CNSTN

ICARST 2017

# The efficiency of radiation processing by the Tunisian $^{60}Co$ industrial irradiator after 16 years of use

L. Ounalli*[1, 2], N. Mejri[1], A. Mejri[1], J. Chatti[1], BM. Najla[1]

[1] Tunisian Center for Nuclear Sciences and Technology
[2] Laboratory in Energy and Matter for Nuclear Sciences Development

# Outline


1. Introduction


2. Materials & Methods


3. Results


3. 1 GRP for sterilization of health care products


Dose Uniformity Ratio (DUR)


3.2 GRP for agro-food products


Global Dose Uniformity (GDU)


Microbiological tests

4. Conclusion

# 1. Introduction

# 1. Introduction

- **1999**: commissioning of The CNSTN $^{60}Co$ gamma irradiator
- It has been mainly used for:
  - **sterilization of single use medical and pharmaceutical devices**

    (gloves, syringes, suture, gowns, masks... )
  - **decontamination of agro-food products**

    (spices, aromatics, potatoes, onions and garlic, dried fruits …).

•At third half life (**2009-2015**): the $^{60}Co$ irradiator has a **low source activity** (407 TBq at November 2015) → this activity leads to **a very low dose rate** and require **a very long time** to irradiate efficiently products which **makes expensive the cost of processing**.

➢It becomes judicious to study **the dose distribution**.

➢Determine **the dose uniformity** as well as **the agro-food security**.

# 1. Introduction


As the **Good Manufacturing Practice** (**GMP**) is considered in the manufacturing process, the **Good Radiation Processing** (**GRP**) is also one of the relevant elements of the product manufacture.

- In the present study, we aim to insure the safety of radiation processing of both **health care (high dose)** and **agro-food (low dose)** products .

# 1. Introduction (food Irradiation)

Downsizing of the Harmful organisms in the food components:

- The salmonella bacteria causing food poisoning

- Lengthen the duration of the food preservation

- Control the parasites and insects

- The prevention of vegetation (Potato - Onions - garlic)

# 1. Introduction (radiation sterilization)

- Single use medical devices

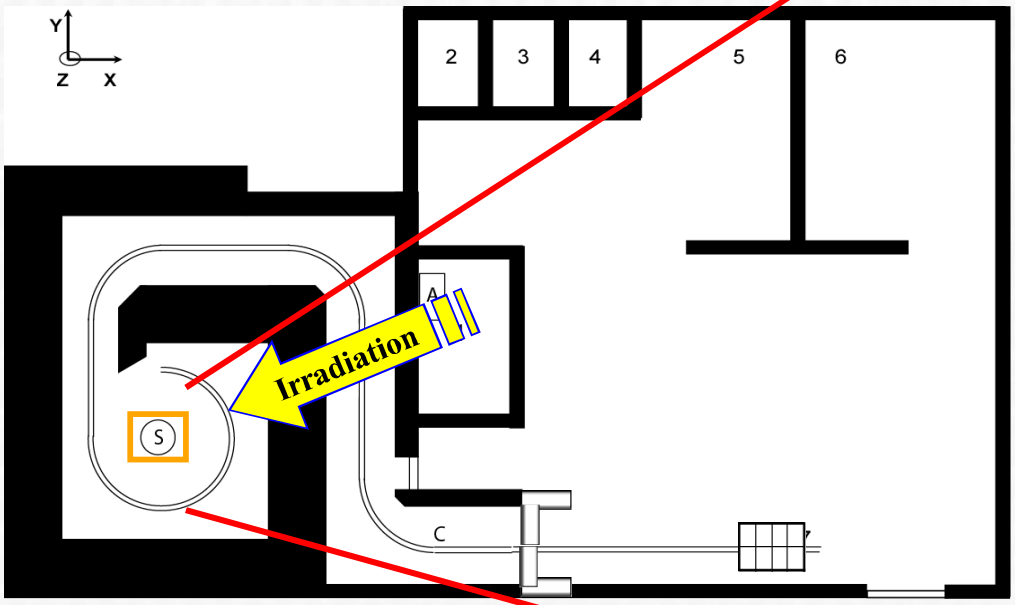
- Laboratory equipments

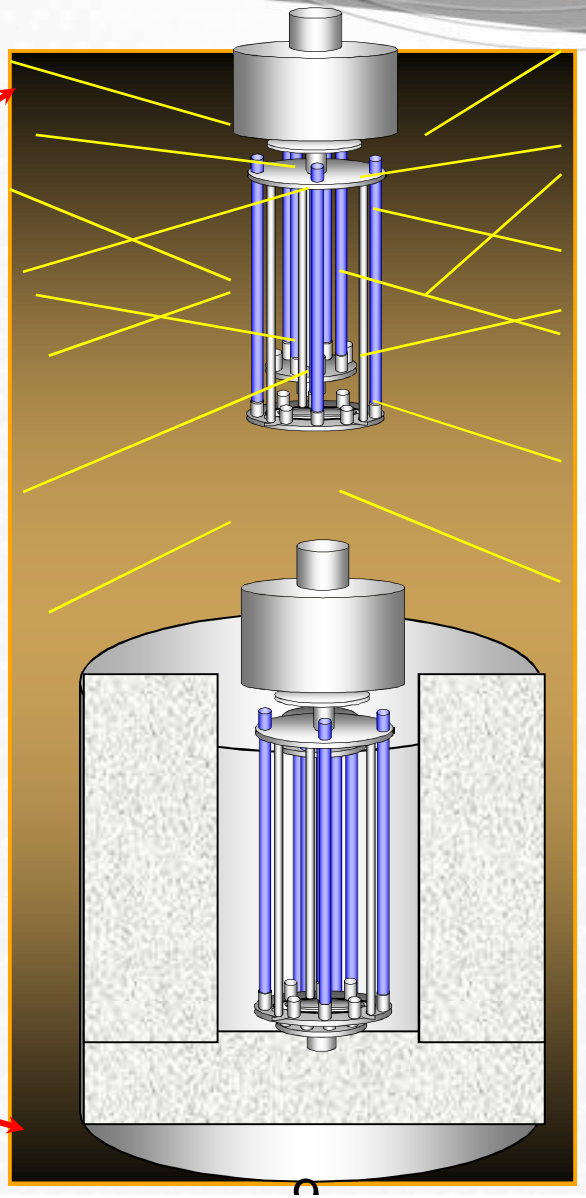
- Some cosmetics and pharmaceutical items

- Canning materials

# 2. Methods

# 2. Materials & Methods:
# 2.1 Description of the $^{60}Co$ irradiator



# 2. Materials & Methods:
## 2.2 Dosimeters: The persual of Frick dosimeters
## 40 Gy< Dose range < 400 Gy

Spectronic “GENESYS”

Absorbance reading at λ ~ 303 nm

**Frick preparation**

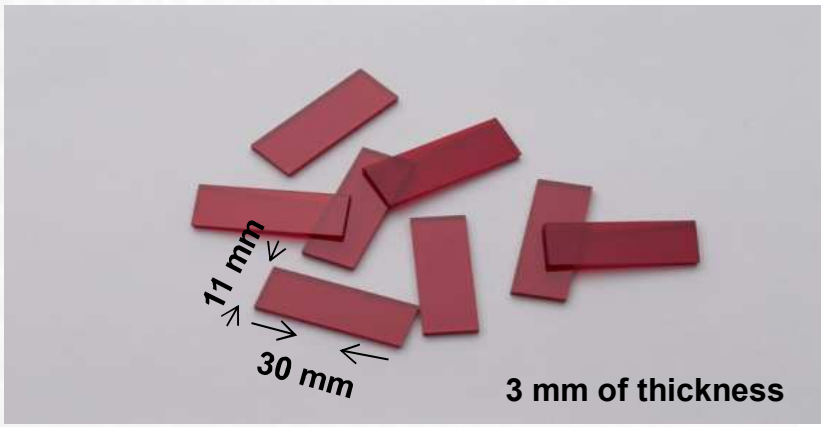
- Ferrous Ammonium Sulfate $(NH_4)_2Fe(SO_4)_2$ 6 $H_2O$ (0.392 g)
- Sodium Chloride (NaCl) (0.058 g)
- Sulfuric Acid ($H_2SO_4$) (12.5 ml)
- Distilled water (1l)

➢ Considered as a **reference dosimeter**

# 2. Materials & Methods:
# 2.2 Dosimeters: The persual of Red Perpex dosimeters
# 5 kGy< Dose range < 50 kGy

Spectronic “GENESYS”

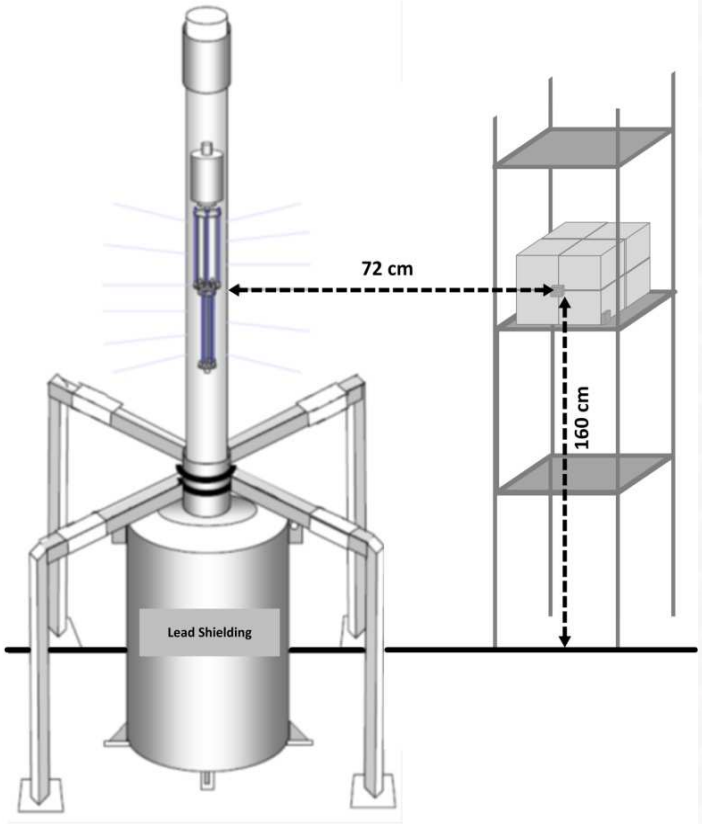
Absorbance reading at λ ~ 640 nm



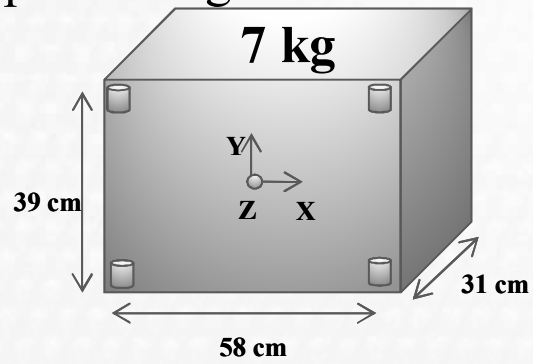

**Red Perpex**

- Red Perspex dosimeter type 4034 (Harwell-UK)
- The perusal of dosimeters was realized 24 hours after irradiation.
- Uncertainties of measurements at 1σ (95% CL) are evaluated following ASTM Standard and was found ± 4.5% .

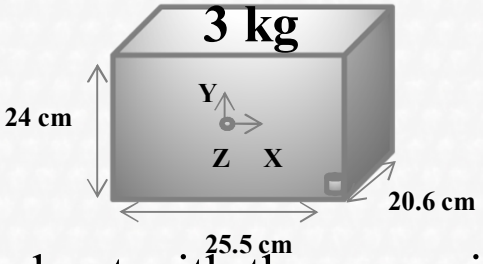
# 2. Materials & Methods:
## 2.3 The setup of the experiment of the dose distribution measurements




**Single use medical devices**: Sixteen boxes with dimension 80 x 58 x 62 cm were used for the processing batch.




**Garlic**: box with dimension and size 20.6 x 25.5 x 24 cm and 3 kg, respectively..




The dose distribution measurements were carried out with the same single use medical product with a density of 0.114 g/cm$^3$.

# 2. Materials & Methods:
# 2.3 The setup of the experiment of the dose distribution measurements

## Single use medical devices:

- In this part, we are interested to follow the absorbed dose in a routine processing of same single use medical product **from 2009 to 2015**.
- Dosimeters were placed at **minimum** and **maximum** dose positions during routine irradiation of a process load.
- The recorded maximum and minimum absorbed doses during the 3rd $T_{1/2}$ allowed the deduction of the Dose Uniformity Ratio.

## Garlic (Allium sativum L):

- It was subjected to gamma irradiation doses of **50**, **100** and **150 Gy** to provide safer product.
- After dose distribution studies, the microbiological quality of irradiated and non irradiated samples were immediately assessed by counting the number of **total aerobic mesophilic bacteria, yeast and mold**.

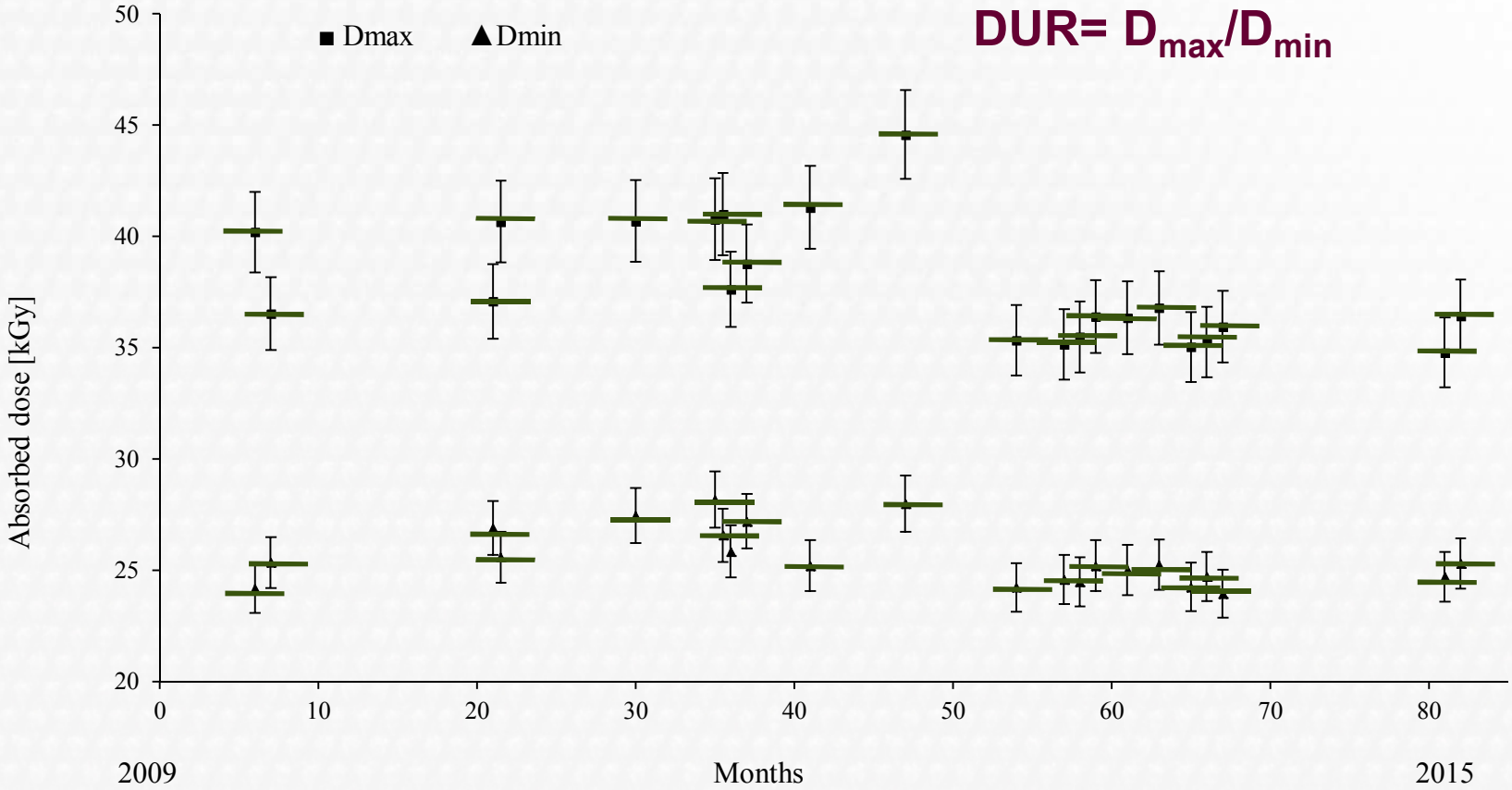
# 3. Results

# 3. Results:

## 3. 1 GRP for sterilization of health care product

**Dose Uniformity Ratio value**

**DUR= $D_{max}/D_{min}$**




Dmin and Dmax received by single use medical product during the 3rd $T_{1/2}$.

**1.5 < the dose limit ratio for many applications < 3**

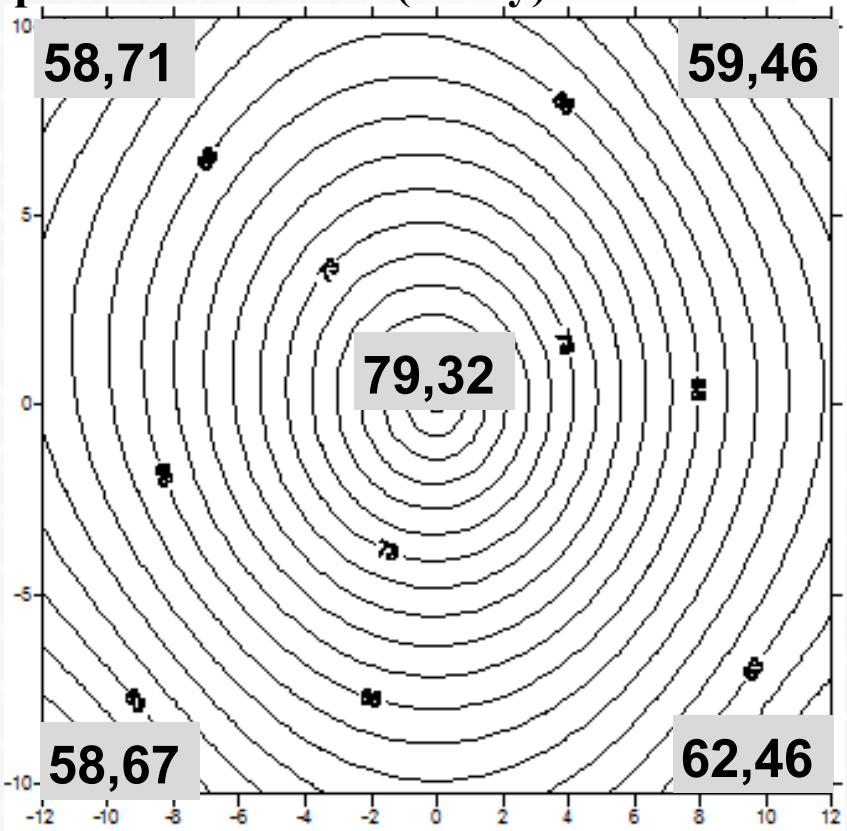
**ISO/ASTM 52303 Standard, 2015, Standard Guide for Absorbed-Dose Mapping in Radiation Processing Facilities.**

# 3. Results
# 3. 2 GRP for agro-food products (Dose Uniformity Ratio)

**Global Dose Uniformity/$_{\text{Front and Back faces}}$**

**GDU= $D_{max}/D_{min}$ =1.35 < 1.5**

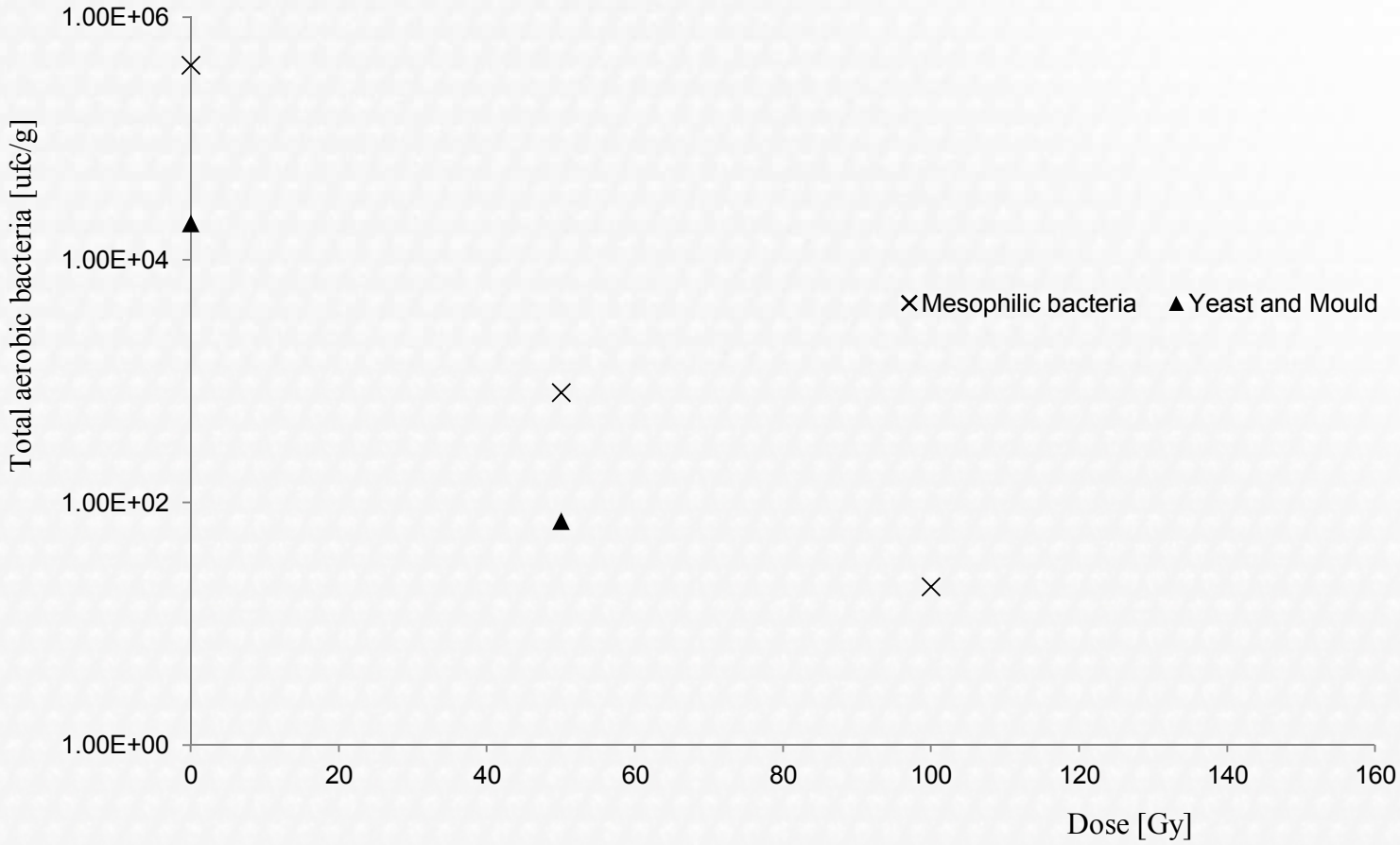
**Isodose curves of $D_{abs}$ distribution in the product back face (50 Gy)**



# 3. Results
# 3. 2 GRP for agro-food products (Microbiological tests)

| Dose [Gy] | Samples | Total aeorobic mesophelic bacteria [ufc/g] | Yeast & Mold [ufc/g] |
|---|---|---|---|
| 0 | $5_{Front}$ | $1.10^5$ | $2.10^4$ |
| | $5_{Back}$ | $3.10^5$ | $3.10^4$ |
| | $5_M$ | $4.10^5$ | $2.10^4$ |
| 50 | $5_{Front}$ | $6.10^2$ | $6.10^1$ |
| | $5_{Back}$ | $7.10^2$ | $5.10^1$ |
| | $5_M$ | $8.10^2$ | $7.10^1$ |
| 100 | $5_{Front}$ | $1.10^1$ | none |
| | $5_{Back}$ | $1.10^1$ | none |
| | $5_M$ | $2.10^1$ | none |
| 150 | $5_{Front}$ | none | none |
| | $5_{Back}$ | none | none |
| | $5_M$ | none | none |

# 3. Results
# 3. 2 GRP for agro-food products (Microbiological tests)



# 4. Conclusion

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- The study of the absorbed dose distribution confirmed the **Good Radiation Processing** of the product with regard to the gamma source direction.
- Based on **GRP indicators 'Dose Uniformity Ratio, Global Dose Uniformity and microbiological tests'**, the $^{60}Co$ irradiator showed its efficiency in irradiation processing even at the end of the source life.
- Chromatographic analysis of non irradiated and irradiated garlic are under study …


شكرا

Merci

Thank you

Спасибо

감사해요

المركز الوطني للعلوم والتكنولوجيا النووية

National Centre for Nuclear Science and Technology )

Sidi Thabet Technopark 2020 Ariana - Tunisia
Tel : (+216) 71 537 803 Fax : (+216) 71 537 555
official@cnstn.rnrt.tn / www.cnstn.rnrt.tn