Study of radioprotective molecules and radioresistant microorganisms isolated from xerophytes.

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INTRODUCTION

- Ionizing radiation (IR) is a type of energy released by atoms in the form of electromagnetic waves or particles.
- People are exposed to natural sources of ionizing radiation, such as in soil, water, and vegetation, as well as in human-made sources, such as x-rays and medical devices.
- Ionizing radiation has many beneficial applications, including uses in medicine, industry, agriculture and research.
- As the use of ionizing radiation increases, so does the potential for health hazards if not properly used or contained.
- Acute health effects such as skin burns or acute radiation syndrome can occur when doses of radiation exceed certain levels.
- Low doses of ionizing radiation can increase the risk of longer term effects such as cancer.
IR interact with biological tissues and induce cellular damage by the generation of free radicals.

So there is urgent need for radioprotection and development of the dosimetry.

However, applicability of the majority of chemical agents remains limited, owing to their high toxicity (Kaushik et al., 2012).

The majority of presently available dosimeters—devices that measure exposure to ionizing radiation—are synthetic and high-cost.

So the search for alternative sources, including plants, is now the topic of vivid research.
Materials and Methods

- **Sampling of xerophytes**
  - *Rhamnus lycioides*
  - *Panicum turgidum*
  - *Cistanche violacea*

- **Extraction of polyphenolic compounds**
  - Biochemical analyses
  - Physico-chemical characterization
  - Biodosimetry applications

- **Identification of radioresistant microorganisms**
  - Culturable and unculturable approaches
  - Omics analysis
  - Extraction of secondary metabolites
  - Applications in radioprotection
1) Polyphenolic compounds as radiation biodosimeter

Sampling of xerophyte *Rhamnus lycioides*
Bou-Hedma National Park, Southern of Tunisia.

Extraction/Identification of polyphenolic compounds
Maceration with methanol, LCMS Identification.

Effect of gamma radiation on optical parameters of plant extracts (1-30 kGy)
Colorimetry and UV-visible analyses.

Structural and morphological properties of irradiated extracts

Chemical investigations of polyphenols after gamma radiation
Fourier Transforms InfraRed (FTIR).
2) Radioresistant microorganisms

- Sampling of xerophytes from arid regions of Tunisia

  - Expose the roots to $\gamma$ rays (10 kGy)

  - *Panicum turgidum*
    - Next-Generation Sequencing (NGS) of microbial genomic DNA from irradiated roots.
    - Isolation and identification of culturable microorganisms.
    - Genome sequencing of *Kocuria* sp. PT10 and *Promicromonospora* sp. PT9.
    - Radioprotective effect of radioresistant strains against *E.coli*.
    - Isolation/Identification of radioresistant bacteria from irradiated roots.
    - Screening of exopolysaccharides (EPS) production.
    - Evaluation of radioprotective effect of EPS using MTT assay.
    - Evaluation of antioxidant activities of irradiated EPS.

  - *Cistanche violacea*
Application of Polyphenolic extracts as radiation biodosimeter.

0 kGy

10 kGy

20 kGy

30 kGy
Isolation of radioresistant microorganisms

A collection of 32 bacterial strains isolated from irradiated roots of Panicum turgidum were assigned by 16S rDNA gene sequence analyses to the following genera with uneven distribution:

- Acinetobacter
- Bacillus
- Kocuria
- Microbacterium
- Micrococcus
- Olivibacter
- Pantoea
- Promicromonospora
- Staphylococcus
Viability of *E. coli* under gamma treatment with supernatant of radioresistant bacteria using MTT assay

- **E. coli**
- **Microbacterium sp. PT8 + E. coli**
- **Micrococcus sp. PT11 + E. coli**
- **Promicromonospora sp. PT9 + E. coli**
- **Kocuria sp. PT10 + E. coli**

Radioprotective effect:
- $D_{10} = 4.35$
- $D_{10} = 2.58$
- $D_{10} = 2.88$
- $D_{10} = 4.75$
### Genome sequencing of PT10 and PT9

<table>
<thead>
<tr>
<th>Features</th>
<th>Kocuria sp. PT10</th>
<th>Promicromonospora sp. PT9</th>
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<tbody>
<tr>
<td>Genome size (bp)</td>
<td>2,656,287</td>
<td>6,582,650</td>
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<tr>
<td>G+C content (%)</td>
<td>70.68</td>
<td>71.20</td>
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<tr>
<td>Protein coding genes (%)</td>
<td>89.76</td>
<td>91.91</td>
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**Mecanisms of defense against Stress oxidative**

- Several ROS scavenging genes involved in protection of its cytosolic proteins from oxidation and DNA double-strand breaks (DSBs) repair.
- Exp: DNA mismatch repair protein MutT, DNA replication and repair protein RecF, etc.
- Extremozymes and extremeolytes.
- Secondary metabolites: Siderophore, bacteriocin, terpene, Arylomycin biosynthesis, antibiotic, etc.
- Genes contributing to plant-beneficial functions.
- Several reactive oxygen species (ROS) scavenging genes involved in recovery from ionizing radiations.
- Exp: Nucleotide-binding universal stress protein UspA family, Universal stress protein MSMEG_4207, etc.
- Secondary metabolites: oligosaccharide, ectoine, lassopeptide, siderophore, etc.
- Antibacterial and antifungal activities.
Extraction of secondary metabolites
Conclusions

Polyphenolic extracts from *Rhamnus lycioides*

Investigate the dosimetric features of phenolic extracts from the xerophyte *Rhamnus lycioides*.

The irradiation of polyphenols produced significant dose-dependence change in their optical and morphological properties.

Irradiated samples had a clear visual change following irradiation.

Polyphenolic compounds of xerophytes can be valorized as natural and cheap radiation biodosimeter with dose range 1–25 kGy.
Radioresistant microorganisms

An unexpected diversity of radioresistant actinobacteria colonize the xerophyte plants in arid regions of Tunisia.

These strains might represent a valuable source of new species and biologically compounds.

Producing radioprotective compounds such as exopolysaccharides.

Having various applications in radioprotection.
Thank You

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