# FOOD IRRADIATION TECHNOLOGY, LEGISLATION AND APPLICATION IN TURKEY

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Gamma-Pak Sterilizasyon Sanayi ve Tic. A.Ş.
Çerkezköy – TEKİRDAĞ

- Food irradiation technology is outstanding food preservation method after 1980's.
- It is a physical process that exposes food to a highly penetrating form of energy gamma-rays, x-rays and high energy electrons. This can inactivate the DNA of microorganisms without changing the basic nature of treated food.
- Irradiation;
  - Enhances hygienic quality of food
  - Reduces food loses
  - Reduces food borne diseases
  - Facilitates food trade
- Commercial use of food irradiation has increased in Asia and USA , while decreasing in EU countries.

- Health and safety authorities in over 60 countries worldwide have approved the irradiation of over 60 kinds of food stuffs.
- Mostly : Spices, grains, chicken, beef, seafood, dry fruits and vegetables and other food products.
- Worldwide irradiated food in 2005 was 405.000 ton / year (IAEA)

# WHO ENDORSES FOOD IRRADIATION

- Many prominent organizations, researchers and government organizations :
  FDA, Dep. Of Agriculture
  US Public Health Service
  National Science and Technology Council,
  Council for Agriculture Science and Technology (CAST)
  US Army Surgeon General, NASA
  International : WHO, FAO, IAEA

# THE MAIN FEATURES OF IRRADIATION PROCESS

- It is a cold method. Increase in temperature is quite minor during the process.
- Process is highly safe.
- It is effective on all kinds of microorganisms.
- It does not leave residue on the product.
- Process control is very easy. Only one parameter is required for this control. (Dose: time, speed)

# EFFECT OF IRRADIATION ON MICROORGANISMS

- The effect of irradiation on microorganisms changes based on factors such as the kind and species of microorganisms, the composition of the food, if there is oxygen in the environment or not, physical structure of the food (like temperature and humidity) and condition of microorganisms (age, proliferation period, sporing or non-sporing). In research up until our day there are no microorganisms that have gained resistance to irradiation.

  Irradiation can easily kill many bacteria and parasites. Gram-positive bacteria are more resistant to irradiation than gram-negatives. Other than few exceptions, sporing bacteria are more resistant than non-sporing ones.

| ORGANISM | $D_{10}$ Value (kGy) |
|---|---|
| Micrococcus radiodurans | 2.2 |
| Clostridium type A spores | 1.2 |
| Saccharomyces cerevisiae | 0.5 |
| Aspergillus niger | 0.47 |
| Streptococcus faecium | 0.3 |
| Staphylococcus aureus | 0.2 |
| Salmonella typhimurium | 0.12 |
| Escherichia coli | 0.11 |
| Vibrio parahacmolyticus | 0.51 |
| Pseudomonas | 0.45 |

$D_{10}$ value : Dose needed to reduce number of microorganisms to 1/10 value.

- We may list resistance of microorganisms to irradiation as follows:
- Gram-negative < Gram-positive
- Fungus< Spores Yeast< Viruses

# $D_{10}$ Values (kGy) for Foodborne Pathogens in Meat and Poultry at Irradiation Temperatures of 5 and -20 °C

| Pathogen | $D_{10}$ value (kGy) @ 0-5 °C | $D_{10}$ value (kGy) @ ≤ -20 °C |
|---|---|---|
| Camplyobacter jejuni | 0,18 | 0,24 |
| Escherichia coli O157:H7 | 0,30<br>0,24<br>0,54 | 0,57<br>0,31 |
| Listeria monocytogenes | 0,45<br>0,59<br>0,61 | 1,21<br>0,61 |
| Salmonella species | 0,41<br>0,70<br>0,62<br>0,64 | 0,63<br>0,92<br>0,80 |
| Staphylococcus aureus | 0,46<br>0,45<br>0,66 | 0,74<br>0,45 |
| Yersinia enterocolitica | 0,19<br>0,25 | 0,40<br>0,25 |

# FOOD IRRADIATION AND HISTORICAL PROGRESS OF IRRADIATION FACILITIES

Initiation of food irradiation is quite old and goes back to 1920's. When we look at its historical progress;

- **1921:** Firstly it was applied with X-ray machinery for rendering *Trichniella spiralis* parasites in pork meat harmless (patent received in USA)
- **1930:** All kinds of food items packed in Metal Boxes were preserved through irradiation (x-rays) method in France (patent received in France)
- **1943**: Work on irradiation of military food packets (hamburger meat) in USA
- **1947:** Brasch and Huber published a report on preservation and sterilization of raw food through accelerated electrons.
- **1950-51:** American Government provided financial support in order to facilitate research in various universities.
- **1954:** American Naval Forces had interest in this and contracted research to MIT.
- **1963-64:** FOA permitted irradiation of wheat and wheat products to prevent infestation and also germination of potatoes in 1964.
- **1958:** Production of Gamma Irradiation devices was started for commercial purposes.

# HISTORICAL PROGRESS OF FOOD IRRADIATION

- **1958-59:** Irradiation and consumption of irradiated products were allowed in Soviet Russia in order to prevent germination of potatoes and infestation of grains.

- **1980:** Real progress was achieved following 1980's. Experts committee of FAO, IAEA and WHO made a declaration that there is no risk in consuming food items irradiated up to 10 kGy. In year 1983, a general standard in the field of food irradiation and also a regulation for food irradiation devices were published by Codex Alimantarius.
- **1983** : Following 1983, many countries made legal regulations that approve food irradiation.
- **1997** : USA also made red meat irradiation lawful. Besides, it acknowledged the irradiation method as an alternative method to quarantine control.
- **1999** : Turkey published Food Irradiation Regulation and approved the irradiation of food items.
- **2003** : Codex Alimantarius acknowledged that the 10kGy dose limit could be exceeded when required in food irradiation and thus it accepted the application of technological dosage.
- **2005** **:** Irradiation was started to be used for quarantine purposes. (Irradiated tropical fruits like mango, papaya, etc. were allowed to enter USA from Hawaii, Thailand, Australia, India, Brazil and Mexico.)

# FOOD IRRADIATION FACILITIES
# 1-GAMMA IRRADIATION FACILITIES

a) Source : Co-60 or Cs-137 isotopes are used.
b) Process is applicable in huge sized packages/parcels/palets.
c) In big facilities that carry out contract manufacturing Co-60 is preferred 95% of the time.
d) For small units such as blood irradiation, Cs-137 is used.

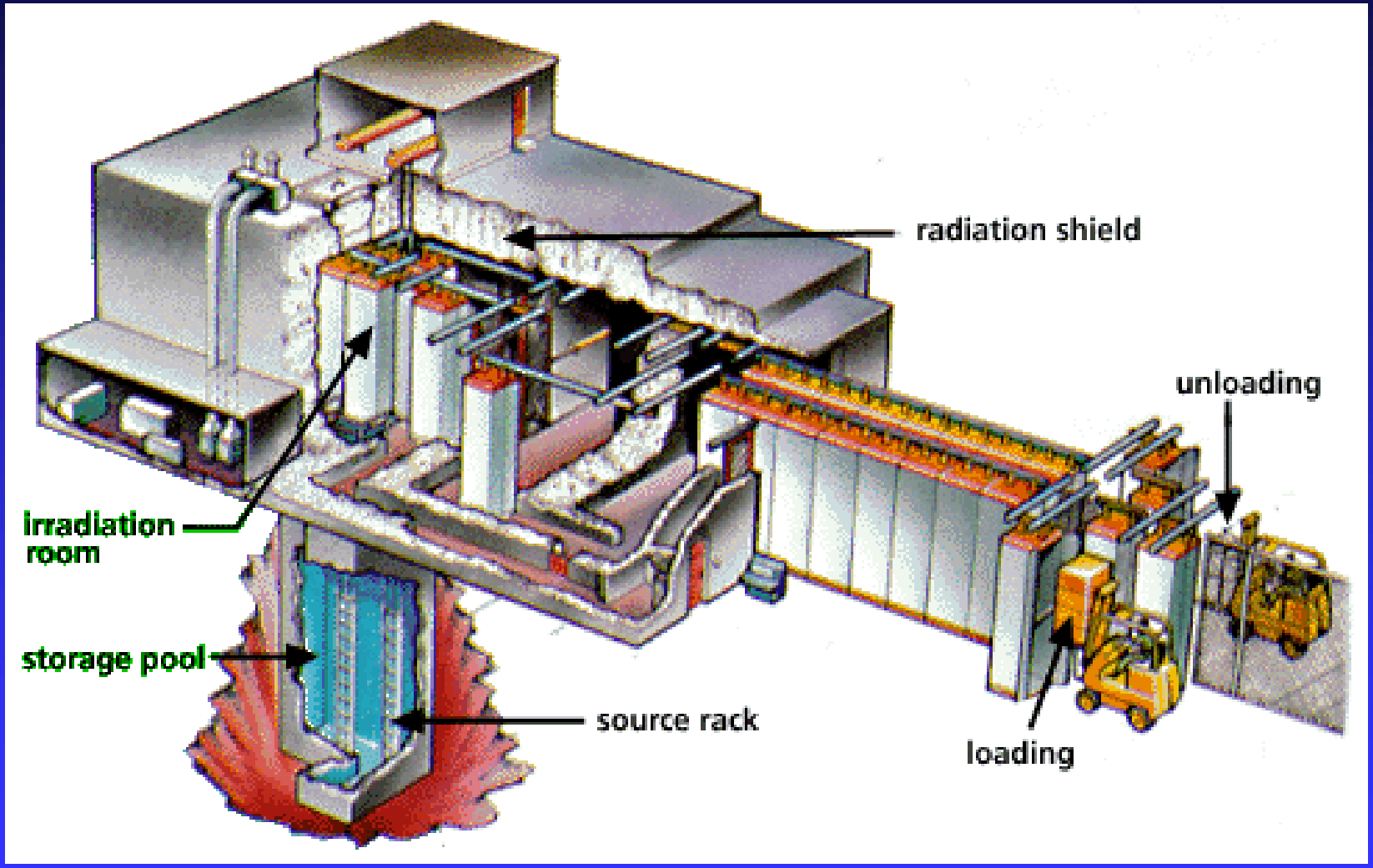
**Co-60 Sources**

- Dose speed is high (A)
- Irradiation penetration is high (1.25 MeV) (A)
- Used in metallic form (safe) (A)
- Special production for these systems (A)
- Half life is short (5.3 years) (D.A)

**Cs- 137 Sources**

- Dose speed is low (D.A)
- Irradiation penetration is low (0.66 MeV) (D.A)
- Used in the form of salt / safety is low (D.A)
- Product of fission (A/DA)
- Half life is long (A)

# GAMMA CARRIER TYPE IRRADIATOR



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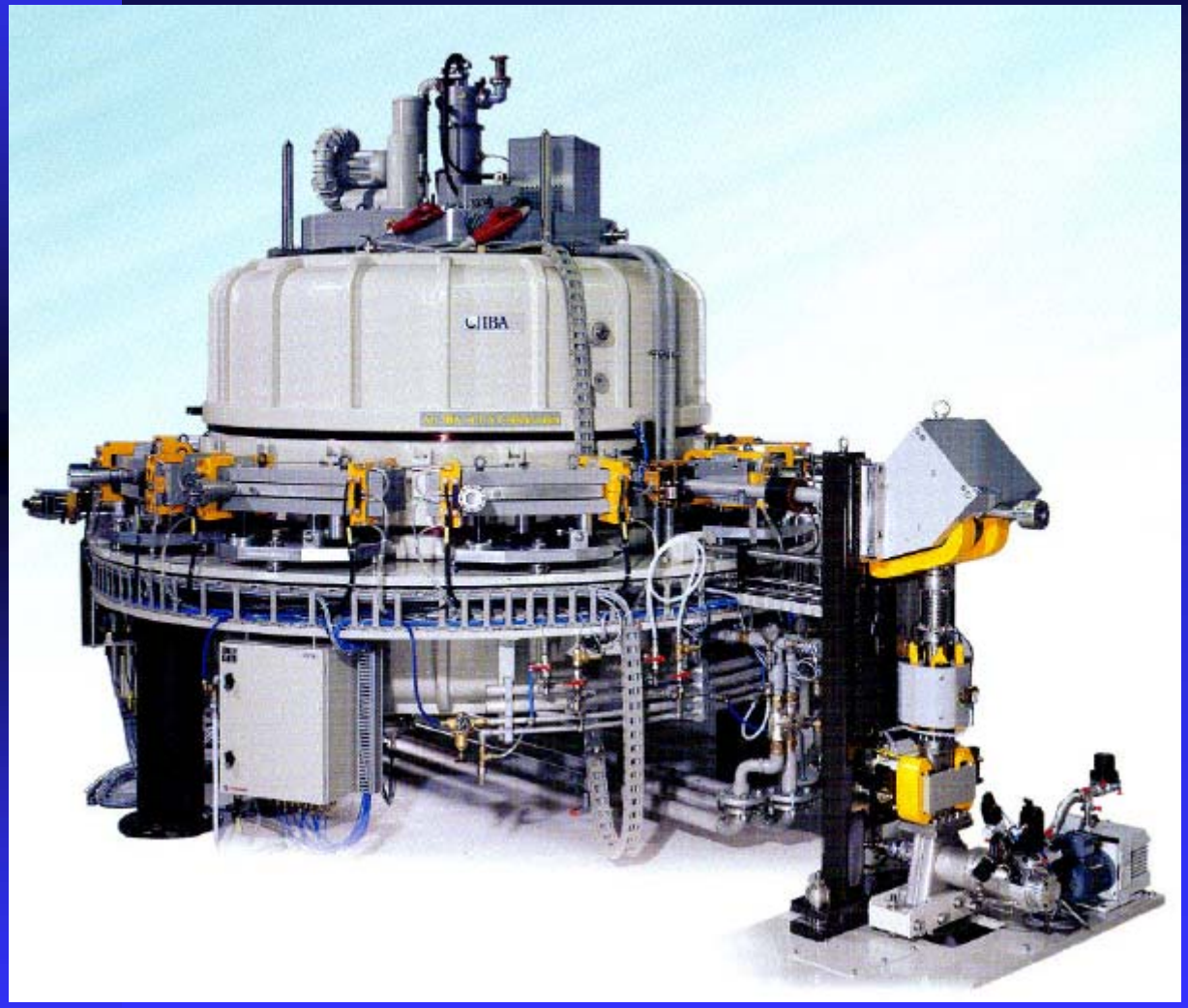
# FOOD IRRADIATION FACILITIES
# 2-ELECTRON ACCELERATORS

- They do not contain radioactive sources. Radiation is produced with electrical/electronic devices just like in x-ray devices.
- Their operation is more costly and complicated compared to gamma facilities.
- Accelerated electron beams up to 10 MeV are used in irradiation of small packages and parcels. Because of fast processing, they are more applicable to irradiate frozen foods.

# CIRCULAR ELECTRON ACCELERATOR







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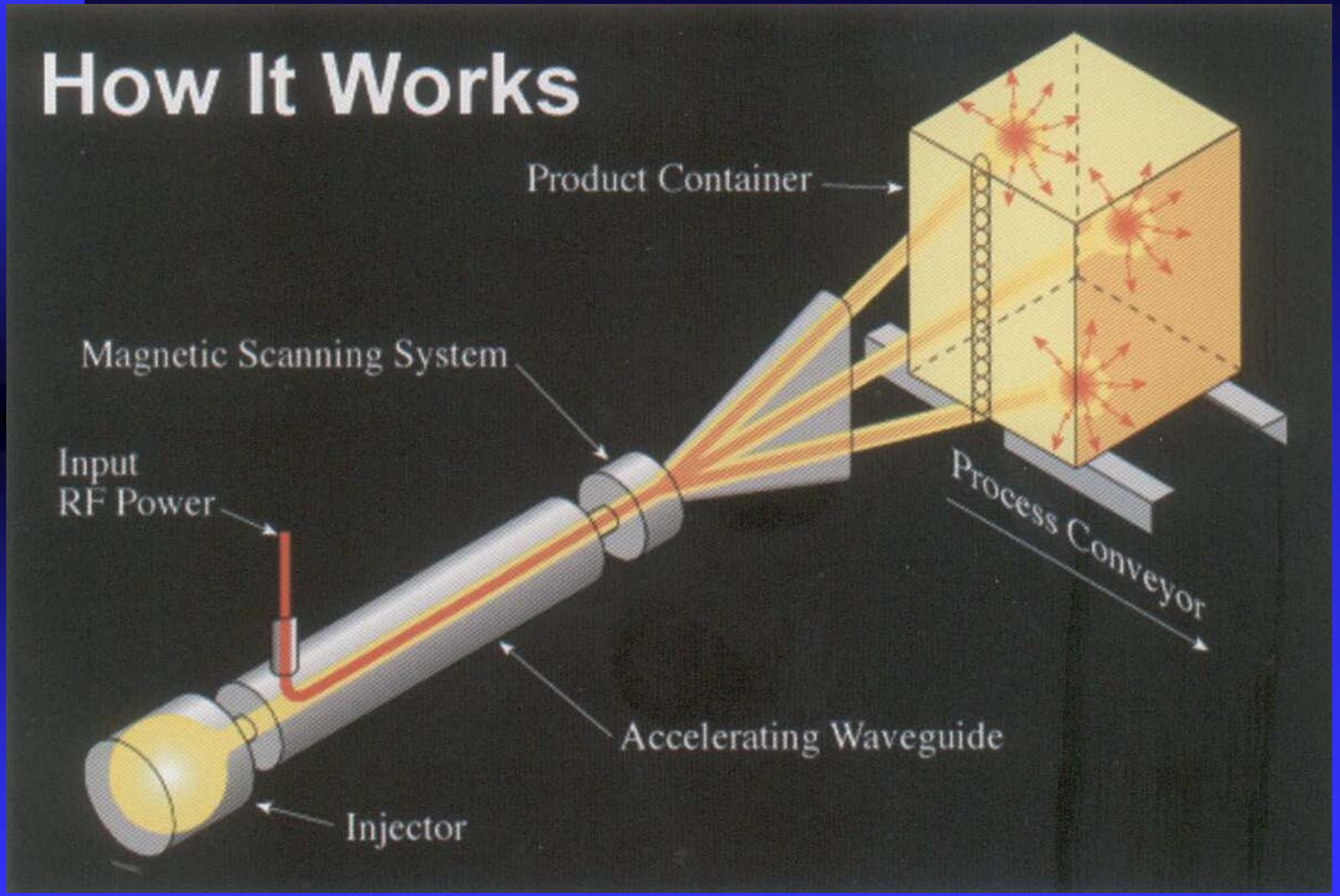
# LINEAR ACCELERATOR and IRRADIATION



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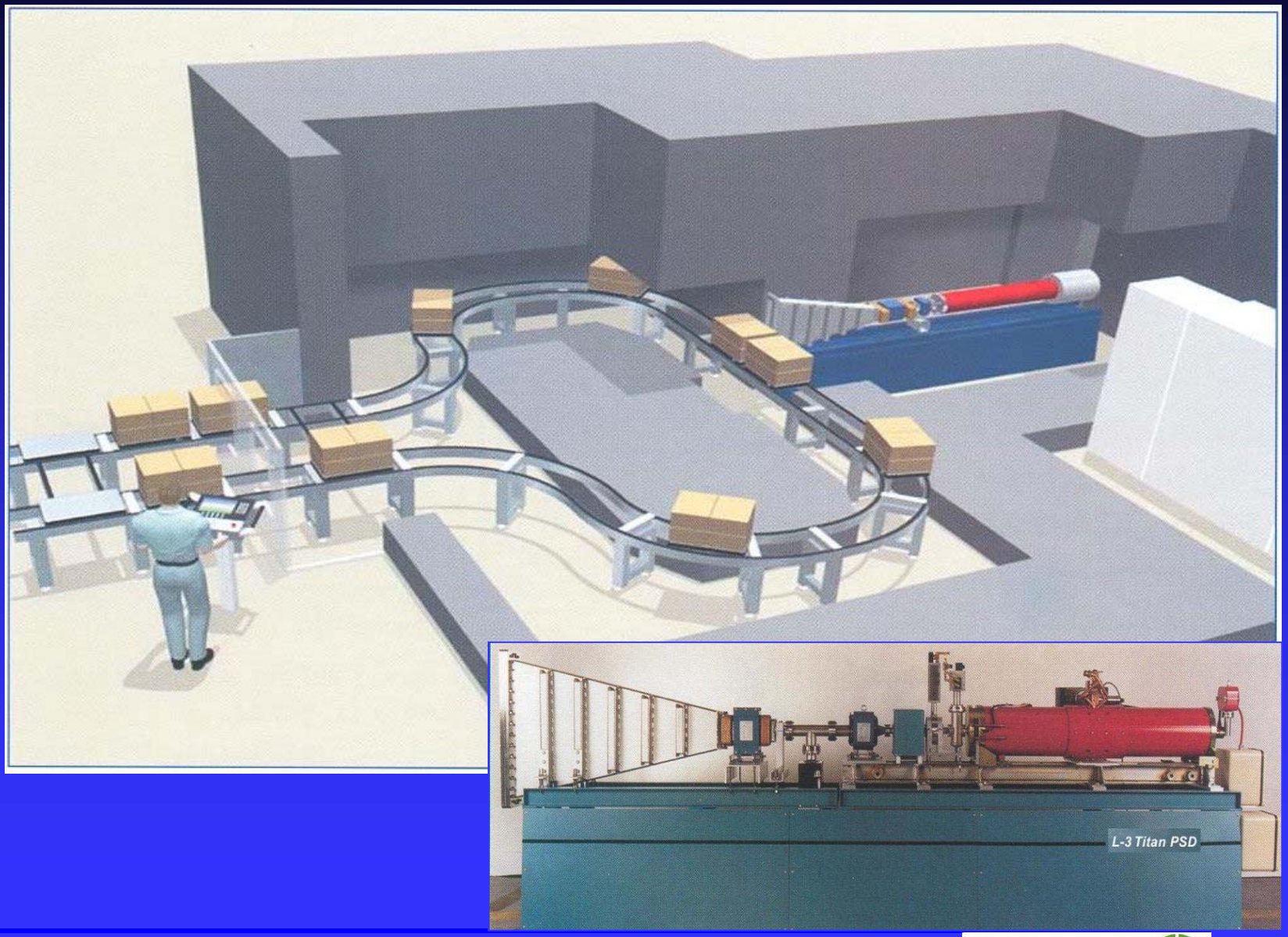
# FOOD IRRADIATION FACILITIES
# 3- X–RAY IRRADIATION FACILITIES

- X-rays generated from up to 5 Mev accelerated electrons, are used. These are systems like gamma irradiators that are suitable for processing huge packages/parcels and pallets. Compared to the energy used, the irradiation power generated is low. X-ray devices are very practical for QUARANTINE treatments of fresh fruits and vegetables.

# X-RAY IRRADIATION FACILITY



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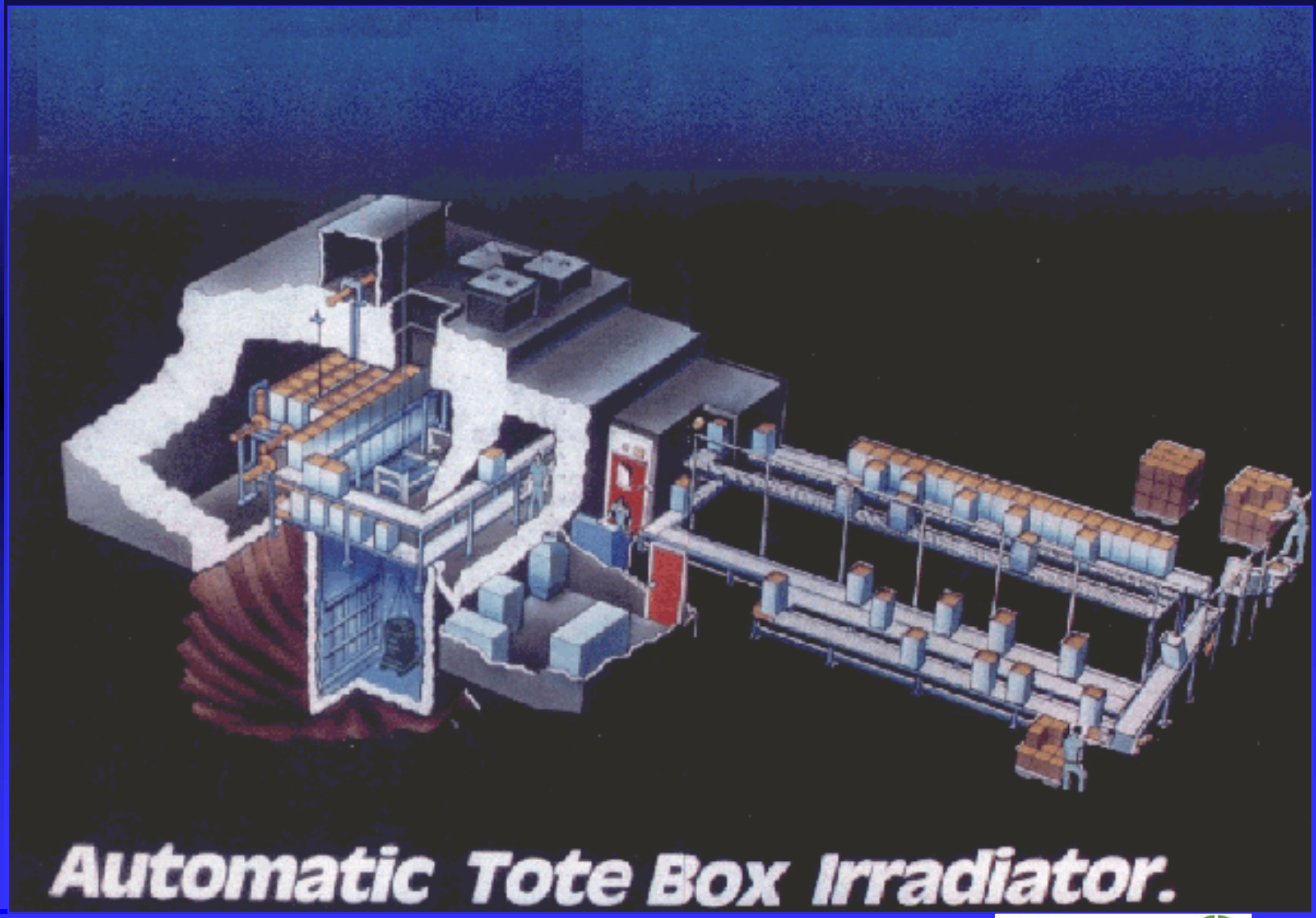
# ESTABLISHED FOOD IRRADIATION FACILITIES AROUND THE WORLD

- Currently, there are legal regulations for food irradiation in 60 countries around the world.
- Globally, there are about 200 gamma irradiation facilities. Among these, approximately 80 of them have received food irradiation licenses. It is assumed that there are about 10-15 electron and X-ray devices that carry out food irradiation.

# IRRADIATION FACILITIESESTABLISHED IN TURKEY

- In Turkey, there are 2 multi-purpose gamma irradiation facilities that are suitable for food irradiation. Both are licensed by the Ministry of Agriculture and Rural Affairs.
- Co-60 Gamma Irradiation Facility established for commercial purposes by Gamma-Pak Sterilizasyon A.S. in Çerkezköy. (Max. 3 million Ci capacity - Private Sector)
- Co-60 Gamma Irradiation Facility established in Turkish Atomic Energy Authority (TAEK), Sarayköy, ANKARA with sponsoring of UNDP/IAEA that aims at wide spreading irradiation technology throughout the country (Max. 1 million Ci capacity - Government Sector)

# GAMMA-PAK AUTOMATIC TOTE BOX IRRADIATOR



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# GAMMA-PAK IRRADIATION FACILITY
## PRODUCT LOADING and UNLOADING

# GAMMA-PAK IRRADIATION FACILITY
## (PREPARATION OF FROZEN FOOD ITEMS FOR IRRADIATION)



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# GAMMA-PAK IRRADIATION FACILITY
# WAREHOUSE




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# GAMMA-PAK IRRADIATION FACILITY (WAREHOUSE ENTRY & EXIT)




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# FOOD IRRADIATION LEGISLATION IN TURKEY

- Food Irradiation Legislation was issued in Turkey on 6 November 1999 by the Ministry of Agriculture and Rural Affairs and this way irradiation has gained legal status.
- According to this legislation, although each food item is approved separately in many other countries, irradiation is approvable for groups of food items in Turkey.
- All food items except milk and dairy products are approved for irradiation in 7 groups.
- Licensing is based on the criteria stated in international codex (Codex Alimentarus).
- It is obligatory to label all packages with “Irradiated” inscription as well as the radura symbol.

# LICENSING OF IRRADIATION FACILITIES IN TURKEY

- Food irradiation licenses are provided by the Ministry of Agriculture and Rural Affairs following the inspection of a commission consisting of the Ministry of Agriculture and Rural Affairs General Directorate for Protection and Control, Turkish Atomic Energy Authority and Provincial Agriculture Authority.
- The 2 gamma irradiation facilities established in Turkey have been licensed by the Ministry of Agriculture and Rural Affairs.

## FOOD IRRADIATION REGULATION OF TURKEY
## OFFICIAL JOURNAL NO:23868, NOVEMBER 6, 1999
## ANNEX 1 :IRRADIATION DOSES WHICH APPLICATION IS PERMITTED TO THE FOOD'S GROUPS ACCORDING TO THE DETERMINED TECHNOLOGIC PURPOSES

| FOOD GROUP | PURPOSE | Doz (kGy) | |
|---|---|---|---|
| | | Min. | Maks. |
| Grup 1 - Bulbs, roots and tubers | Preventing giving shoots, germination and sprouting during storage | | 0,2 |
| Grup 2 - Fresh fruits and vegetables ( those out of group 1 | a)To delay ripening<br>b) Insect disinfestation<br>c) Prolonging the shelf life<br>d) Quarantine control | <br><br><br>(x) | 1,0<br>1,0<br>2,5<br>1,0 |
| Group 3 – Cereals and their milled products, nuts, oil seeds, pulses dried vegetables and dried fruits | a) Insect disinfestation<br>b) Reduction of microbial load<br>c)Extension of shelf life | | 1,0<br>5,0<br>5,0 |

# FOOD IRRADIATION REGULATION OF TURKEY

| FOOD GROUP | PURPOSE | Dose (kGy) | |
|---|---|---|---|
| | | Min. | Max. |
| Grup 4 – Raw fish, selfish and their products (fresh or frozen) frozen frog legs | a) Reduction of some pathogenic microorganisms<br>b) Extension of shelf life<br>c) Control of infection by parasites | (x)<br><br>(xx) | 5,0<br>3,0<br>2,0 |
| Grup 5 – Poultry meat and red meat and their products (fresh or frozen) | a) Reduction of some pathogenic microorganisms<br>b) Extension of shelf life<br>c) Control of infection by parasites | (x)<br><br>(x) | 7,0<br>3,0<br>3,0 |

# FOOD IRRADIATION REGULATION OF TURKEY

| FOOD GROUP | PURPOSE | Dose (kGy) | |
|---|---|---|---|
| | | Min. | Max. |
| Grup 6 – Dry vegetables, spices, dry herbs, condiments and vegetable teas | a) Reduction of some pathogenic microorganisms<br>b) Insect disinfestation | (x) | 10,0(xxx)<br>1,0 |
| Grup 7- Dried food of animal orgin | a) Insect disinfestation<br>b) Control of the moulds | | 1,0<br>3,0 |

(x) The minimum dose level may be determined for a nuisible organism

(xx) The minimum dose level may be determined for ensuring the hygienic quality of the food

(xxx) The maximum dose levels over 10 kGy are applied to the totality of the food in the banner that the average dose not exceeding 10 kGy

# IRRADIATED FOOD EXPORT FROM 3rd COUNTRIES TO EUROPEAN UNION COUNTRIES

- According to EU regulations / Directive : 1999/2/EC, in order to export irradiated food items from 3rd countries to EU members, the irradiation facility should have been inspected and approved by the European Commission.

- GAMMA-PAK was inspected and approved by the European Commission in 2004.

# FOOD IRRADIATION APPLICATIONS IN TURKEY

- In Turkey, irradiation of food items for commercial purposes is carried out for the last 10 years.
- Research is being done by Turkish Atomic Energy Authority (TAEK) and universities for 20-25 years.
- In Turkey, mainly various types of spices, dried vegetation and fruits, dried nuts, frog legs, snails, meat and meat products, seafood and pet food are disinfected from microorganisms through irradiation methods.
  -Gamma-Pak (%70) and TAEK (%30).-

# FOOD IRRADIATION APPLICATIONS IN TURKEY

- Irradiated quantities in Gamma-Pak irradiation facility in the last 5 years is given in the table below.

2006 year total : 2.833 ton
2007 year total : 2.534 ton
2008 year total : 2.496 ton
2009 year total : 2.880 ton
2010 year total : 3.000 ton (estimated)
average : 2.760 ton

Gamma-Pak (private ) : 2.760 ton
TAEK (government) : 816 ton
Total in Turkey : 3.576 ton food irradiation is being carried out..
In the world, 405.000 ton reported in 2005
This is expected to be more than 500.000 ton in 2010.

Food irradiation has been increasing in USA and Asia countries, but decreasing in European Union countries.

# FOOD IRRADIATION APPLICATIONS IN TURKEY
## Irradiated food percentages in Gamma-Pak in 2009

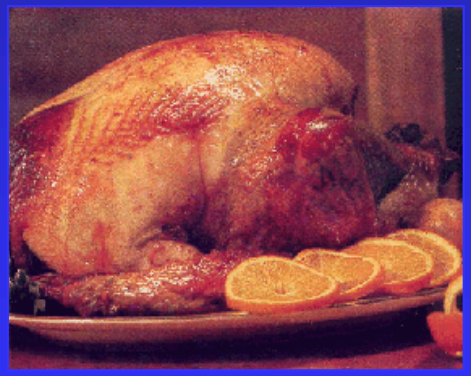
| | | |
|---|---|---|
| SPICE | 88.59% | Chili pepper, black pepper, curcuma, caraway, coriander, cinnamon, mint, herba origani, ginger, safflower, sumach, cordamon |
| DRIED VEGETATION | 3.35% | Onion, garlic, egg plant, leek, coleslaw, tomatoe, parsley, carrot, green pea, broccoli |
| FROZEN | 3,0% | Grinded meat and Chopped meat (increased to %10 in 2010) frog leg, snail, fish |
| HERBAL TEA | 2.06% | Linden, daphne, sage, senna, rosehip, camomile, cherry stem, grean tea |
| GRAINS | 1.17% | Flour, bread crumbs, lentil, sunflower seed, chickpea, common bean |
| DRIED NUTS | 1.15% | Almond, pistachio, hazelnut, corn knick-knacks, pine nut |
| OTHER | 0.27% | Ready made soup |
| DRIED FRUITS | 0.23% | Apple, date, fig, apricot, cherry |
| OILSEEDS | 0.14% | Mustard seed, flaxseed, opium poppy |

# IRRADIATED FOOD SYMBOL (RADURA)

**IRRADIATED**

**Due to Turkish Regulation, It is necessary to put radura symbol and "Irradiated" word on irradiated food products.**

# IRRADIATED FOOD ITEMS ARE IN MARKET SHELVES



# FOOD IRRADIATION BROCHURES

RHODOTRON

## Food Treatment

Cold pasteurization of foodstuffs with electron beams (and X-rays generated from electron beams) have an important role in improving the safety and preserving the quality of our food supply, especially meat, poultry and seafood. Additionally, electron beams and/or X-rays can be used to extend the shelf life of many perishable foods, and to disinfest grains and other stored or quarantined produce items.

### Other Applications

- Sterilization of food packaging
- Bioburden reduction of consumer goods
- Disinfection of hospital wastes
- Degradation of toxic wastes and selected polymer resins
- Sanitization of sewage and waste-water
- Depolymerization of cellulose
- Radiation doping of semiconductors
- Coloration of glass and gemstones

# INCREASE SALES


## with Fresh Irradiated Produce.

Grocers gain a distinct competitive advantage when they offer their customers fresh irradiated foods. Jim Corrigan, owner of Carrot Top, in Northbrook, Illinois, explains: "By stocking irradiated produce, I can reduce my retail price because there is less spoilage, and still maintain gross dollars and gross percentage. At the same time, I can continue to provide a quality product, and my customers can enjoy the benefits of increased shelf life."

Carrot Top was the first store in the Midwest to offer strawberries and citrus fruits treated by irradiation. Sales of the irradiated fruits were outstanding. Quality was the big determining factor: customers clearly preferred the products that stayed fresh longer.

Premium quality irradiated produce, including fresh mushrooms, tomatoes, and citrus, is now available from Nations Pride, the irradiated food specialists.

Nations Pride

For more information, contact Don Rayburn.
Tel: (813) 754-7201 • Fax: (813) 754-7506
1801 Thonotosassa Rd., Suite 4, Plant City, Florida, 33566



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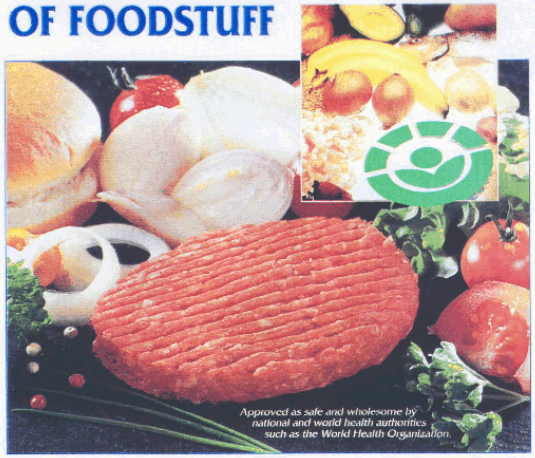
# IRRADIATED FOOD BROCHURES

## ELECTRONIC PASTEURIZATION OF FOODSTUFF




**The application of relatively small doses of ionizing energy to various foodstuff ("Electronic Food Pasteurization") provides important safety and economic benefits to food producers, distributors and the general consuming public. Although these advantages have long been known and debated, the true commercial potential of this technology is only now beginning to be globally realized. This is because national and international regulatory bodies are, with increasing frequency and authority, promulgating new laws in favor of electronic pasteurization as a means of improving food safety.**

Following earlier approvals for pasteurization of poultry and pork, on December 2, 1997, the American Food and Drug Administration (FDA) approved the process for beef. This newest regulatory approval was petitioned by one of IBA's earliest RHODOTRON® customers, and is one of the most important such approvals to date. Treatment of ground beef to eliminate future outbreaks of E-coli related poisoning in hamburgers will be the key application under this most recent approval. Additionally, meat companies throughout the packaging and distribution chain, are also expected to gain by the shelf-life extension provided by the ionizing process and thus the ability to market a larger percentage of their products as fresh - never frozen - meat.

### X-Ray Processing with a RHODOTRON®

When product thicknesses are limited and well controlled, as is often the case for stacked hamburger patties or packaged cuts of poultry, cold pasteurization with 10 MeV electron beams is your best choice. Alternatively, first converting the electrons to highly penetrating x-rays may be a better solution when product are thicker or highly variable. X-rays are electronically generated, which like electron-beams (and your TV set or microwave oven) can be turned on or off with the press of a button.

X-ray processing with the RHODOTRON® offers many advantages over isotopic sources (gamma rays, $Co^{60}$), the most important of which includes quicker processing of foodstuff, less temperature increase, less time out of cold storage, the ability to instantaneously match changes in production rates (by electronically increasing or decreasing source power), and tighter dose spreads (by better penetration).

The RHODOTRON® is unique in that the same accelerator can be used to provide economical and industrially useful outputs in both electron-beam and x-ray mode.

**The benefits of the electronic food pasteurization process include:**

- **increased food safety by the reduction or elimination of food borne illnesses such as poisoning from salmonella, E-coli, botulinum, trichinella, campylobacter and mycotoxins**
- **delay of ripening and/or decay in fruits and vegetables**
- **inhibition of sprouting in tubers like potatoes, garlic buds and onions**
- **chemical and pesticide free means of disinfestation of imported and exported foodstuff**
- **increased shelf-life of perishable foodstuff, with complete preservation of freshness qualities**
- **reduction in the potential for post-processing contamination of packaged foodstuff**


A Wegmans, headquartered in Rochester, N.Y., offers fresh irradiated ground beef in 1- and 3-pound packages at 80- and 90-percent lean. The product sells for 10 to 30 cents more per pound than regular ground beef.

◄ This Wegmans store in Fayetteville, N.Y., displays its new line of private-labeled irradiated fresh ground beef on the end of its self-serve, fresh-meat case. A large overhead sign reading "A Rare Opportunity. New! Irradiated Fresh Ground Beef" draws customers to the section.

▼ "Cook your burgers the way you like them!" is printed on Wegmans' meat-case dividers. This is one slogan the retailer uses to attract customers to its irradiated fresh ground beef.


irradiated product is sold in about 32 states in an estimated 2,500 retail stores.

Although the number of retailers selling irradiated meats is growing, the percentage remains small.

"Shelf space is limited, and markets generally are reluctant to try new products, especially products which the public views as controversial," says Christine Bruhn, director of consumer research and food marketing specialist at the University of California-Davis. "But whenever irradiated meat has been offered, consumers have purchased.

"The time is ripe for presenting safety-enhanced irradiated food to the consumer."

Wegmans agrees and began offering irradiated fresh ground beef in May, just in time for the "burger time of year." The 63-store chain is the first in the nation to offer irradiated fresh ground beef under its private label.

"We took a giant leap to introduce Wegmans irradiated fresh ground beef," says Eben Kennedy, Wegmans' seafood and meat category merchant, but "people are telling us they like it through sales."

Sales, in fact, have surpassed the company's expectations.

**"Irradiated meats appeal to any demographic because we're giving the customer peace of mind because they know they're giving their family a safe product that tastes great."**

**— Jeanne Colleluori, a Wegmans communications specialist**

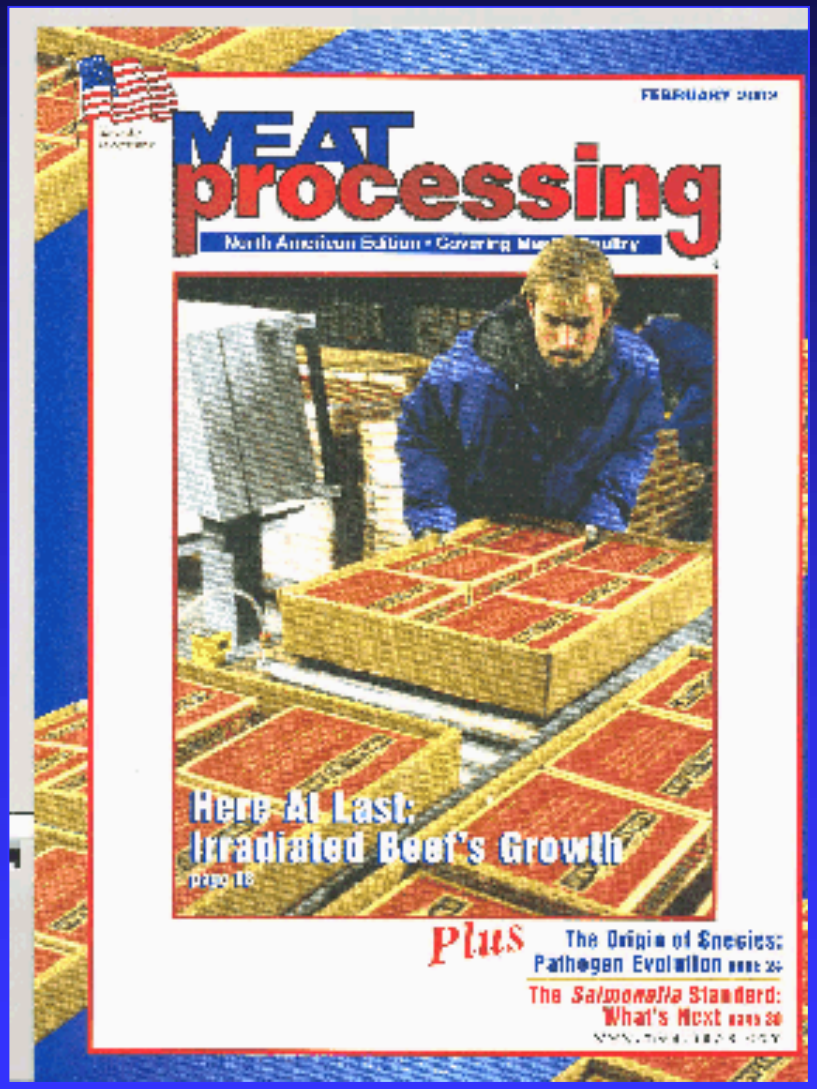
Wegmans offers the product in 1- and 3-pound packages at 80- and 90-percent lean. The product sells for 10 to 30 cents more per pound than regular ground beef, but consumers don't seem to mind.

"We're giving them peace of mind for a few cents more per burger," says Jeanne Colleluori, communications specialist in consumer affairs for Wegmans. "We look at it as a choice for our customers."

Wegmans customers are choosing irradiated ground beef partly as a result of an extensive advertising and education campaign.

The campaign began with Wegmans employees, when each meat department received sampling kits, merchandising grids, a video explaining the process and a sheet of

# FOOD IRRADIATION BROCHURES



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# IRRADIATED FOOD ITEMS

Food Items Processed with Gamma, Electron and X – Rays

# IRRADIATES SAMPLES OF VARIOUS SPICES

# PACKAGING OF IRRADIATED FOOD ITEMS - TURKEY





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# PACKAGING OF IRRADIATED FOOD ITEMS - TURKEY





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# PACKAGING OF IRRADIATED FOOD ITEMS




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# PACKAGING OF IRRADIATED FOOD ITEMS

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# THANKS FOR LISTENING



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