Food Irradiation in Vietnam: Current Applications & Challenges

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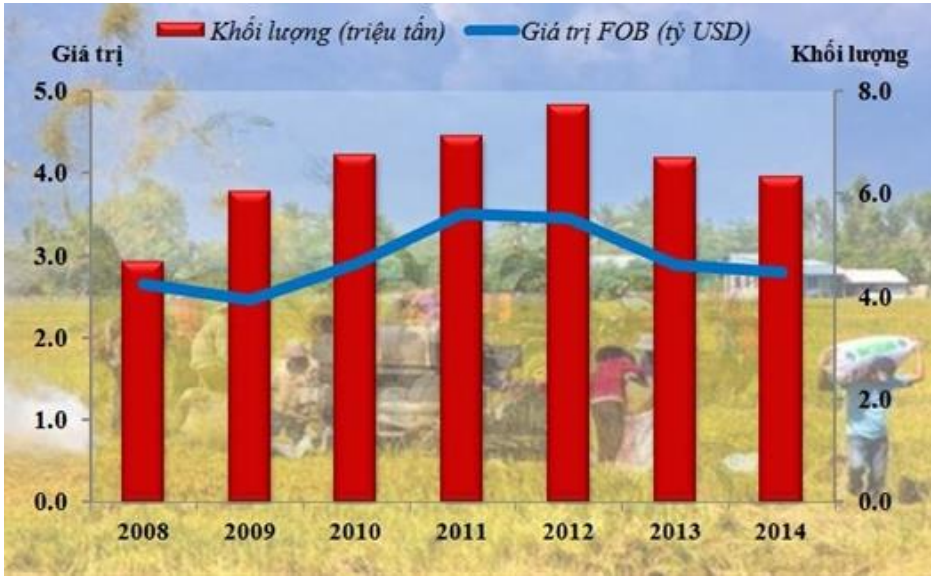
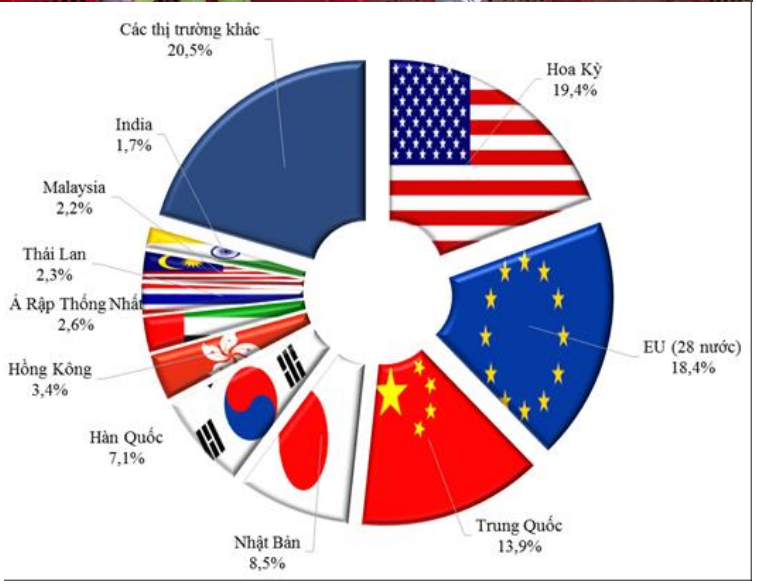
Vietnam Agricultural Production

Developing country with high proportion of agriculture-forestry-fishery in GDP



Vietnam rice export



Markets for Vietnam agriculture products

Purposes of Food Irradiation

Irradiation is Single Process

Multiple Effects

Sprouting Inhibition

Maturation Delay

Pasteurization and Pathogen Reduction

Shelf-life Extension

Insect Disinfection

Quarantine treatment

Decontamination

Gamma Facility (Hanoi Irradiation Center)

IRRADIATION AS SPROUTING INHIBITION METHOD FOR BULBS AND TUBERS

Potatoes after 3 months preservation

Non-irradiated and irradiated at 100 Gy

Non-irradiated and irradiated at 50 Gy
Sweet potatoes after 3 months preservation

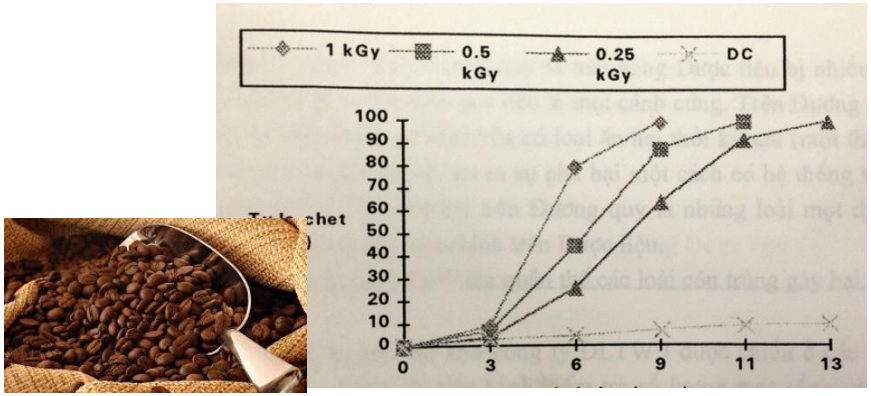
Non-irradiated and irradiated at 60 Gy

100 Gy

Onions after 1 month preservation at ambient conditions

INSECT DISINFECTATION FOR PRESERVATION OF GRAINS (RICE, MAIZE, BEANS…)

Irradiated at 60 Gy Non-irradiated

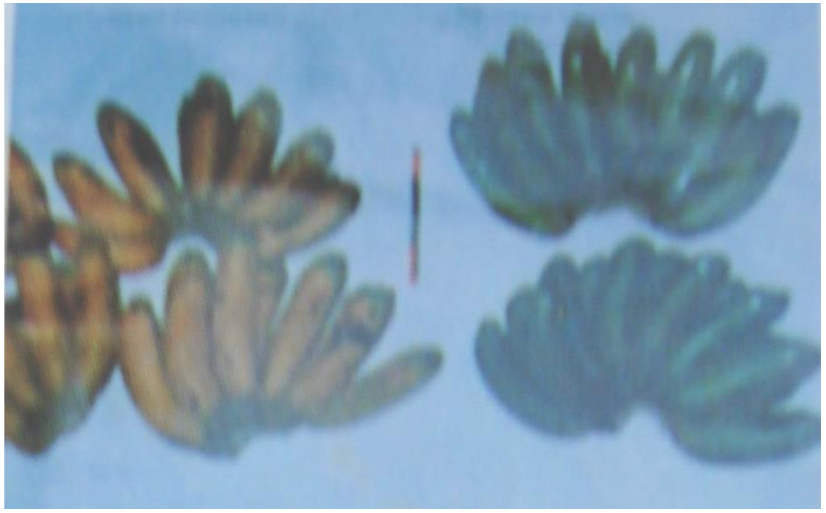


Death rate (%) of coffee bean weevil by gamma irradiation during with storage

Non-irradiated Rice

Gamma Irradiation for infected rice with doses of 50-75Gy

DELAY MATURATION OF FRESH FRUITS



Bananas: Non-irradiated and irradiated at 150 Gy

Non-irradiated and irradiated at 250 Gy

Mangoes after 1 weeks preservation at ambient conditions

Non-irradiated and irradiated at 300 Gy

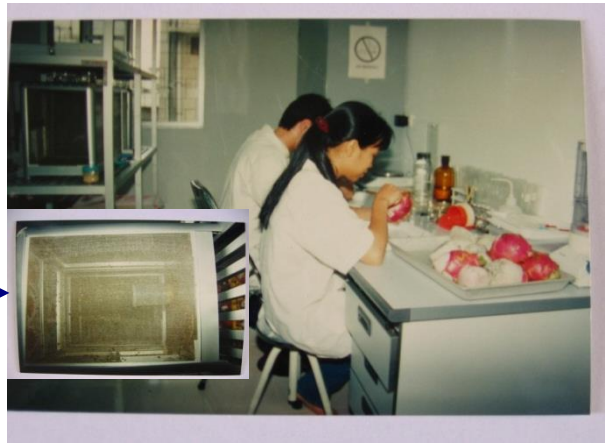
Papayas after 10 days preservation at room temperature

Non-irradiated oranges kept at RT for 1 week

Irradiated at 300 Gy

RADIATION QUARANTINE TREATMENT

Collecting Mealybugs



Isolated *Bactrocera dorsalis* Hendel from dragon fruits

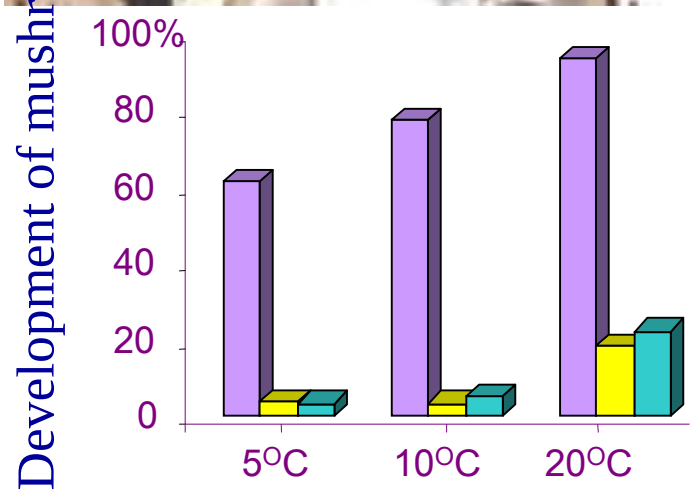
Storage of dragon fruits include infected ones irradiated at various radiation dose

Dose (Gy)	Hatching ratio (%)	Percentage of pupation (%)
0	87,67 ± 0,42	83,52 ± 0,38
150	23,2 ± 0,53	0
250	0	0
350	0	0

Egg hatch rate, adult emergence of *B. dorsalis* Hendel at different stages were prevented by gamma irradiation. Survival and reproduction of fruit flies and mealybugs infected in dragon fruits are completely controlled by irradiated even at low radiation dose of 250 Gy.

SHELF-LIFE EXTENSION OF FRESH FRUITS

Litchi: Non-irradiated and irradiated at 500 Gy
After 10 days storage at 10°C

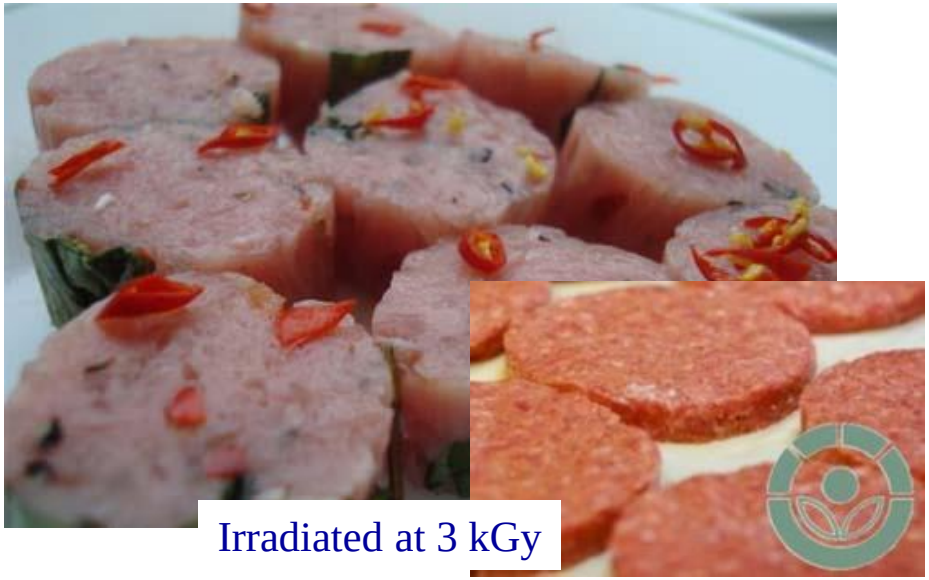


Storage Temperature

Non-irradiated irradiated at 500 Gy

PASTEURIZATION, CONTROL PATHOGENS & SPOILAGE MICROBES FROM FERMENTED FOODS

Vietnamese fermented pork roll



Irradiated at 3 kGy

Gamma irradiation of 3-5 kGy can control all illness causing microorganisms (*E.coli*, *Salmonella*, *Vibrio*...) existing in Vietnam fermented pork roll

Dried fishes storaged after 1 month

Irradiated at 1,5 kGy

Non-irradiated

DECONTAMINATION FOR SPICES, DRIED ENZYMES AND FUNCTIONAL FOODS

Total number of aerobic bacteria / fungi (CFU/g)			
Storage period for dehydrated enzymes (month)	Radiation dose (kGy)		
	0	5	10
Papain (extraction from papaya – *carcia papayceae*)			
1	4.2×10^3 / 66	ND	ND
4	3.7×10^4 / 225	ND	ND
Bromelain (extraction from pineapple – *ananas commosus bromeliacea*)			
1	2.2×10^4 / 165	4.3×10^2 / 150	ND
4	5.5×10^5 / 760	7.5×10^3 / 415	ND
Pepsin (supported by Vietnam Health Ministry)			
1	4.2×10^3 / 160	ND	ND
4	3.4×10^4 / 425	ND	ND

ND: Non detected

CONSUMER ACCEPTANCE AND MARKETING OF IRRADIATED FOODS

Irradiated onions with label was sold at Hanoi for the first time in 1995 (free market). **About 70% customers bought irradiated onions after explanation on irradiation**

- **Make Training Programs for Customers on Radiation Technology and Food Irradiation**
- **Media programs and interviews on food irradiation**
- **Hold seminars, conferences on food irradiation**

Dr. Ricardo MOLINS, *Hanoi 16 October 2003*

Vietnamese clearance of food irradiation

(Issued by Decision of the Minister of Health of Vietnam, No. 3616/2004/QD-BYT)

Class	Food/Purpose of irradiation	Dose (kGy) Min. - Max.
1	Agricultural products (bulbs, roots and tubes) Inhibit sprouting during storage 	0.1 - 0.2
2	Fresh fruits and vegetables (other than class 1) a) Slow-down ripening b) Killing insects & parasites c) Self-life extension d) Quarantine treatment 	 0.3 - 1.0 0.3 – 1.0 1.0 – 2.5 0.2 – 1.0
3	Cereals, milled cereal products, nuts, oil seed, pulses, dried vegetables and dried fruits a) Killing insects & parasites b) Pasteurization of pathogenic microorganisms c) Sprouting inhibition 	 0.3 – 1.0 1.5 – 5.0 0.1 – 0.25
4	Aquatic food and its products including spineless, amphibian animals (fresh or frozen) a) Elimination of pathogenic microorganisms b) Self-life extension c) Eradication of infected insects, parasites 	 1.0 – 7.0 1.0 – 3.0 0.1 – 2.0

Vietnamese clearance of food irradiation
(Issued by Decision of the Minister of Health of Vietnam No. 3616/2004/QD-BYT) *(Cont.)*

Class	Food/Purpose of irradiation	Dose (kGy) Min. - Max.
5	Raw poultry and meat and their products (fresh and frozen) a) Elimination of pathogenic microorganisms b) Self-life extension c) Control of parasitic flora and fauna 	 1.0 – 7.0 1.0 – 3.0 0.5 – 2.0
6	Dry vegetables, spices, and dry herbs a) Elimination of pathogenic microorganisms *(Some spice products: pepper, ginger powders, oregano, mint leaves… can be treated with dose up to 12 kGy as in TCVN 7415: 2010)*  b) Killing insects & parasites	2.0 - 10.0 0.3 – 1.0
7	Dried food of animal origin a) Killing insects & parasites b) Control molds and fungus c) Elimination of pathogenic microorganisms 	0.3 – 1.0 1.0 – 3.0 2.0 – 7.0

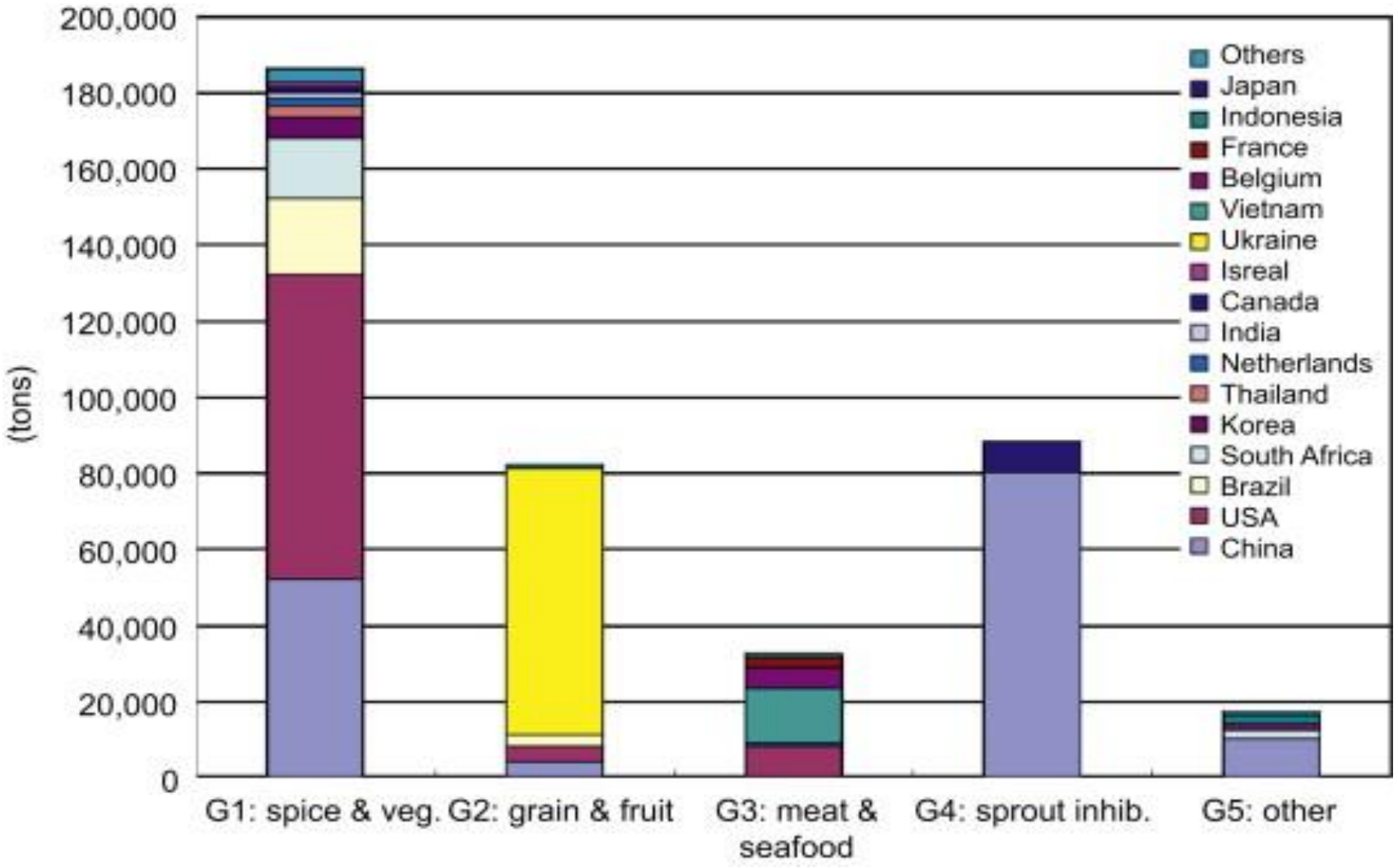
Current Vietnam Codex and Regulations related to Food Irradiation

No.	Name	No. of Code
1	Good Irradiation Practice for the control of microflora in fish, frog legs and shrimps	TCVN 7414: 2004
2	Good Irradiation Practice for insect disinfestation of dried fish and salted fish	TCVN 7516: 2004
3	Foodstuffs - Detection of irradiated food containing bone - Method by ESP spectroscopy	TCVN 7410: 2004 EN1786: 1996
4	Foodstuffs – Thermo-luminescence detection of irradiated food from which silicate minerals can be isolated	TCVN 7412: 2004 EN 1788: 1996
5	Foodstuffs - Detection of irradiated food containing fat - Gas chromatographic analysis of hydrocarbons	TCVN 7408: 2004
6	Good irradiation practice for insect disinfestation of cereal grains	TCVN 7509: 2005
7	Good irradiation practice for extend shelf-life of banana, mango and papaya	TCVN 7510: 2005

Current Vietnam Codex and Regulations related to Food Irradiation

No.	Name	No. of Code
8	Irradiated foods - General requirements	TCVN 7247: 2008 (Rev. 2) CODEX STAN 106-1983
9	Practice for the operation of irradiation facilities used for treatment of food	TCVN 7250: 2008 (Rev. 2) CAC/RCP 19-1979 (Rev.1 – 1983)
10	Practice for dosimetry in gamma irradiation facilities for food processing	TCVN 7248: 2008 (Rev. 2) ISO 15554:1998
11	Practice for dosimetry in electron and bremsstrahlung irradiation facilities for food processing	TCVN 7249: 2008 (Rev. 2) ISO 15562:1998
12	Good irradiation practice for packed red meat and fresh and frozen poultry (to control pathogens and/or extend shelf-life)	TCVN 7413: 2010
13	Good irradiation practice for the control of pathogens and other microflora in spices, herbs and other vegetable seasonings	TCVN 7415: 2010

Facilitate to the food producers and traders



Boosting of radiation processing for exported foods with the development of private sector

Contribution to Economic Growth

Improve the quality and value of Vietnamese fresh fruits in global market

bsi.

Certificate of Registration

QUALITY MANAGEMENT SYSTEM - ISO 9001:2008

This is to certify that: **THE RESEARCH AND DEVELOPMENT CENTER FOR RADIATION TECHNOLOGY (VINAGAMMA)**
No 202A, Street 11, Linh Xuan Ward,
Thu Duc District, Ho Chi Minh City,
Vietnam.

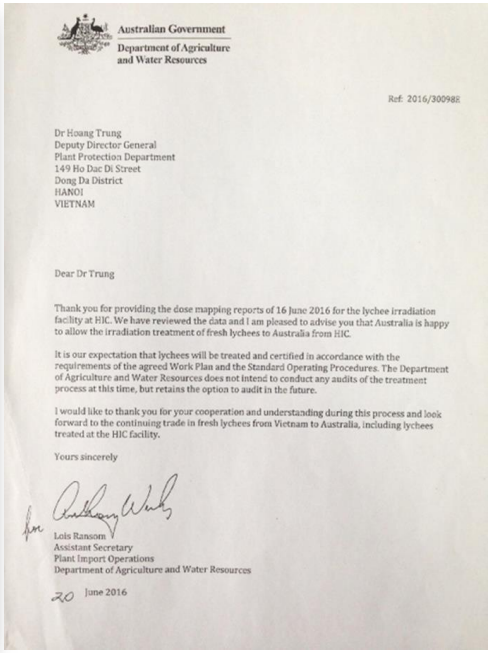
Holds Certificate Number: FM 593133
and operates a Quality Management System which complies with the requirements of ISO 9001:2008 for the following scope:

Providing of radiation processing services including sterilization of medical products and pasteurization of foodstuff.

For and on behalf of BSI: Gary Fenton, Global Assurance Director

Originally registered: **10/12/2012** Latest Issue: **10/12/2012** Expiry Date: **09/12/2015**

...making excellence a habit.



Australian Government
Department of Agriculture and Water Resources

Ref: 2016/30098E

Dr Hoang Trung
Deputy Director General
Plant Protection Department
149 Ho Duc Di Street
Dong Da District
HANOI
VIETNAM

Dear Dr Trung

Thank you for providing the dose mapping reports of 16 June 2016 for the lychee irradiation facility at HIC. We have reviewed the data and I am pleased to advise you that Australia is happy to allow the irradiation treatment of fresh lychees to Australia from HIC.

It is our expectation that lychees will be treated and certified in accordance with the requirements of the agreed Work Plan and the Standard Operating Procedures. The Department of Agriculture and Water Resources does not intend to conduct any audits of the treatment process at this time, but retains the option to audit in the future.

I would like to thank you for your cooperation and understanding during this process and look forward to the continuing trade in fresh lychees from Vietnam to Australia, including lychees treated at the HIC facility.

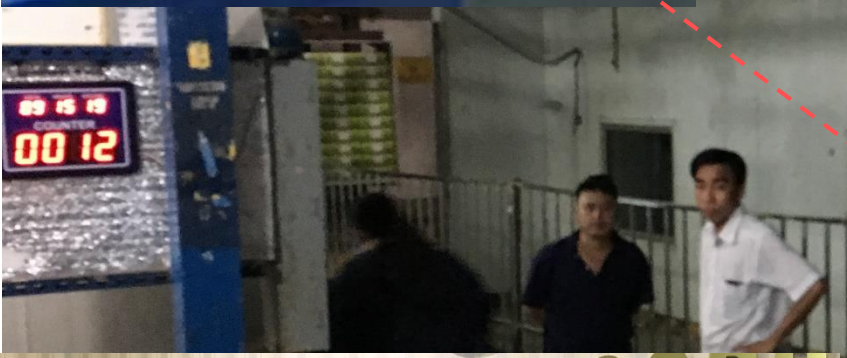
Yours sincerely

Lois Ransom
Assistant Secretary
Plant Import Operations
Department of Agriculture and Water Resources

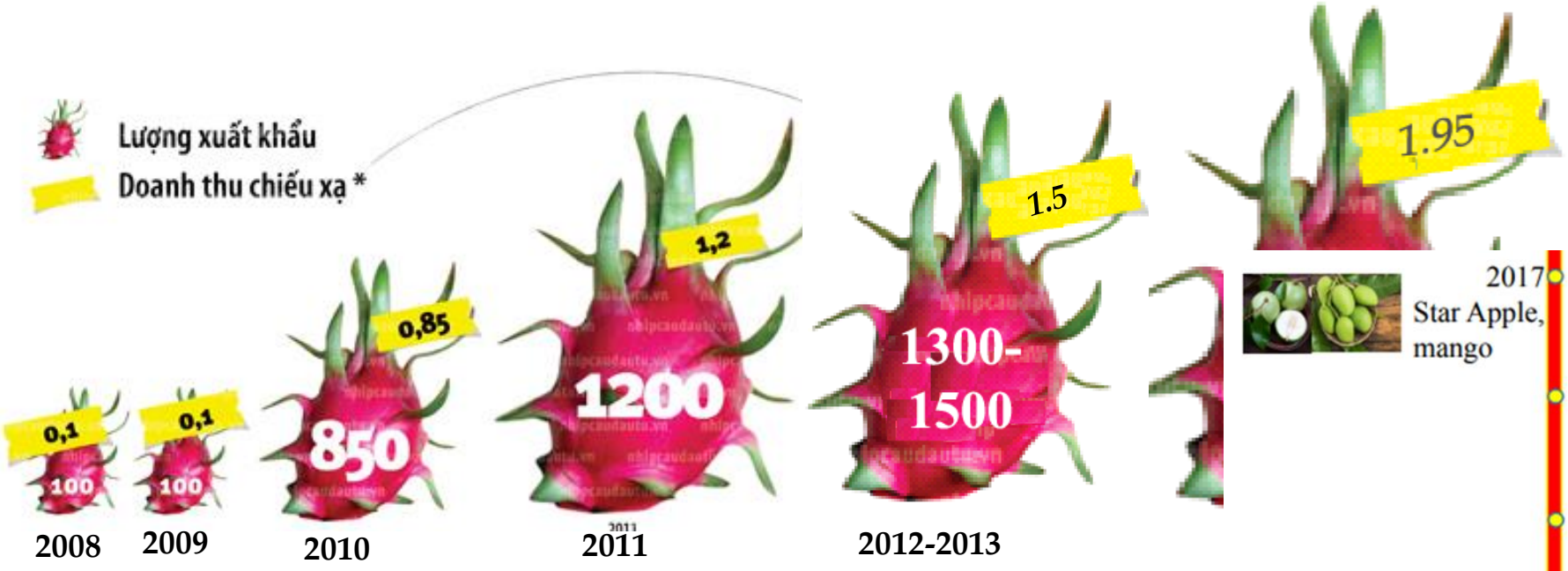
20 June 2016

and safe our environment

Development of FI & Radiation Processing



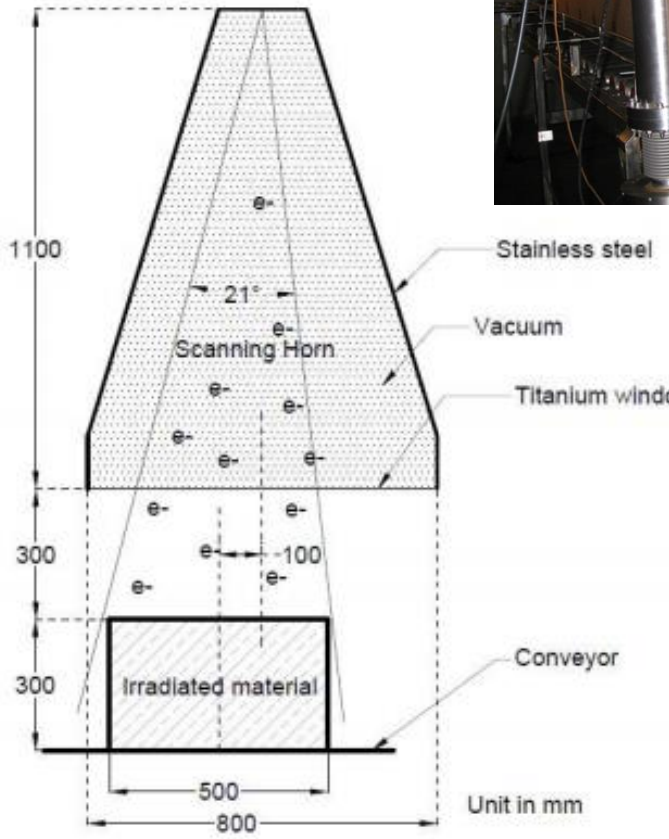
Radiation phytosanitary treatment of fresh fruits to US



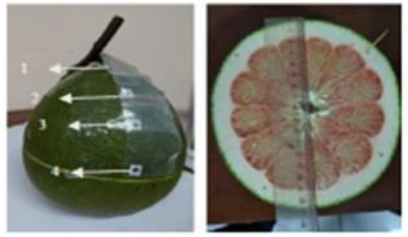
EB Technology for Food Irradiation

10 MeV EB, Vinagamma

Model of EB irradiation using UERL-10-15S



Dose mapping for fresh fruits irradiated by EB



EB Irradiation for food in Vinagamma

+ Pasteurization and decontamination: frozen seafood, dried seafood, frozen cut fruits, spices, hydrated vegetables, functional food….
+ Though EB processing much quicker than gamma, it can only proceed the thin packages of food products due to its low penetration.

Comparison of irradiation modalities in FI

Facilities (*characteristics*)	**Gamma**	**EB**	**X-ray**
Source type	Cobalt-60 metal	Electron accelerator	Electron accelerator
Source power	Radioactive decay	Electricity	Electricity
Radiation present	Continuously	Only in operation	Only in operation
Radiation direction	Isotropic (through 360º)	Unidirectional	Unidirectional
Replenish/replace	Yes	Not simple	Not simple
Supply	**Increasingly difficult**	Increasingly easy	Increasingly easy
Processing and Impacts			
Penetration	High (Pallet loads with 2-sided treatment)	Limited (~ 38 mm in unit mass for 10 MeV)	High (Pallet loads with 2-sided treatment)
Dosimetry & dose uniformity	Reasonable uniformity and easy measurement	Harder to measure and achieve uniformity	Good uniformity and easy measurement
Dose rate and processing speed*	Slow but can treat pallets	Fast but for small packages	Slow but can treat pallets
Overall efficiency	Moderate	Moderate to good	Poor
Operation	Simple, reliable	More complex	More complex
Commercial track record	Well established	Limited	Limited
Capital cost*	**High**	**Higher**	**Highest**
Processing costs* (include repaying capital)	**Low at low throughputs**	**Low at high throughputs**	**Low at very high throughputs**
Transport & management of radioactive materials	**Yes** *(increasing risks)*	No	No
Power Use	Lowest	Higher	Highest
Water use	Lowest	Higher	Highest
Public concern	High	**Low to Moderate**	**Low to Moderate**

Risks and Challenges for gamma facilities

Production of gamma sources based on cobalt-60 at Russia's Research Institute for Atomic Reactors (NIIAR)

1. Decline in supplier and cost increase

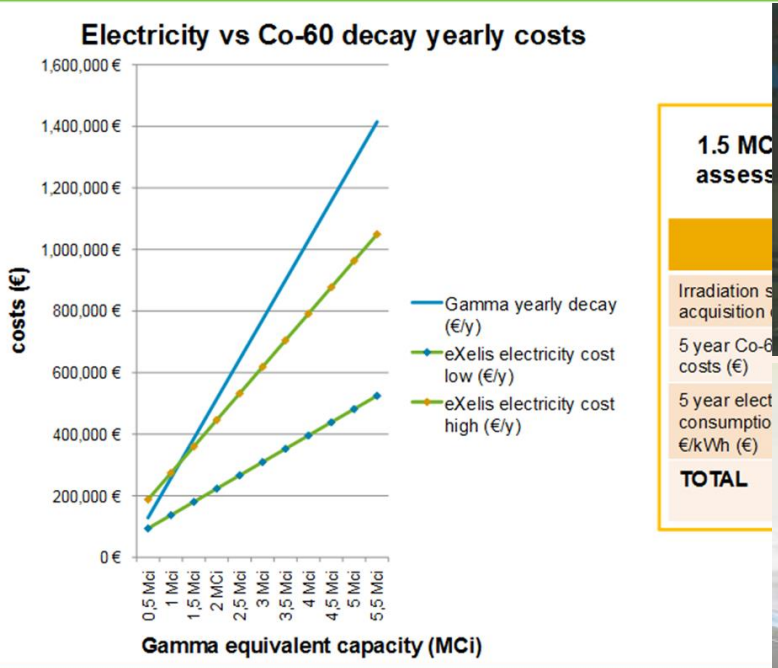
2. Unsafe Replenishing/ Replacing (private sector)

3. Security risks in transportation & storage (especially for used radioactive sources)

4. Low customer acceptance

Benefits and challenges of EB technology

Cost evaluation: Gamma vs X-rays



1.5 MC
assess

Irradiation s
acquisition
5 year Co-6
costs (€)
5 year elect
consumptio
€/kWh (€)
TOTAL

6

+ High capital investment of technology (~ 5-6 mil. USD) may be compensated by its relatively low operating costs.
+ Simplicity of construction and easy operation and control (on/off)
+ High electric energy, beam power
+ High customer acceptance

- Require high and very stable electric supply
- Difficulties in maintenance and non-availability of spare parts
- Power components with limited life time, lead to downtime due to long failures
- New systems require several years for market

Challenges of Food Irradiation in Vietnam

1. Availability of fumigants, preservative chemicals, which usually caused harmful effects to human and environment

2. Limitation in processing capacity of facilities & the bad habit of using traditional foods

IN CONCLUSION

Food irradiation becomes new branch in Vietnam industry, with

✔ 08 gamma facility (03 belong VINATOM),

✔ 01 LINAC (Sonson)

✔ 01 EB (Vinagamma)

✔ 01 X-ray for study (Dalat University)

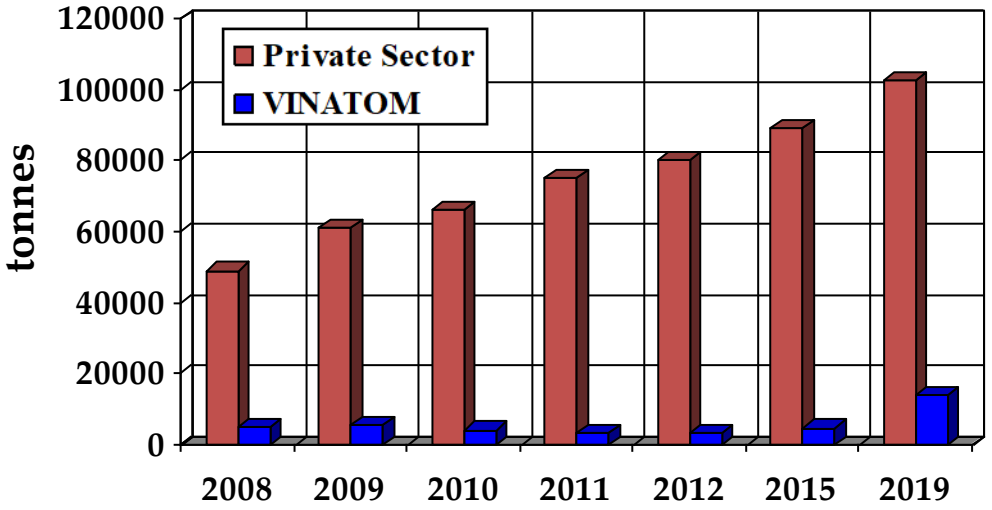
✔ 01 EB/X-ray (API, Bac Ninh)

Planing: 01 EB (CORAD, Toan Phat)

Public Citizen 30 YEARS
Protecting Health, Safety & Democracy

The Problems with Irradiated Food:

IN CONCLUSION



- Food Irradiation is not only beneficial in reducing post-harvest losses, ensuring sanitary and phytosanitary for food as well as other agricultural products, but also facilitating the regional and global food trade.
- Food Irradiation and radiation processing are rapidly developing in Vietnam, especially in private sector for both exportation and domestic use, but this nascent industry is facing with big challenges in security, technology and competition.
- VINATOM should keep its key role in mastering the technology, maintaining the facilities, leading new practices and applications via research activities and cooperation with IAEA and RCA. Also, promote coordination with policymakers & regulators to issue the technical documents and guidelines for its development.

Thank you very much
for attention !

References

- Hanoi Irradiation Center

  http://chieuxa.vn/

- Vietnam Atomic Energy Institute

  http://www.vinatom.gov.vn

- International Atomic Energy Agency

  https://www.iaea.org/topics/food-and-agriculture

- World Health Organization

  Safety and Nutritional Adequacy of Irradiated Foods

- Institute of Food Technologists

  Radiation Preservation of Foods