

ELECTRON BEAM IRRADIATION EFFECTS ON SOME PACKAGED DRIED FOOD ITEMS

Nelida L. del MASTRO¹ & Sandra R. MATTIOLO²

1. Nuclear and Energy Research Institute, IPEN-CNEN/SP

2. Navy Technological Center – CTMSP

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Electron beam irradiation

- **decontamination of organic and inorganic materials:**

- spacecraft components and materials for planetary protection
- suppression of microbe contaminants and the sterilization of peat

- **food pasteurization/ preservation**

food for astronauts during space missions

Food for radical sports practitioners

- small nutritious snack foods are needed
- food preparation must guarantee long shelf life
- be compact or lightweight for easiness of carrying
- commercial individually packaged foods can be used either for sports practitioners like adventure racing or eventually as military rations.

Brazilian legislation on irradiated food

- **γ rays from ^{60}Co** ($T_{1/2}$: 5,263y; β_- : 0.314 MeV; γ : 1.173 e 1.332 MeV);
- **γ rays from ^{137}Cs** ($T_{1/2}$: 30y; β_- : 0.514 e 1.176 MeV, (decays to ^{137m}Ba , $T_{1/2}$: 2.554 min.; γ : 0.662 MeV);
- **Electron beam up to 10 MeV;**
- **X rays up to 5 MeV**

Objective

This work describes the application of electron beam irradiation on some food items used in sport training diets. The results of microbiological and sensory analyses of the diverse irradiated samples are presented.

Material

- **fiber rich cookies**

packaged individually in polypropylene film, weighing 15g \pm 10% with 1.5% humidity, 3% mineral residue and 10% fiber

- **fruit cereal bars**

packaged individually in metalized bi-oriented polypropylene film, weighing around 25g, containing dehydrated banana, crisp cereal, rice and maize flour, malt extract with 10% humidity and 2% mineral residue.

Material

- **instant dehydrated asparagus soup**

pouches contained cereals and vegetables, flour, powder milk with 10% humidity, 3% protein, 4% fat, 60% carbohydrates and 12% mineral salts.

- **instant Brazilian corn pudding**

weighing around 25g packaged in aluminum pouches containing powder milk, sugar, maize flour with 2% humidity.

EB Irradiation

- EB accelerator Dynamitron (Radiation Dynamics Inc.) model JOB 188 with doses of 5 and 10kGy, track speed 3.36 m/min.
- Fiber rich cookies and fruit cereal bars were irradiated both sides.
- According to the density and thickness of the diverse samples (Table I) different energy and current were applied (Table II). Perspex Harwell Amber dosimeter were placed in the same tray.

Table I. Density and thickness of the diverse samples

• Sample	Density(g/cm ³)	Thickness(cm)
• Fiber cookies	0.486	1.51
• Fruit bars	0.816	1.32
• Asp. Soup	0.744	0.30
• Corn pudding	0.802	0.38

Table II. Electron beam energy and current

• Sample	Energy(MeV)	Current(mA)
• Fiber cookies	1.119	2.4
• Fruit bars	1.449	2.8
• Asp. Soup	0.994	2.2
• Corn pudding	1.198	2.5

Microbial analyses

Plating and Most Probable Number (MPN) by the multiple tubes technique were used following the Norms of the Brazilian Instituto Adolfo Lutz, a regional reference laboratory

- Yeast and moulds, total coliforms, fecal coliforms, *Bacillus cereus* and *Staphylococcus aureus* were assayed.
- In none of the samples fecal coliforms, *Bacillus cereus* or *Staphylococcus aureus* were present.

Sensory evaluation

Sensory acceptability of a control (non-irradiated) samples and two irradiated ones (5 and 10kGy) was determined ($n = 48$) using an hedonic scale. The Control Difference (ABNT, 1995), overall test included sensory characteristics for appearance, aroma, texture and flavor attributes.

RESULTS

Table III. Microbiological characteristics of irradiated packaged **fiber rich cookies**

Time (months)	0kGy	Radiation dose 5kGy	10kGy
0	Yeast and moulds count: 10/g Total <i>E.coli</i> : Non-detectable	<10/g ND	<10/g ND
3	Yeast and moulds count: <10/g Total <i>E.coli</i> ND	<10/g ND	<10/g ND
6	Yeast and moulds count: <10/g Total <i>E.coli</i> : ND	<10/g ND	<10/g ND

RESULTS

Table IV. Microbiological characteristics of irradiated packaged **fruit cereal bars**

Time (months)	0kGy	Radiation dose 5kGy	10kGy
0	Yeast and moulds count: 10/g Total <i>E.coli</i> : Non- detectable	<10/g ND	<10/g ND
3	Yeast and moulds count: <10/g Total <i>E.coli</i> ND	<10/g ND	<10/g ND
6	Yeast and moulds count: 20/g Total <i>E.coli</i> : ND	<10/g ND	<10/g ND

RESULTS

Table V. Microbiological characteristic of irradiated packaged **dehydrated asparagus soup**

Time (months)	0kGy	Radiation dose 5kGy	10kGy
0	Yeast and moulds count: 6.5x10 ² /g Total <i>E.coli</i> : 43/g	<10/g ND	<10/g ND
3	Yeast and moulds count: 6.5x10 ² /g Total <i>E.coli</i> 50/g	<10/g ND	<10/g ND
6	Yeast and moulds count: 1.7x10 ² /g Total <i>E.coli</i> : 23/g	<10/g ND	<10/g ND

RESULTS

Table VI. Microbiological characteristic of irradiated packaged **Brazilian corn pudding**

Time (months)	0kGy	Radiation dose 5kGy	10kGy
0	Yeast and moulds count: <10/g Total <i>E.coli</i> : ND	<10/g ND	<10/g ND
3	Yeast and moulds count: 30/g Total <i>E.coli</i> 50/g	<10/g ND	<10/g ND
6	Yeast and moulds count: 10/g Total <i>E.coli</i> : 23/g	<10/g ND	<10/g ND

RESULTS

Sensory Evaluation

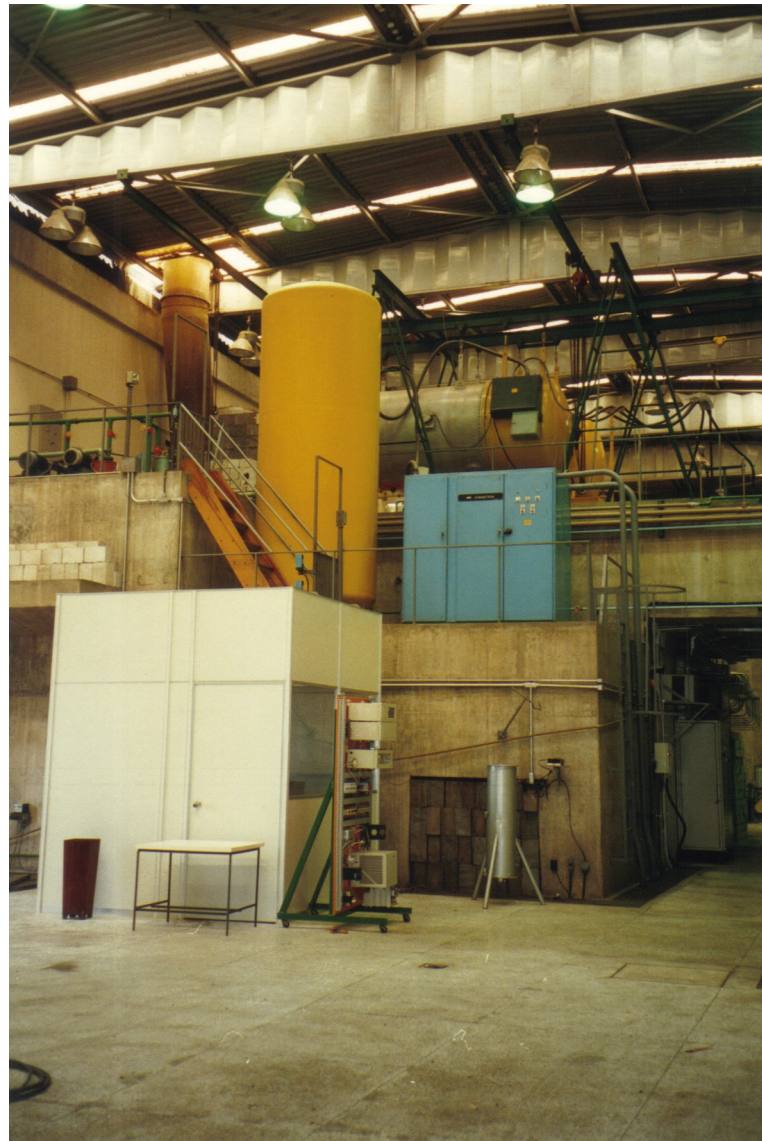
Judgment of pleasantness ranging from:

“1. Dislike very much” to “5. Like very much”

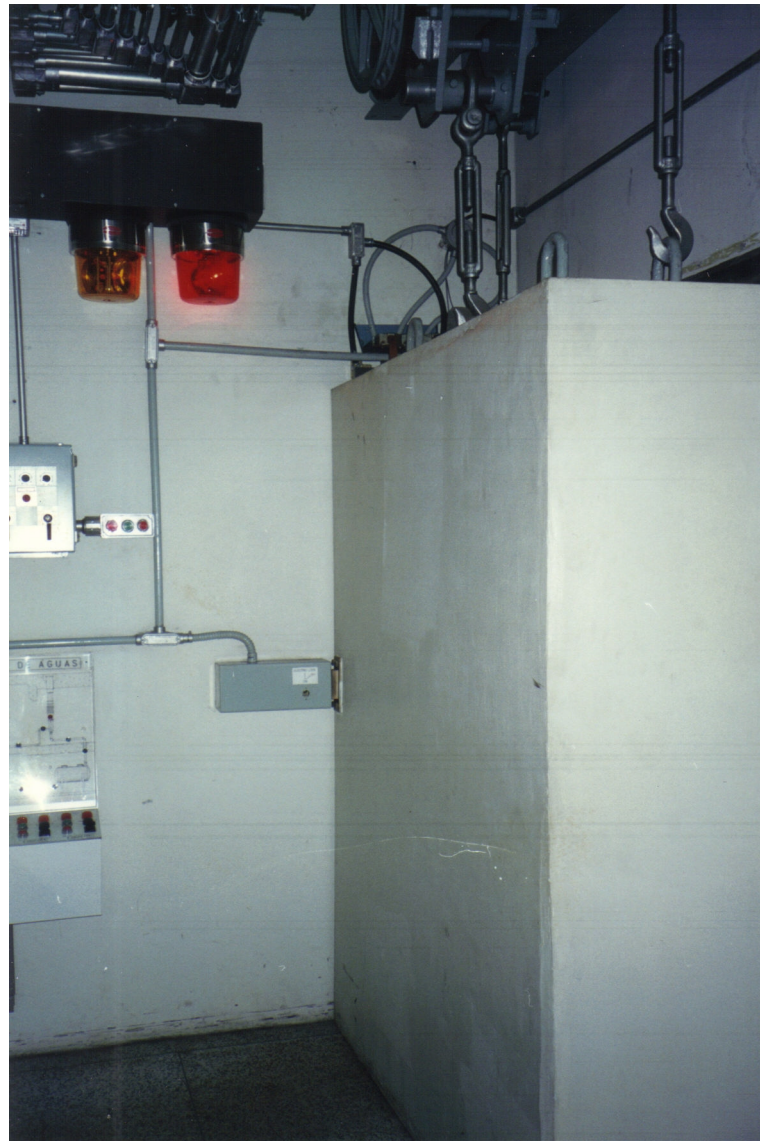
- Non-irradiated samples scored 4 and 5
- All irradiated samples got low scores
- Irradiation impacted aroma and flavor attributes
- Texture and appearance were preserved



Entrance to the EB irradiation room



View of the EB
accelerator



Closing door of the EB irradiation compartment



EB accelerator control panel



Labelling samples



Sticking samples to
a wooden board



Electron beam accelerator Dynamitron (Radiation Dynamics Inc.)



Fruit cereal bars



Fiber rich cookies



Instant dehydrated asparagus soup



Instant Brazilian corn pudding

Conclusions

EB irradiation of packaged fiber rich cookies, fruit cereal bars, dehydrated asparagus soup and instant Brazilian corn pudding with dose of $\geq 5\text{kGy}$:

- Induced significant reduction of fungus and yeasts load;
- Caused differences on sensory characteristics of aroma and flavor but not in appearance and texture;
- Packaging of the irradiated samples endured the EB processing with doses up to 10kGy as no posterior contamination could be perceived up to 6 months;
- For this kind of products with low contamination load a much lower EB irradiation dose would be appropriate and recommended for the extension of shelf life.

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