

## EFFECT OF E-BEAM IRRADIATION ON THE MICROBIAL QUALITY OF MINIMALLY PROCESSED PRODUCTS : A CASE OF A COMMERCIALIZED READY TO EAT SALAD.

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## ACCELERATORS FOR RESEARCH AND SUSTAINABLE DEVELOPMENT

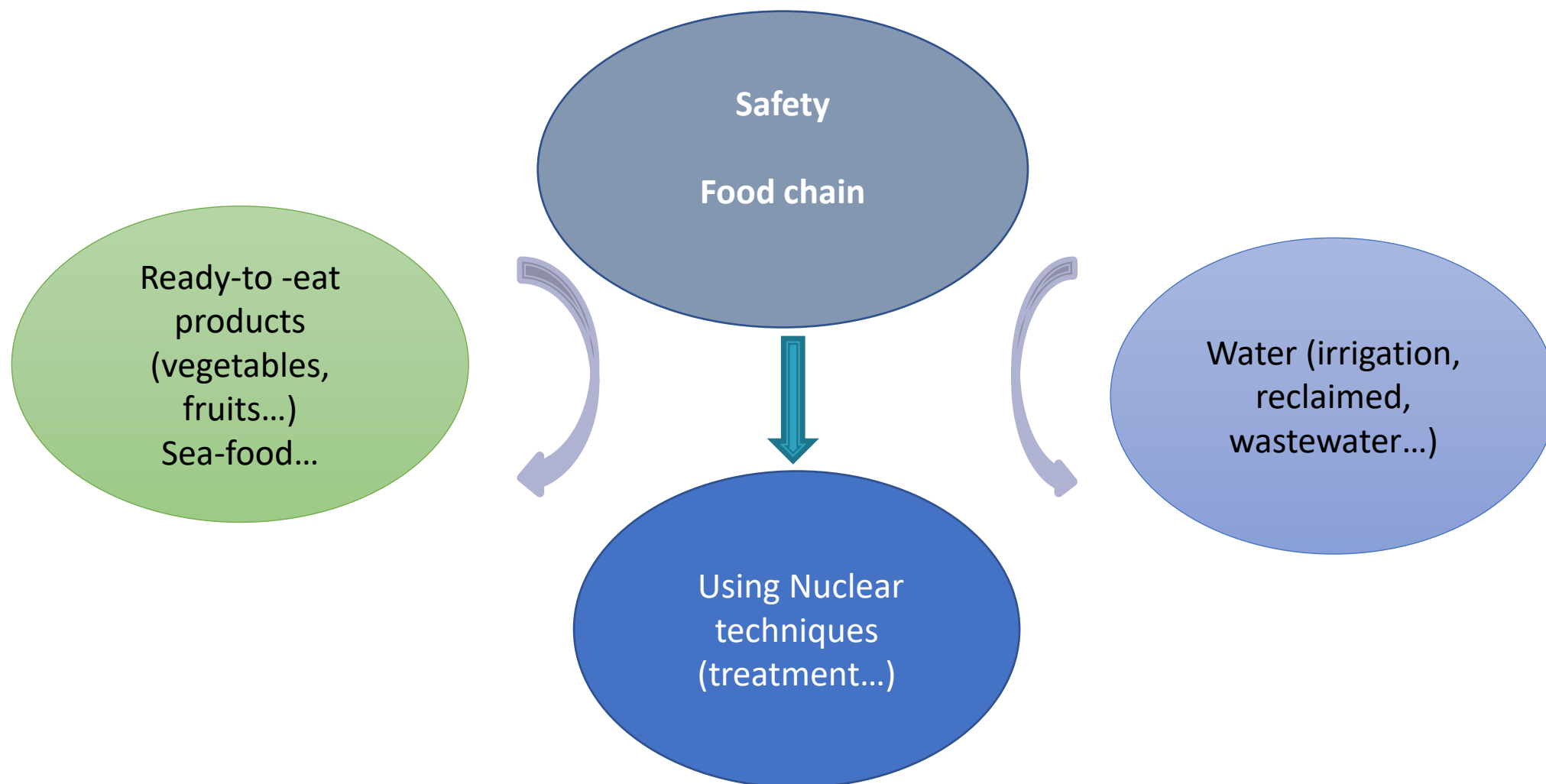
From good practices towards socioeconomic impact



**23–27 May 2022**

IAEA Headquarters, Vienna, Austria

## Laboratory of Biotechnologies and Nuclear Techniques



## Socio-economic Challenges related to commercialized Ready-to-Eat products

Changes in eating habits : High consumption of fresh vegetables and fruits



Food borne disease:  
*Salmonella*,  
*Escherichia coli* O157:  
H7, *Clostridium*  
*perfringens*, *Shigella*.



Shelf-life extension  
: Spoilage  
microorganisms,  
biofilm  
formation...

Treatment : **safe** and  
**sustainable** supplies  
of food



Investing in non-thermal processing  
→ pathogens elimination  
→ shelf-life extension.

Chlorination



Biopreservation

Pathogens  
resistance

Acetic acid

Affecting  
organoleptic /  
nutritive  
properties



Treatment :  
safe and  
sustainable  
food supply



Ionizing  
irradiation

Gamma

E-Beam



# Objectives

- Evaluate the microbiological quality of ready-to-eat salads before and after packaging process in agri-food industry.
- Evaluate the effect of gamma irradiation on naturally occurring and artificially contaminating selected microorganisms.
- Evaluate the effect of E-Beam irradiation on naturally occurring and artificially contaminating selected microorganisms.



# Methodology

**Ready-to-eat salads**



- Collected from an agri-food industry.
- Collected end-point commercialized products (supermarkets)
- The shelf life indicated : 4 to 6 days.
- The treatment process (chlorination treatment, peeling process and citric acid treatment).
- Processed within 24h.

**Irradiation treatment**

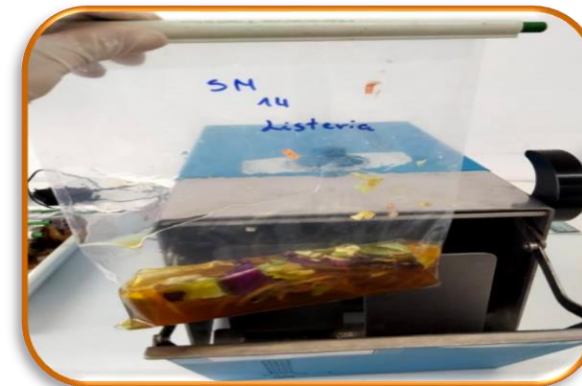
- Naturally occurring microorganisms during storage period (at 4°C)
- Artificially contaminated samples (*Staphylococcus aureus*) ( $10^6$   $10^7$ ) CFU/mL.

# Methodology

Ready-to-eat salads



25 g in 225ml EPT



Microorganisms	Standardized Method
Total aerobic plate count	ISO 4833-2:2013
<i>Staphylococcus aureus</i>	ISO 6888-1:2004
Spores of <i>Clostridium perfringens</i>	ISO 15213:2003
Yeast and molds	ISO 88-059:2001



# Results

Naturally occurring microorganisms

Microorganism	Raw product	Washing treatment	Packaged product	End-point product
Total aerobic plate count	7 Log <sub>10</sub> /25g	5 Log <sub>10</sub> /25g	4.8Log <sub>10</sub> /25g	8.4 Log <sub>10</sub> /25g
<i>Staphylococcus</i> spp.	3.7 Log <sub>10</sub> /25g	ND	2.1Log <sub>10</sub> /25g	2.5 Log <sub>10</sub> /25g
Yeasts	5.6 Log <sub>10</sub> /25g	5.5 Log <sub>10</sub> /25g	7.4Log <sub>10</sub> /25g	7.25Log <sub>10</sub> /25g
Molds	5.5 Log <sub>10</sub> /25g	ND	2Log <sub>10</sub> /25g	6.2Log <sub>10</sub> /25g
<i>Clostridium perfringens</i>	2.5Log <sub>10</sub> /25g	2.5Log <sub>10</sub> /25g	2.5Log <sub>10</sub> /25g	2.6Log <sub>10</sub> /25g

# Results

## E-Beam irradiation

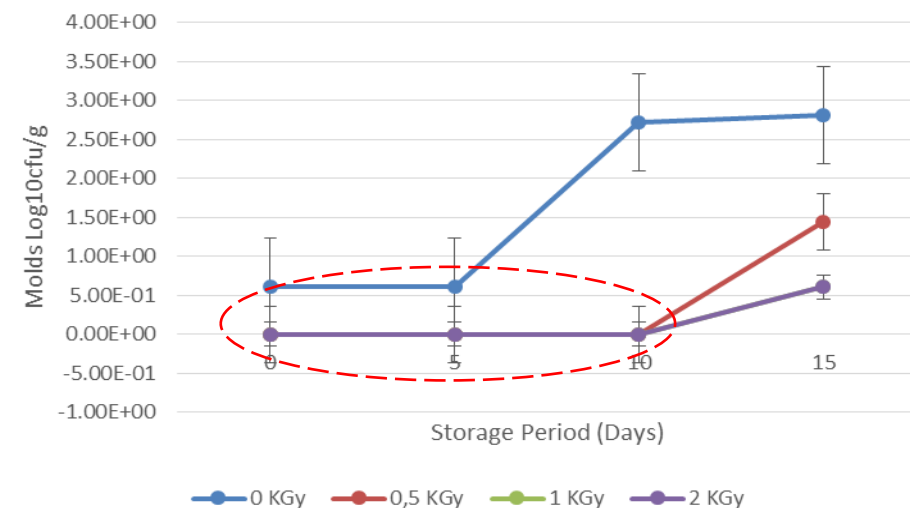
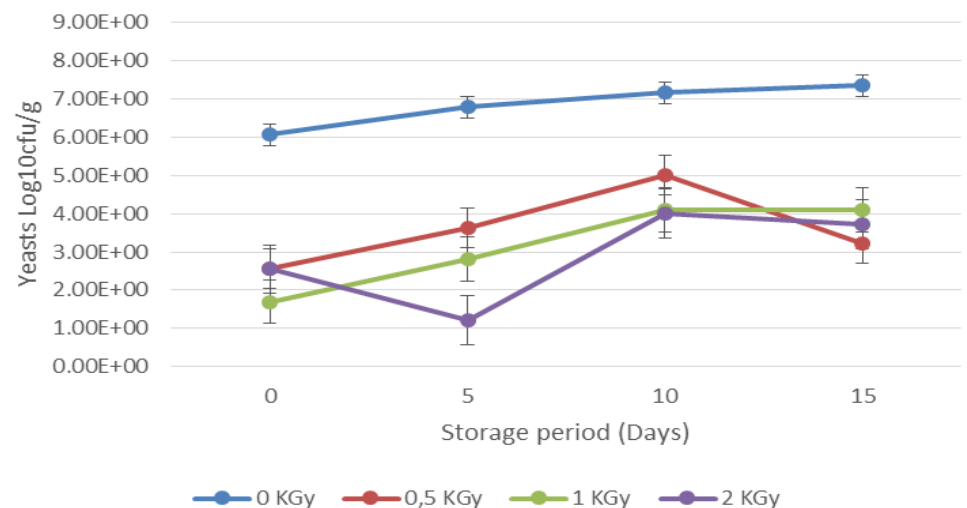
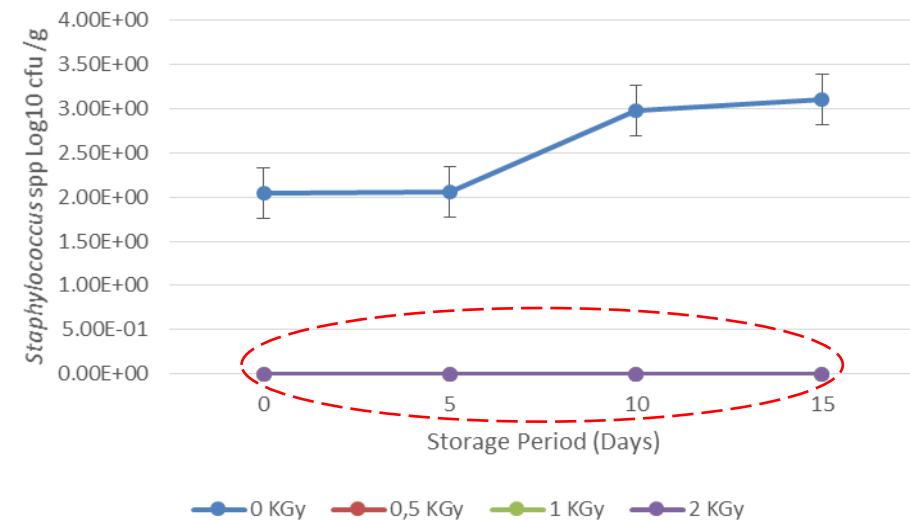
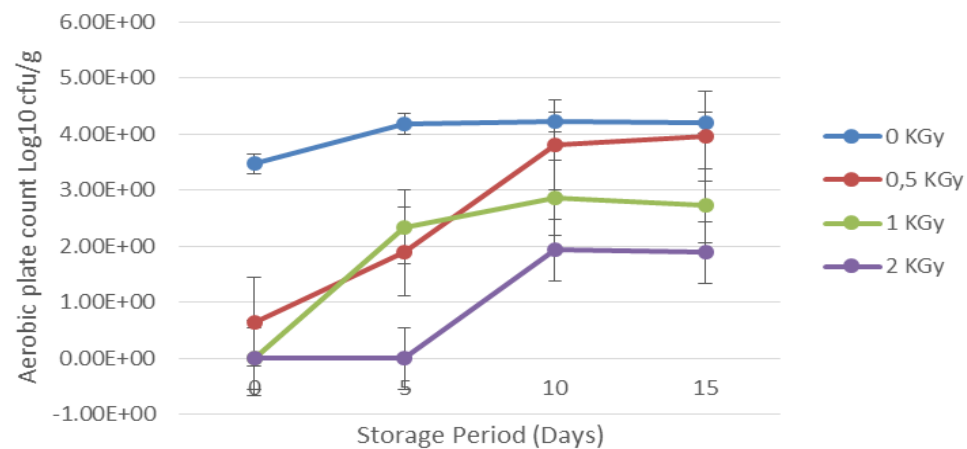
- CIRCE 3, SGN, France
- Applied doses : 2; 3 and 4 kGy
- Artificial contaminated samples with *Staph aureus*
- Naturally occurring microorganisms

## Gamma irradiation

- Co<sub>60</sub> source
- Applied doses : 0.5; 1 and 2 kGy
- Artificial contaminated samples with *Staph aureus*
- Naturally occurring microorganisms

# Results

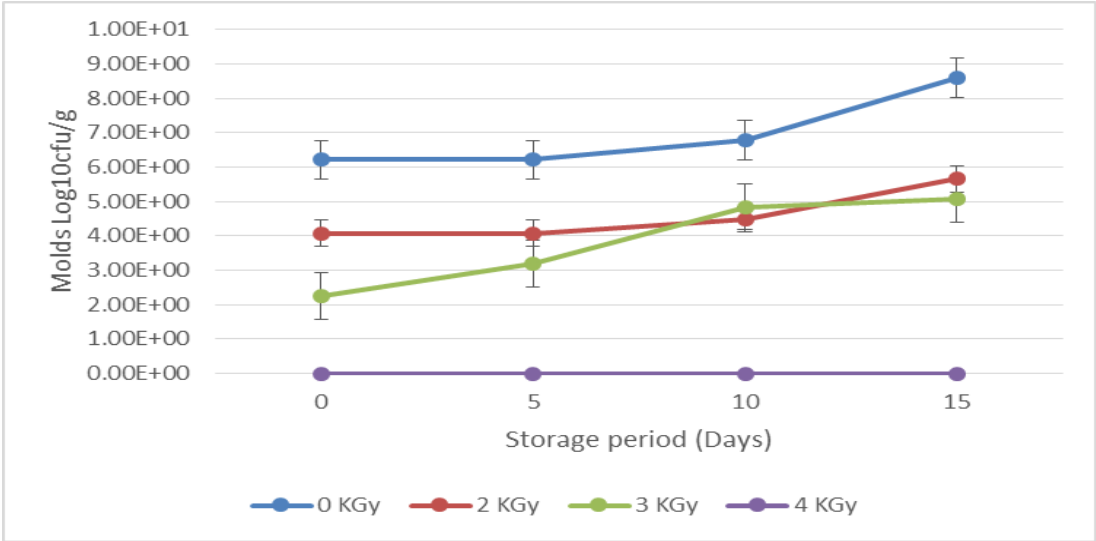
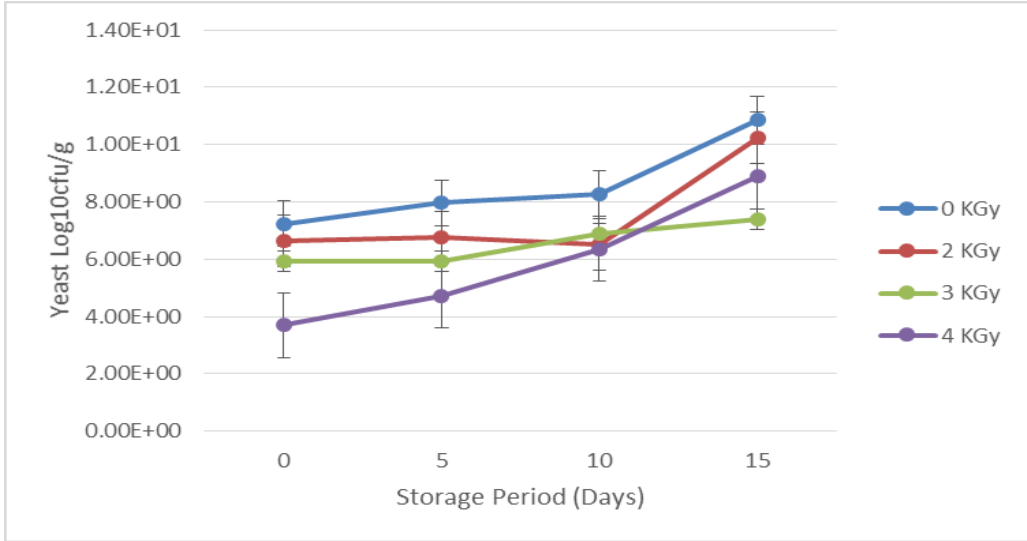
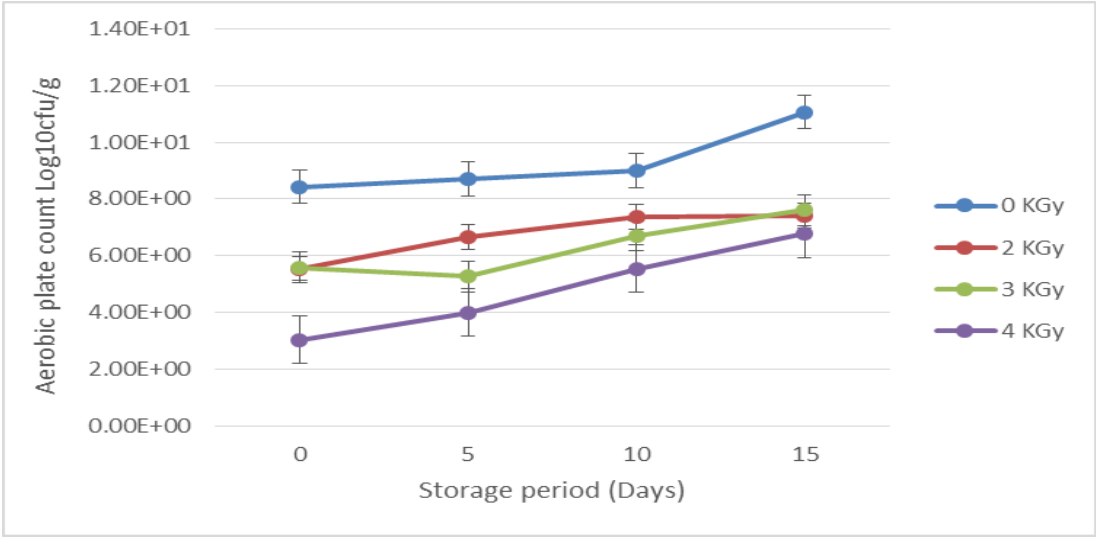
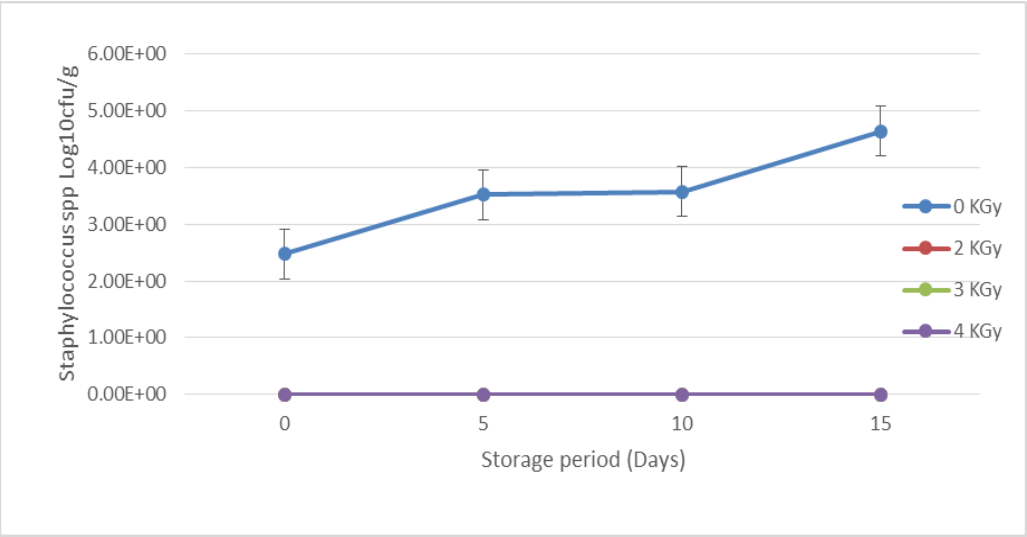
## Gamma irradiation



- 🍏 Results of gamma irradiation showed that an optimal dose of 2kGy offered a pathogen-free, hygienic product in comparison with controls (regarding *Staphylococcus* spp).
- 🍏 Shelf-life extension of commercialized ready to eat salad at refrigeration temperature due to considerable reduction of Total aerobic count and yeasts and molds.
- 🍏 Maximum dose of 2kGy is not effective against sporulating bacteria (*Clostridium perfringens*)

# Results

## E-Beam irradiation

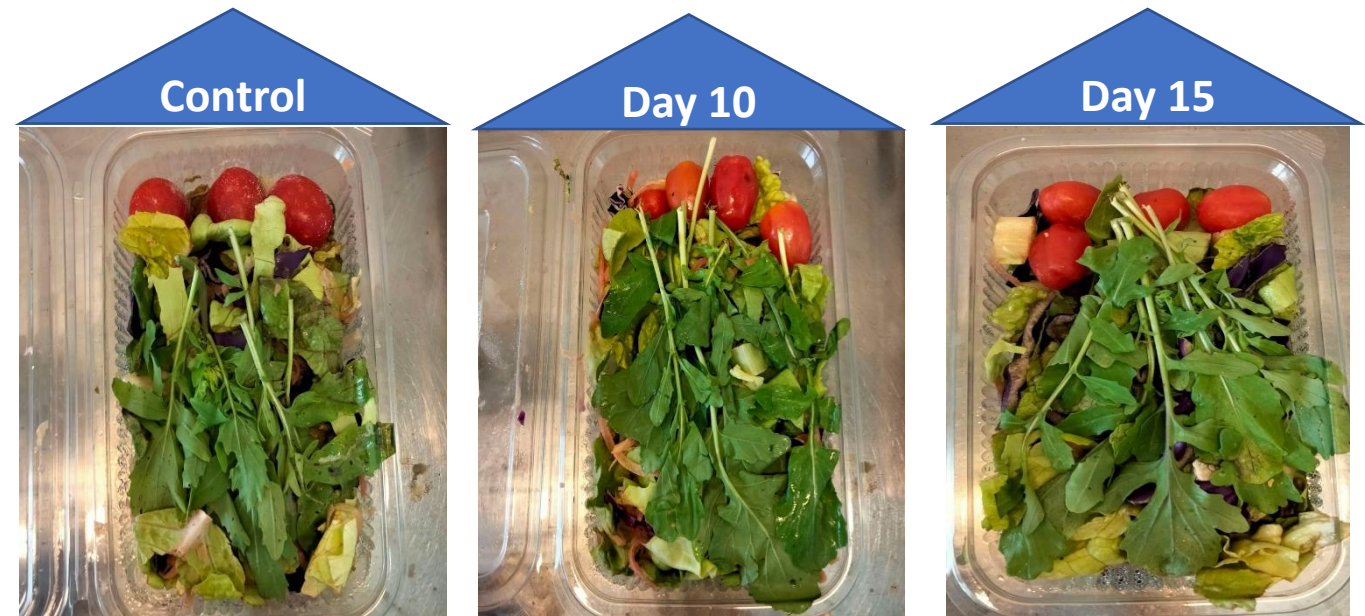
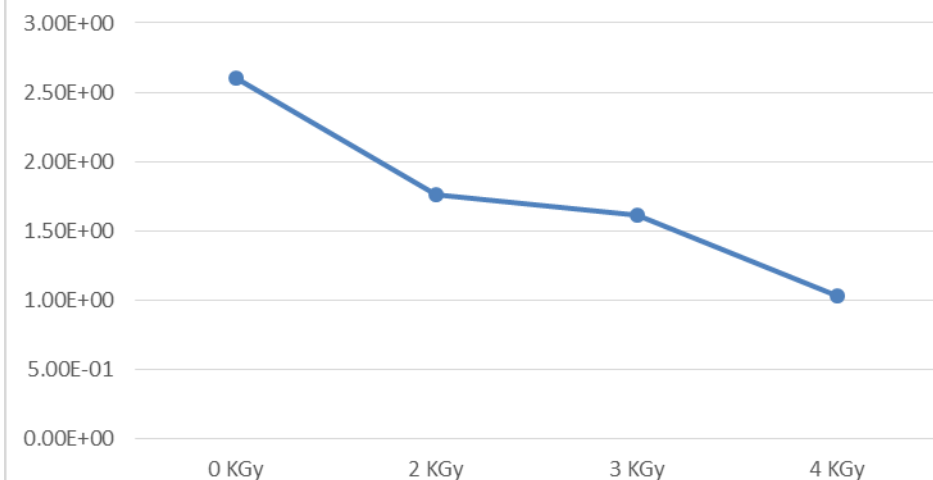




# Results

## E-Beam irradiation

*Clostridium perfringens*



4kGy → extension of shelf-life to more than 10 days

# Results

## *Staphylococcus* spp.

Initial mean concentration (2,5 Log10cfu/g)			
	Dose (KGy)		
	2	3	4
EB reduction Log scale	2.50E+00	2.50E+00	2.50E+00

## Total aerobic count

Initial mean concentration 8,43 Log10cfu/g			
	Dose KGy		
	2	3	4
EB reduction Log scale	2.88E+00	2.85E+00	5.41E+00

## Yeast

Initial mean concentration 7,25 Log10cfu/g			
	Dose KGy		
	2	3	4
EB reduction log scale	0.6	1.4	3.6

## E-Beam irradiation

## Molds

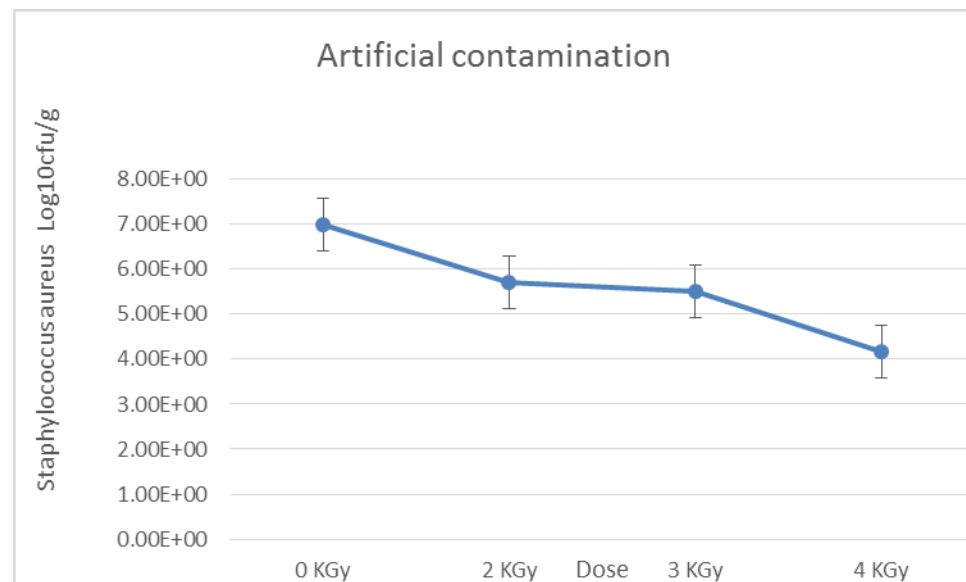
Initial mean concentration 6,22 Log10cfu/g			
	Dose KGy		
	2	3	4
EB reduction log scale	2.14	3.96	6.22

## *Clostridium perfringens*

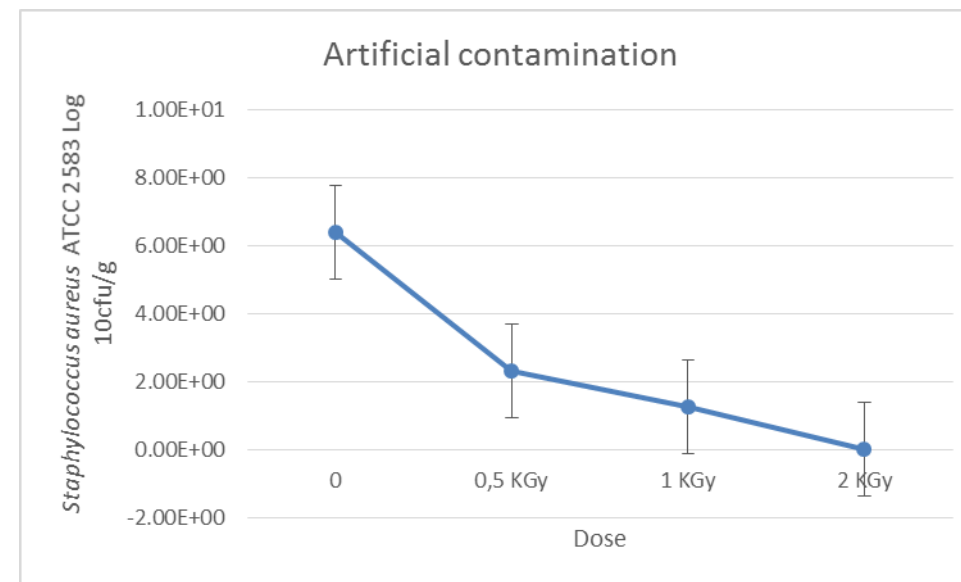
Initial mean concentration 2,6 Log10cfu/g			
	Dose KGy		
	2	3	4
EB reduction log scale	0.84	0.98	1.57

# Results

Artificial contamination by *Staphylococcus aureus* strain (ATCC 25823).



E-Beam irradiation



Gamma irradiation

# Results

Artificial contamination by *Staphylococcus aureus* strain (ATCC 25823).

E-Beam irradiation

Artificial Contamination (10E7 CFU)			
	Dose kGy		
	2	3	4
EB reduction log scale	1.30E+00	1.50E+00	3.00E+00

Gamma irradiation

Artificial Contamination (10E6 CFU)			
	Dose kGy		
	0.5	1	2
Gamma reduction log scale	3.50E+00	4.00E+00	6.00E+00

**$D_{10}$  *Staphylococcus aureus* E-Beam irradiated >  $D_{10}$  *Staphylococcus aureus* Gamma irradiated.**

# Conclusions

- 🍏 E-Beam irradiation is more effective against sporulating bacteria (*Clostridium perfringens*) at a dose of 4 kGy.
- 🍏 Spores are more resistant to ionizing irradiation treatment than bacteria and viruses → usefulness as indicators of irradiation treatment efficiency for food preservation.
- 🍏 Log reduction of microbial load using irradiation is dependent on the initial concentration of naturally occurring microorganisms → steps of an efficient pre-treatment in the agro-food industry are requisite to guarantee safe food for consumers.
- 🍏 Results corroborate the use of E-Beam irradiation for food preservation after packaging process, as it extends its shelf-life with a reduced processing time comparatively to Gamma irradiation.







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# Effect of Gamma Irradiation on Microbial Quality of Minimally Processed Product in Tunisia: A Case of Ready to Eat Salad

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