiated chicken meat was much lower... The production...was not increased by changing the basal medium or by adding a vitamin supplement.

- Raltech Scientific Services Inc., Madison, Wisconsin. "Final Report: Evaluation of the mutagenicity of irradiated sterilized chicken by the sex-linked recessive lethal test in *Drosophila melanogaster*." Contract DAMD 17-76-C-6047, submitted to U.S. Army Medical Research and Development Command, Fort Detrick, Frederick, Maryland. June 15, 1979.

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Mutations in Fruit Flies [I]

An increase in the rate of mutation has been found in *Drosophila melanogaster* reared on a basic medium that was irradiated with a sterilizing dose (150,000 rads) of cobalt-60 gamma rays... Visible changes were two to six times more frequent in the irradiated series than in the controls,...[such as] half-thorax, vestigial wings and incurved wings.

- Swaminathan, M.S. et al. "Mutations: Incidence in *Drosophila melanogaster* reared on irradiated medium." *Science*, 141:637-638, 1963.

Mutations in Fruit Flies [II]

[S]everal experimental variables in culture medium may be associated with increased mutation frequencies in *Drosophila*; namely irradiated whole food... The increased mutation frequencies associated with flies cultured on aged food implies that the [toxic products] are long lived.

- Rinehart, R.R. and Ratty, F.J. "Mutation in *Drosophila melanogaster* cultured on irradiated whole food or food components." *Intern Journ Rad Biol*, 12(4):347-354, 1967.

Mutations in Fruit Flies [III]

There was an approximate twofold increase in sex-linked recessive lethality [in *Drosophila melanogaster* cultured in irradiated medium]. This increase can be attributed largely to an increase in gonial mutants.

- Rinehart, R.R. and Ratty, F.J. "Mutation in *Drosophila melanogaster* cultured on irradiated food." *Genetics*, 52(6):1119-1126, 1965.

Mutations in Fruit Flies [IV]

[A] small but constant increase in sex-linked and autosomal recessive lethal frequencies [was observed in *Drosophila melanogaster* cultured in irradiated medium]... A linear relationship of dose and effect was obtained with regard to dominant lethals.

- Kesavan, P.C. and Swaminathan, M.S. "Mutagenic effects of irradiated culture media in *Drosophila melanogaster*." *Indian Journal of Genetics*, 29:173-183, 1969. Cited in Kesavan, P.C. and Swaminathan, M.S. "Cytotoxic and mutagenic effects of irradiated substrates and food material." *Radiation Botany*, 11:253-281, 1971.

Stunted Growth of Rats

In general, the irradiated foods produced a depressed growth rate... The effect of the radiation variable is significant... Higher intake coupled with the lower growth rates of rats on the rations containing irradiated carrots resulted in a lower [food] efficiency.

- Tinsley, I.J. et al. "The growth, reproduction, longevity, and histopathology of rats fed gamma-irradiated carrots." *Toxicology and Applied Pharmacology*, 16:306-317, 1970.

Mutations in Salmonella

Groups of Swiss albino mice (SPF) fed with normal and gamma-irradiated food at doses of 0.75, 1.5, and 3.0 Mrad, were injected intraperitoneally with *Salmonella typhimurium* TA 1530 for the host mediated assay test of mutagenesis. The results indicate that there is a significant increase in mutation frequency induced by the 3 Mrad sterilized food.

- Johnston-Arthur T., M. Brena-Valle, K. Turanitz, R. Hruby, and G. Stehlik. "Mutagenicity of irradiated food in the host mediated assay system." *Studia Biophysica*, (Berlin), 50:137-141, 1975.



What's in the Beef?

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A Special Report



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What's in the Beef?

Research on irradiated foods and the effectiveness of the irradiation process dates to the 1950s. In the beginning, most research focused on the extent to which irradiation kills harmful microorganisms, and whether irradiated foods are palatable.

By and large, both of these questions have been satisfactorily answered: Foods “treated” with sufficient amounts of radiation can kill nearly all *E. coli*, *Salmonella*, *Listeria* and other pathogens found in food while leaving it edible, though perhaps with a scorched taste, unpleasant smell or discoloration.

In recent years, however, attention has turned toward questions of whether irradiated foods are toxic or could cause cancer, genetic damage or other health problems.

Irradiated foods fed to test animals have, indeed, been associated with a wide range of adverse health effects, including premature death, mutations and other genetic abnormalities, fetal death and other reproductive problems, a rare form of cancer, immune system disorders, fatal internal bleeding, organ damage, tumors, stunted growth and nutritional deficiencies.¹

Further, irradiation results in the formation of many chemical byproducts, some of which have toxic properties.

Perhaps most significantly, it was discovered in 1972 that irradiation of beef results in the formation of a class of chemicals known as 2-alkylcyclobutanones, or 2-ACBs.² Subsequent research determined that 2-ACBs are formed when certain fats – fats that are ubiquitous in food – are exposed to radiation.

These chemicals are so distinct from natural food components that they are used as “markers” to determine whether food has been irradiated. By the mid-1990s, the uniqueness of 2-ACBs to irradiated foods had been established.^{3,4,5,6,7,8,9,10,11,12}

Research then began into the question of whether these chemicals are toxic, or could cause cancer or genetic damage.

The results, preliminary as they may be, are of great concern. In several studies conducted over the past five years, 2-ACBs in their pure form have been associated with promoting colon cancer in rats, genetic damage in rats, and genetic and cellular damage in human and rat cells. The most recent and most extensive study was conducted by a team of German and French researchers working under a grant from the

European Union.^{13,14,15,16}

In the wake of these findings, Public Citizen and the Center for Food Safety hired a well-established food testing laboratory, Lebensmittel Consulting of Fostoria, Ohio, to test a variety of commercially available, irradiated ground beef products for the presence of 2-ACBs.

Materials and Methods

- Fresh, non-irradiated ground beef was purchased at a Safeway store in Washington, DC, and was tested raw and cooked.
- Fresh ground beef irradiated with an electron-beam irradiator by SureBeam Corp. was purchased at a Safeway store in Washington, DC, and a D'Agostino's store in New York City, and was tested raw and cooked.
- Pre-formed, frozen ground beef patties irradiated with a gamma-ray irradiator by Food Technology Service and sold under the "New Generation" label, was purchased at a Publix store in Hollywood, Fla., and was tested raw and cooked.
- Cooked hamburgers made from ground beef irradiated with an electron-beam irradiator by SureBeam Corp. of San Diego, were purchased at a Dairy Queen restaurant in Minneapolis. (*For detailed information on these companies, see p. 9*)

The meat was shipped to the laboratory in dry ice using standard shipping methods.

Patties with a thickness similar to the pre-formed New Generation patties were made with the non-irradiated beef and the fresh SureBeam irradiated ground beef. The patties were cooked in a skillet on each side until the meat was thoroughly browned on each side.

Two samples of each type of meat were analyzed, one by gas chromatography/mass spectrometry, and one by gas chromatography/flame ionization detection.

The Findings

The two types of 2-ACBs that have been associated with colon tumor promotion in rats, and with cellular and genetic damage in human cells were detected in all three irradiated ground beef products. These chemicals are 2-tetradecenylcyclobutaneone (2-tDeCB) and 2-tetracylcyclobutanone (2-tDCB).

A third type of 2-ACB associated with cellular and genetic damage in human cells was also detected in all three irradiated ground beef products. This chemical is 2-dodecylcyclobutanone (2-dDCB).

Among the three types of irradiated ground beef that had been cooked, SureBeam contained the highest levels of 2-tDeCB and 2-tDCB, while "New Generation" contained the highest level of 2-dDCB.

Among the two types of irradiated ground beef tested raw, "New Generation" contained the highest level of 2-tDCB and 2-dDCB, while SureBeam contained the highest level of 2-tDeCB.

No 2-ACBs were detected in the non-irradiated ground beef, whether raw or cooked. The absence of 2-ACBs in non-irradiated ground beef confirms the findings of numerous previous studies. (*See Notes 3-12.*)

Cooking of the irradiated beef generally, but not always, reduced the amount of 2-ACBs. (*See Table, next page.*)

Overall, 2-dDCB was detected in the greatest quantity, followed by 2-tDeCB and 2-tDCB.

The lead scientist at Lebensmittel Consulting speculated that the Dairy Queen hamburgers, though having the highest percentage of fat among the three irradiated types of beef, may have had the lowest levels of 2-ACBs due to the way they were cooked. Reasons for other variations in the results

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could not immediately be determined. The relationships between irradiation dose, fat content, cooking method and types of beef are not yet fully understood.

Discussion

In the European Union study, rats that drank solutions of 2-tDeCB and 2-tDCB, in conjunction with exposure to a known colon carcinogen, developed more large tumors, more multiple tumors, and more pre-tumorous lesions than rats only exposed to the carcinogen. Of the two chemicals, 2-tDeCB had a greater tumor promotion effect.

Additionally, in the European Union study, 2-tDeCB and 2-tDCB were detected in

small quantities in the adipose tissue (fat) and feces of the rats. But because most of the chemicals could not be accounted for, scientists have strongly recommended that more research be conducted into how the body metabolizes

2-ACBs. It is possible that the chemicals could be stored in other parts of the body, or could give rise to still other chemicals if the body breaks them down.

Because they have not been found to occur naturally in any food, 2-ACBs are known as “unique radiolytic products.” These chemicals are formed when certain “precursor” fatty acids are exposed to irradiation: 2-tDeCB is derived from oleic acid; 2-tDCB is

2-ACBs Detected in Irradiated Ground Beef

Beef type	2-dDCB ¹		2-tDeDCB ²		2-tDCB ³	
	micrograms per gram ⁴ of		micrograms per gram of		micrograms per gram of	
	meat	fat	meat	fat	meat	fat
Non-irradiated, raw	0.0000	0.000	0.0000	0.000	0.0000	0.000
	0.0000	0.000	0.0000	0.000	0.0000	0.000
Non-irradiated, cooked	0.0000	0.000	0.0000	0.000	0.0000	0.000
	0.0000	0.000	0.0000	0.000	0.0000	0.000
SureBeam, raw #1	0.0612	0.72	0.0349	0.41	0.0058	0.1
	0.0663	0.78	0.0374	0.44	0.0056	0.096
SureBeam, cooked #1	0.0544	0.64	0.0062	0.073	0.0007	0.008
	0.0621	0.73	0.0086	0.101	0.0009	0.01
SureBeam, raw #2	0.0331	0.57	0.0081	0.14	0.0008	0.014
	0.0307	0.53	0.0050	0.087	0.0008	0.013
SureBeam, cooked #2	0.0296	0.51	0.0081	0.14	0.0020	0.034
	0.0278	0.48	0.0075	0.13	0.0017	0.03
New Generation, raw	0.0975	1.5	0.0039	0.06	0.0054	0.093
	0.1040	1.6	0.0035	0.054	0.0058	0.1
New Generation, cooked	0.0910	1.4	0.0018	0.027	0.0012	0.02
	0.0832	1.28	0.0016	0.025	0.0008	0.013
Dairy Queen, cooked	0.0178	0.081	0.0003	0.0015	0.0002	0.004
	0.0185	0.084	0.0003	0.0012	0.0002	0.004

¹ Dodecylcyclobutanone

² Tetradecenylcyclobutanone

³ Tetradecylcyclobutanone

⁴ parts per million (ppm)

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derived from stearic acid; and 2-dDCB is derived from palmitic acid. (See *Table, next page.*)

Although the tests commissioned by Public Citizen and The Center for Food Safety only assessed the presence of 2-ACBs in irradiated ground beef, other researchers have detected the chemicals in many other irradiated foods: chicken, pork, lamb, eggs, duck, peanuts, mangoes, papayas, mangoes, freshwater tilapia, and saltwater mullet. (See *Notes 3-12.*)

The fatty acids that serve as precursors to 2-ACBs occur in virtually all foods that contain even a very small amount of fat. These foods include many that the Food and Drug Administration has legalized for irradiation, including red meat, poultry, fruit, vegetables and eggs. These foods also include many that the FDA is considering for legalization, including shellfish and ready-to-eat foods. Among the foods that contain oleic, stearic and palmitic acids are:

- *Red meat* – beef, pork, lamb, veal.
- *Poultry* – chicken, turkey, duck, goose, pheasant, chicken eggs.
- *Shellfish* – crab, oysters, shrimp.
- *Fruit* – apple, apricot, avocado, banana, blueberry, cherry, currant, fig, grapefruit, grape, guava, lemon, mango, olive, orange, papaya, peach, pear, pineapple, plum, raspberry, strawberry, tangerine.
- *Vegetables* – potato, tomato, pepper, cabbage, cauliflower, turnip, cucumber, pumpkin, pea, soybeans, sweet potato, corn.
- *Ready-to-eat foods* – pizza, frozen meals, peanut butter, raisins, granola bars, cake,

cookies, oatmeal and potato chips.¹⁷

Without knowing the types and levels of 2-ACBs in irradiated forms of these and other foods, toxicologists can only guess at the potential toxicity risks they could pose to humans who eat them.

Words of Caution

Members of the European Union research team concluded:

“[I]t seems not appropriate to draw a final conclusion concerning the risk associated with human consumption of irradiated fat-containing foods. However, since our results point towards toxic, genotoxic and even tumor promoting activity of certain 2-ACB, we strongly recommend to carry out further research, including confirmation of our results by other laboratories, to elucidate a possible risk associated with the consumption of irradiated fat-containing foods... To characterize the potential risk, hazards need to be identified, the exposure, the exact dose-response and particularly the kinetics and metabolism of 2-ACB in the living organism should be elucidated. All these studies are deemed necessary to gain insight into the mechanisms of the toxic effects. Numerous

questions still remain to be answered, and much research is left to be done, before a qualified risk assessment can be performed.”¹⁸

Additionally, the scientists stated:

2-ACB Byproducts of Irradiated Fatty Acids

Oleic¹ 2-tetradecylcyclobutanone (2-tDeCB)
Stearic² 2-tetradecylcyclobutanone (2-tDCB)
Palmitic³ 2-dodecylcyclobutanone (2-dDCB)

¹ Oleic acid (C_{18:1}) is a monounsaturated fatty acid

² Stearic acid (C_{18:0}) is a saturated fatty acid

³ Palmitic acid (C_{16:0}) is a saturated fatty acid

“The relevancy of these results for the risk assessment of human consumption of irradiated food remains to be elucidated... In light of the expected extended application of food irradiation, however, it seems necessary to further clarify the potential toxicity of 2-ACBs and their contribution to a possible risk associated with human consumption of irradiated fat-containing food.”¹⁹

Further, the scientists stated:

“[W]e feel that our new data ... raise some doubts or at least suggest that caution should be exercised before any risk to consumers by exposure to these compounds is denied... It needs to be shown that despite the presence of potentially cyto- and genotoxic radiation-induced agents, the consumption of irradiated fat-containing food is safe for consumers.”²⁰

Earlier this year, the U.S. Department of Agriculture lifted the ban on serving irradiated ground beef as part of the National School Lunch Program. European Union research team member Francis Raul, Ph.D., of Louis Pasteur University in Strasbourg, France, was quoted in *The New York Times* of Oct. 15, 2003 as saying: “It is perhaps too early to start irradiating beef to give to children.”

Independent experts echo the concerns of the European Union research team.

Professor William W. Au, Ph. D., of the Department of Preventive Medicine at the University of Texas Medical Branch in Galveston, TX, stated:

“[In the European Union study on rats,] a portion of the [2-ACBs]

crossed the intestinal barrier, entered the blood stream and accumulated in adipose tissue of the animal. Therefore, consumption of irradiated food for a long time can cause significant accumulation of the toxic 2-ACB in the adipose tissues of consumers... [C]onsumption of an improper diet together with food that contains 2-ACB which acts as a tumor promoter can increase the risk for the development of colon cancer. Under this scenario, individuals who would normally outlive the risk for colon cancer might develop the cancer from the promoting effect of 2-ACB. Without a systematic investigation in the population, this serious concern has not been addressed yet... Short-term safety evaluation of components of irradiated food products, rather than on whole food, needs to be systematically conducted. Therefore, regulatory agencies and industries need to ensure that the irradiation process will not produce serious and long-term health effects to consumers.”²¹

Chinthalapally V. Rao, Ph. D., of the Division of Nutritional Carcinogenesis at the Institute For Cancer Prevention in Valhalla, New York, one of the leading cancer research centers recognized by the National Institutes of Health stated:

“[F]urther investigations are warranted to identify and assess the exact levels at which [2-ACBs] may exert tumor promoting effects. Also, a full-length study investigating the cancer promoting effects of 2-alkylcyclobutanones in irradiated foods (*per se*) and their mechanism(s) of action, is urgently

needed to address public health concerns. A thorough investigation of the effect of 2-alkylcyclobutanones at levels consumed by the human population and in models (*in vitro* and *in vivo*) of various types of cancers is warranted before proposing that irradiated foods do or do not promote colon cancer.”²²

The FDA's Position

For more than 15 years, the FDA has asserted that the chemical byproducts formed in irradiated foods are identical or similar to natural food components.

This assertion has been made on several occasions in the *Federal Register*, the official record of the U.S. government:

“[R]adiolytic products are typically identical to substances that occur naturally in foods.”²³ (Stated in 1997, when the FDA rejected citizens’ requests to suspend the legalization of irradiation for poultry.)

“There is no evidence, or any reason to believe, that the toxicity or carcinogenicity of any unique radiolytic products is different from that of other food components.”²⁴ (Stated in 1987, when the FDA rejected citizens’ requests to suspend the legalization of irradiation for fruit, vegetables and pork.)

“Because any [radiolytic products] are likely to be toxicologically similar to other food components, it would be virtually impossible to detect potential toxicological properties of these substances.”²⁵ (Stated in 1986, when the FDA legalized irradiation for fruit and vegetables.)

With the discovery of 2-ACBs, and the revelation that these chemicals are cancer promoters and have other toxic properties, these assertions made by the FDA are no longer true. There is now ample evidence that 2-ACBs do not occur naturally in non-irradiated food, and that they do have toxic properties.

In addition to the potential hazards posed by 2-ACBs, red meat consumption is a well-known risk factor for a myriad of health problems. Further, grilling coats beef with polycyclic aromatic hydrocarbons, known carcinogens.²⁶ And, grilling creates heterocyclic amines, which are mutagens and carcinogens associated with respiratory tract cancers (from the fumes), and are known colon carcinogens.^{27,28,29}

Clearly, the tumor promotion effects of 2-ACBs in irradiated ground beef must be investigated as to whether they act synergistically with these known colon carcinogens when hamburgers are grilled.

Finally, one published study has found that irradiation doubles the amount of *trans* fat in irradiated compared to non-irradiated ground beef.³⁰ Well-established nutrition science suggests that doubling of *trans* fat will increase the risk of chronic heart disease associated with this harmful fat.³¹ Further, an increase in *trans* fat also increases the risks of a variety of other human health problems, including increasing levels of LDL (“bad”) cholesterol and decreasing levels of HDL (“good”) cholesterol.^{32,33} The FDA must investigate this issue fully.

Recommendations

Public Citizen and The Center for Food Safety make the following recommendations:

- Based on the toxicity risks outlined above, and the potential *trans* fat increase, the FDA should promptly rescind its 1997 approval of irradiation for beef.

What's in the Beef?

- Currently, the FDA is considering petitions to legalize irradiation for “ready-to-eat” foods (which comprise 37 percent of the typical American’s diet); crustacean shellfish (such as crabs, shrimp and lobsters); molluscan shellfish (such as clams, oysters and mussels); and certain red meat products. The FDA is also considering a petition to increase the maximum allowable irradiation dose for poultry. The FDA should refrain from legalizing irradiation for any of these or additional types of food until comprehensive, published, peer-reviewed research is conducted into the potential carcinogenicity, genotoxicity and overall toxicity of 2-ACBs that are known or suspected to be present in foods covered by pending before the FDA. This must include assessing synergistic effects, such as assessing the tumor promotion effect of certain 2-ACBs in combination with pre-existing carcinogenic properties that may be associated with such foods.

- The FDA should calculate a 100-fold safety factor for 2-ACBs, which, in the absence of an alternative safety factor justified by evidence, the U.S. Code of Federal Regulations requires must be calculated before a

food additive can be legalized for human consumption. (This safety factor is calculated by establishing the highest level at which no adverse health effect is detected, and dividing that figure by 100.) If hazardous levels of 2-ACBs are detected in foods for which irradiation already has been legalized, these rulings should be rescinded. Likewise, if hazardous levels of 2-ACBs are detected in foods for which irradiation is being considered, these petitions should be denied.

- The U.S. Department of Agriculture, with FDA concurrence, should reverse its decision to allow irradiated ground beef to be served as part of the National School Lunch Program and other nutritional programs until the open issues related to 2-ACBs and other chemicals formed in irradiated beef are sufficiently addressed. Further, the FDA and USDA should recall all irradiated ground beef in distribution. Using our schoolchildren as guinea pigs in a massive uncontrolled feeding experiment – the largest ever conducted anywhere in the world with any irradiated foods – defies common sense and would be immoral until the scientific safety issues are resolved.

Company Information

- **Safeway**, based in Pleasanton, CA, has more than 7,000 stores in the United States and Canada. Irradiated, fresh ground beef is reportedly on sale in about 135 stores in Delaware, Maryland, Virginia and Washington, D.C.

- **D’Agostino’s**, based in Larchmont, N.Y., has about 25 stores in the New York City area. Irradiated, fresh ground beef is reportedly on sale at all stores.

- **Dairy Queen**, based in Edina, Minn., has about 6,000 restaurants in the United States, Canada and 20 other countries. Irradiated hamburgers are reportedly on sale in Minnesota, South Dakota, and

certain parts of the Northeast and Southwest.

- **Publix**, based in Lakeland, Fla., has more than 700 stores in Alabama, Florida, Georgia, South Carolina and Tennessee. Irradiated, frozen ground beef patties are reportedly on sale in all stores.

- **SureBeam**, based in San Diego, irradiates food with linear accelerators that emit electrons nearly to the speed of light.

- **Food Technology Service**, based in Mulberry, FL, near Tampa, irradiates food with gamma rays projected from radioactive cobalt-60.

Notes

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A Broken Record

**How the FDA Legalized $\frac{3}{4}$
and Continues to Legalize $\frac{3}{4}$
Food Irradiation Without
Testing it for Safety**

A special report by

**Public Citizen's
Critical Mass Energy and Environment Program**

The Cancer Prevention Coalition

and

Global Resource Action Center for the Environment

October 2000

Executive Summary

This past May—almost 45 years to the day after a U.S. Army general proudly showed members of Congress a picture of a beef tenderloin that had undergone “radiation sterilization”—irradiated meat went on public sale in the United States.

Today, somewhere in Iowa or Florida or North Dakota, someone is biting into a hamburger that has been irradiated with the equivalent of 150 million chest x-rays—and maybe sprinkling it with spices that have been “treated” with the equivalent of 1 *billion* chest x-rays.

Has the U.S. Food and Drug Administration done its job to ensure that this food—food that has been exposed to deadly radioactive material or electrons fired nearly to the speed of light—is safe for human consumption?

Unfortunately, for the American consumer, the answer is ‘No.’

In the most in-depth investigation ever conducted into the FDA’s oversight of food irradiation, these disturbing facts have come to light:

? Since 1983, FDA agency officials have knowingly and systematically ignored federal regulations and their own testing protocols that must be followed before irradiated food can legally be approved for human consumption.

? Since 1986, FDA officials have legalized irradiation for several major classes of food while relying on nearly 80 scientific studies that the agency’s own expert scientists had dismissed as “deficient.” (The FDA legalized the irradiation of eggs in July, for instance, based on three “deficient” studies, one of which was conducted in 1959.)

? None of the seven key scientific studies that FDA officials used to legitimize their first major approval of food irradiation in 1986 met modern standards. (One of them had actually been declared “deficient” by FDA toxicologists; three others had never been translated into English.)

? FDA officials have systematically dismissed evidence suggesting that irradiated food can be toxic and induce genetic damage. Much of this evidence resulted from government-funded research submitted to the FDA and members of Congress as early as 1968.

? Officials of the FDA, U.S. Army and other federal agencies have consistently misled Congress about the potential hazards of food irradiation, and about the reasons that past research initiatives have failed to demonstrate that irradiated food is safe for human consumption.

In short, the FDA has legalized high-dose radiation “treatments” of fruit, vegetables, beef, pork, lamb, eggs and spices—all without certifying that any of the scientific studies they used to justify these decisions met modern standards.

In this report, we attempt to answer the questions “Who?” “What?” “Where?” and “How?” One question remains: “Why?”

Food Irradiation: Roots and Reasons

From efforts by the Atomic Energy Commission to fulfill the promise of President Eisenhower's "Atoms for Peace" program, to efforts by the Energy Department to find markets for radioactive waste generated by nuclear bomb facilities and power plants... From efforts by the food industry to rid their products of pathogens and extend their global reach by increasing shelf-life, to efforts by the weapons industry to find new applications for "Star Wars" technology...

The history of food irradiation is a long one and, like the technology itself, there is far more to it than meets the eye.

In the mid-1960s, after more than a decade of research, the U.S. Army sent a few thousand pounds of irradiated bacon to military personnel in Vietnam. In 1968, however, the Food and Drug Administration (FDA) revoked the Army's irradiation permit after reviewing previously unreleased Army records indicating that lab animals fed irradiated food suffered premature death, cancer, reproductive dysfunction and other problems.¹

A Congress member remarked after learning of the previously hidden Army documents, "We were guinea pigs."²

Meanwhile, international interest in the technology had grown enough to prevent food irradiation from joining atomic locomotives and airplanes, nuclear-powered pacemakers and wristwatches, and plutonium-heated long johns in the ash bin of history. During a meeting in Rome in 1964, officials from the United Nations and International Atomic Energy Agency resolved to "influence legislation in various countries" and "facilitate international acceptance of the process."³

During the 1970s, pressure mounted on DOE officials to solve their radioactive waste problems at two nuclear bomb factories—Hanford in Washington and Savannah River in South Carolina. Food irradiation rose to the top of the list of solutions. "I frankly would like to see us use everything," a DOE official told a congressional committee in 1983, "including the squeal, if you want to refer to pork, we possibly can."⁴

In 1979 FDA toxicology director Hubert Blumenthal—while serving on the international committee that sought to "influence" national legislation—called for the creation of the FDA's Irradiated Food Committee (IFC). Based on a theoretical calculation of how many new chemicals are formed in irradiated food, the panel recommended no further testing for food irradiated at low levels and for food comprising a small percentage of the typical American's diet.⁵ The panel recommended animal testing for high-level irradiation,⁶ but the battery of tests was far less comprehensive than the battery normally used by the FDA.⁷

Two years later, a second FDA panel reviewed 409 toxicology studies on irradiated food and labeled all but five of them "deficient."⁸ Though none of the five studies met FDA standards, they formed the foundation of FDA rulings to legalize the irradiation of spices in 1983;⁹ pork in 1985;¹⁰ fruit, vegetables and spices in 1986;¹¹ poultry in 1990;¹² beef and lamb in 1997;¹³ and eggs this past July.¹⁴

(See "Food Irradiation Timeline," Appendix I.)

New Chemicals Never Studied

Before legalizing a food additive for human consumption, the FDA is required by federal regulations to establish at least a 100-fold safety factor for humans. This is achieved by determining the highest level at which laboratory animals are unharmed by a proposed additive—the “highest no-adverse effect level”—and then dividing that level by 100.¹⁵

In the case of irradiated food, the “additive” is comprised of new chemical compounds called unique radiolytic products (URPs) formed in food when it is exposed to radiation.

In 1977 the first in-depth analysis of the radiolytic products formed in irradiated food was released. Working under an Army contract, the Federation of American Societies of Experimental Biology (FASEB) of Bethesda, Md., measured the concentrations of 65 chemical compounds in irradiated beef and found that 55 either did not occur naturally in beef, did not occur naturally in any food, or increased in concentration when exposed to radiation. FASEB scientists, for example, measured a 650 percent increase in the concentration of benzene—a “known human carcinogen” according to the U.S. Environmental Protection Agency.¹⁶ (*See Chart 2.*)

FASEB scientists became among the first to publicly acknowledge the unlikelihood of identifying every new chemical formed in irradiated food: “The possible presence of undetected substances can never be excluded.”¹⁷

Despite these uncertainties, the FDA’s Irradiated Food Committee did not recommend further experiments for foods irradiated at low levels or for foods that comprise a very small portion of the typical American’s diet. The IFC also stated, without presenting specific evidence, that any URPs formed in irradiated food likely would not cause health problems in humans because the chemicals likely would be similar to chemicals in non-irradiated food.

The IFC also did not discuss the formation of radiolytic products (unique or otherwise) in poultry, pork, fruit, vegetables, eggs and other classes of food for which the FDA subsequently legalized irradiation.

Furthermore, the IFC report included little or no discussion about establishing a 100-fold safety factor for humans by determining the highest no-adverse effect level for lab animals; how—or even whether—researchers should identify or quantify radiolytic products; or whether the testing of radiolytic products generated in one class of food could be used to demonstrate the safety of other classes of irradiated food.

Most significantly, the IFC prescribed a series of experiments far more limited than those detailed in the FDA’s published guidelines, which required five short-term mutagenicity studies, two-year carcinogenicity tests on two rodent species, one-year toxicity tests on one rodent and one non-rodent species, and a multigeneration reproduction/teratology test on rodents.¹⁸

A review of FDA documents reveals that the agency neither fulfilled its own testing requirements, nor determined the highest no-adverse effect level for lab animals or 100-fold safety factor for humans when the agency legalized the irradiation of pork in 1985; fruit, vegetables and spices in 1986; poultry in 1990; red meat in 1997; and fresh shell eggs in July of this year.

Additionally, the agency failed to fulfill the specific IFC requirement that foods irradiated at doses above 100,000 rads and comprising more than 0.01% of the typical American’s diet be

used in tests in which “the concentration of radiolytic products is maximized.” (emphasis in original).¹⁹ The agency, in fact, has failed to specifically address the issue of radiolytic products in its three most recent food irradiation rulings—poultry in 1990, beef in 1997, and eggs this past July.

Flaws in the FDA’s Key Studies

On April 18, 1986, the FDA approved what would become known as the “Omnibus Rule,” which legalized the irradiation of fruit and vegetables, and tripled the maximum irradiation dose for spices.²⁰

Then-FDA Commissioner Frank Young wrote in the *Federal Register* that five studies endorsed by the agency’s blue-ribbon Irradiated Foods Task Group (IFTG) “were considered by agency reviewers to be properly conducted, fully adequate by 1980 toxicological standards, and able to stand alone in the support of safety. The reports of these...studies indicate no adverse effects from the irradiated foods fed to test animals.”²¹

Listed in the *Federal Register*’s footnotes, however, were *seven* studies—including a 1972 German study that the IFTG had actually declared “deficient” four years earlier. Internal FDA documents that perhaps could explain this discrepancy were either missing from agency files during a recent inspection, or have yet to be produced by FDA officials in response to a formal request under the U.S. Freedom of Information Act.

Beyond this as yet unexplained discrepancy, an analysis of the seven studies reveals numerous flaws that profoundly question not only the adequacy of the studies, but the credibility of the FDA officials who relied on them to legitimize their decisions to approve irradiated food for human consumption:

? None of the seven studies met the FDA’s own testing protocols that the agency must follow to determine the safety of food additives; (*See Appendix IV.*)

? Some of the seven studies actually suggest irradiated food may not be safe for human consumption. In two of the studies, researchers added vitamin E and other nutrients for the specific purpose of reversing the harmful effects of consuming irradiated food; and

? Three of the seven studies were written in French, of which FDA officials possess no English translations. (Public Citizen translated the studies for the purposes of this report.)

Perhaps most alarming, none of the seven FDA studies included short-term experiments to gauge the carcinogenic and mutagenic potential of irradiated food. This failure is of notable concern in light of research presented to Congress in 1968 (some of which was funded by the government) that revealed severe chromosomal damage to human white blood cells;²² a doubling of mutations in fruit flies;²³ and “significantly” impaired cell division of plants grown in an irradiated environment.²⁴

Then-FDA Associate Commissioner Daniel Banes warned Congress members: “Our knowledge 8 or 10 years ago about the teratogenic effect of drugs—for example, thalidomide and its effects on the embryo—was sketchy. In fact, it was practically nonexistent. The questions we ask now about the effects of drugs on the reproductive process and on metabolic systems and the biochemistry of the body are far more subtle and far more advanced. I submit, sir, that the same situation obtains with respect to irradiated food.”²⁵

Major FDA Rulings Based on ‘Deficient’ Science

When the FDA approved its “Omnibus Rule” in the *Federal Register* of April 18, 1986, the agency listed a study conducted by two German scientists as being among the seven studies endorsed by the FDA’s Irradiated Foods Task Group (IFTG).²⁶ Four years earlier, however, IFTG Chair Marcia van Gemert wrote that the study, conducted in Germany in 1972, was scientifically “deficient.” Ironically, van Gemert further wrote that the study, despite its shortcomings, actually “claimed to show adverse effects of irradiated food.”²⁷

Though the most notable example, the German study was but one of 29 “deficient” studies used by FDA officials to establish the soundness of their Omnibus Rule. Spanning a 14-year period beginning with that ruling, FDA officials have cited 79 “deficient” studies in 107 different instances when legalizing irradiation for various classes of food. (*See Chart 3 and Appendix II.*)

As for studies the FDA has relied upon to legalize irradiation that were conducted after the IFTG finished its work in 1982, the agency has not publicly certified that any of them comply with modern scientific standards.

In what would become a common occurrence in the years since the 1986 ruling, FDA officials made no mention in the Omnibus Rule that they were relying on studies labeled “deficient” by the agency’s own Irradiated Foods Task Force. FDA officials, in another oft-repeated occurrence, also did not explain how studies once considered of poor quality could become adequate for the purposes of legalizing irradiated food.

The pattern continued in 1987, when FDA officials rejected requests for a public hearing on the Omnibus Rule by citing 10 IFTG-rejected studies, nine of which—including the German study—previously had been listed when the Omnibus Rule was approved a year earlier.²⁸ In 1988, FDA officials rejected additional requests for a public hearing on the Omnibus Rule by citing nine “deficient” studies, including two by the German researchers.²⁹

In 1990, the FDA relied on 10 “deficient” studies in legalizing the irradiation of poultry.³⁰ Among them was a “deficient” Canadian study that lacked certain histopathological examinations, leading an FDA staffer to write in an internal memo that “there is a fair to good chance” of tumors going undiscovered when only cursory exams are performed.³¹ Marking the first such occurrence, internal FDA memos reveal that staff members raised concerns about the “deficient” studies, but did nothing to keep them from being used to legalize the irradiation of poultry. (*See Appendix V, studies #218, #265, #353.*)

In 1997, FDA officials cited 46 “deficient” studies—the highest number to date—in legalizing the irradiation of beef, pork, lamb and horse meat.³² Most notably, however, the FDA relied on five studies that the agency’s Irradiated Foods Task Group had not only labeled “deficient,” but which the panel specifically stated, ironically, “claimed to show adverse effects of irradiated food”³³

In the FDA’s latest major ruling, agency officials this past July legalized the irradiation of fresh shell eggs.³⁴ In doing so, the FDA relied on three studies that the Irradiated Foods Task Group had labeled “deficient.” An FDA staffer acknowledged that the studies were “deficient,” but made little or no effort to explain how they could be used to legitimize a finding that irradiated eggs are safe to eat.³⁵ (*See Appendix VI.*)

Congress Not Given the Whole Truth

At the 10 congressional hearings devoted to food irradiation since 1955, Congress members put direct questions about the safety, effectiveness, and technological and economic feasibility of food irradiation to officials with the FDA, Army, AEC, Department of Energy, and other federal agencies. Though Congress members expected direct answers, they didn't always get them.

In 1966, Rep. Melvin Price, chair of a key subcommittee of the Joint Committee on Atomic Energy, asked Edward Josephson, head of the Army's food irradiation lab in Natick, Massachusetts, to discuss "what you consider to be the vital and most important" challenges faced by the program.³⁶ Josephson made no mention of the health problems suffered by lab animals fed irradiated food in Army experiments.³⁷

As history would soon show, Josephson knew about these problems.

Two years later, Josephson was back in front of Price's subcommittee. The hearing was held shortly after the FDA revoked the Army's permit to serve irradiated bacon to military personnel and suggested that the Army withdraw its application to irradiate ham. FDA officials took action after they examined previously unreleased raw data from experiments conducted by Army researchers and others that revealed serious health problems in lab animals that ate irradiated food, including premature death and cancer.

Rep. Chet Holifield did not react favorably to the notion that Congress had not been given the complete picture: "I am greatly disturbed by this line of testimony. It is a complete repudiation of what this committee has been told by what we thought were expert people, expert testimony from scientists that had conducted these experiments."³⁸

Despite the revelation of health problems suffered by lab animals, Josephson told subcommittee members, "If there were any reservations as to the safety of irradiation processing, the program would surely not have been carried through to its present state of development."³⁹

The resistance on the part of federal officials to acknowledge to Congress that irradiated food might not be safe for human consumption would continue on-and-off for the next two decades.

In the spring of 1970, a high-ranking AEC official told a House Appropriations subcommittee, "We have not seen adverse factors which would suggest that radiation-processed food is unsafe."⁴⁰ The AEC official made this statement despite the fact that his agency withdrew an application to irradiate strawberries in 1967 after rats fed irradiated peaches developed "significant numbers of tumors"⁴¹; and the fact that AEC-funded research found in 1965 that fruit flies grown on irradiated food experienced a twofold increase in mutations.⁴²

Less-than-forthcoming congressional testimony by FDA officials continued into the 1980s—a critical time in history, as the agency began a series of rulings that enabled the introduction of irradiated food to the retail grocery market on a mass scale.

In 1987 Rep. Douglas Bosco (D-CA) introduced the Food Irradiation Safety and Labeling Requirement Act, which would have blocked the most recent irradiation rulings from taking effect. Then-FDA Commissioner Frank Young glossed over the reasons that the agency revoked the Army's permit to irradiate bacon. Young made no mention of the roles of the Army and AEC, made no mention of the serious health problems experienced by lab animals that ate irradiated food, and made no mention of the AEC's withdrawal of applications to irradiate strawberries, oranges and lemons.

The Present

Coupled with rulings already on the books, pending before the FDA and USDA are petitions and proposed rules that, if approved by the agencies, would result in the legalization of irradiation for nearly every class of food—perhaps within a year. Among the most significant proposals pending before the FDA and USDA, most of which the government is reviewing on an “expedited” basis:

• Last December, the National Food Processors Association (NFPA)—“the voice of the \$460 billion food processing industry”⁴³—asked the FDA to legalize the irradiation of “ready-to-eat” foods, which comprise about a third of the typical American’s diet.⁴⁴

• In February 1999, FDA officials announced that they are looking to change existing federal regulations that require irradiated food be so labeled.⁴⁵ Weakening labeling regulations could allow food companies to use the misleading phrases “cold pasteurized” or “electronically pasteurized.”

• This past May, the USDA proposed allowing imported fruit and vegetables to be irradiated to control 11 species of fruit flies and one species of seed weevil.⁴⁶ The proposed rule includes no analysis of the likelihood that surviving insects could mutate due to radiation exposure.

• Last year, the FDA received petitions from Caudill Seed Co. to legalize the irradiation of alfalfa and other sprouting seeds,⁴⁷ and from the National Fisheries Institute and Louisiana Agriculture and Forestry Department to irradiate shellfish.⁴⁸

If every petition and proposed rule before the FDA and USDA is approved, more than 90 percent of the typical American’s diet will be eligible for irradiation.⁴⁹ Such penetration, however, was not envisioned during the 1950s, 1960s and 1970s, when researchers and policymakers made their decisions based on the notion that irradiated food would not soon comprise a large portion of the typical American’s diet.

The FDA’s Irradiated Food Committee, for instance, stated in 1980: “A rough estimate...suggests that 10% of the total diet may consist of irradiated food in the near future.”⁵⁰

Our Recommendations

The U.S. Food and Drug Administration has repeatedly and consistently failed to abide by federal regulations and the agency’s own policies regarding the regulation of food irradiation. Because of these failings, detailed in this report, the Department of Health and Human Services should take immediate action to:

- (1) Revoke all food irradiation permits issued by the FDA since 1983.
- (2) Establish a joint committee with the U.S. Department of Agriculture to encourage the implementation of sustainable farming, ranching, and food production and transportation practices that will reduce the incidence of food-borne disease—including but not limited to slowing down slaughterlines and restoring the integrity of carcass-by-carcass meat inspection.
- (3) Conduct an Inspector General’s investigation of the FDA’s role in regulating food irradiation since the FDA revoked the Army’s permit to irradiate bacon on August 15, 1968.

(4) Forestall, until the completion of (5) through (8), the approval of all petitions and proposed rules related to food irradiation.

(5) Appoint an independent panel—comprised of no members who have had involvement with the FDA’s food irradiation program—to oversee a testing regime in accordance with the current scientific protocols.

(6) Appoint an independent panel—comprised of no members who have had involvement with the FDA’s food irradiation program—to investigate the agency’s role in regulating food irradiation since the FDA revoked the Army’s permit to irradiate bacon on August 15, 1968.

(7) Compile a complete index of all organizations and facilities engaged in the practice of food irradiation in the United States, including the types and quantities of food that have been irradiated since the organizations and facilities began operation.

(8) Compile a complete index of all groups and facilities engaged in the production, distribution, transportation, marketing, wholesaling and/or retailing of irradiated food in the U.S.

Additionally, complete investigations into the FDA’s role in regulating food irradiation since the agency revoked the Army’s permit to irradiate bacon on August 15, 1968, should be undertaken by the appropriate committees of Congress.