



**Lomonosov Moscow State University**

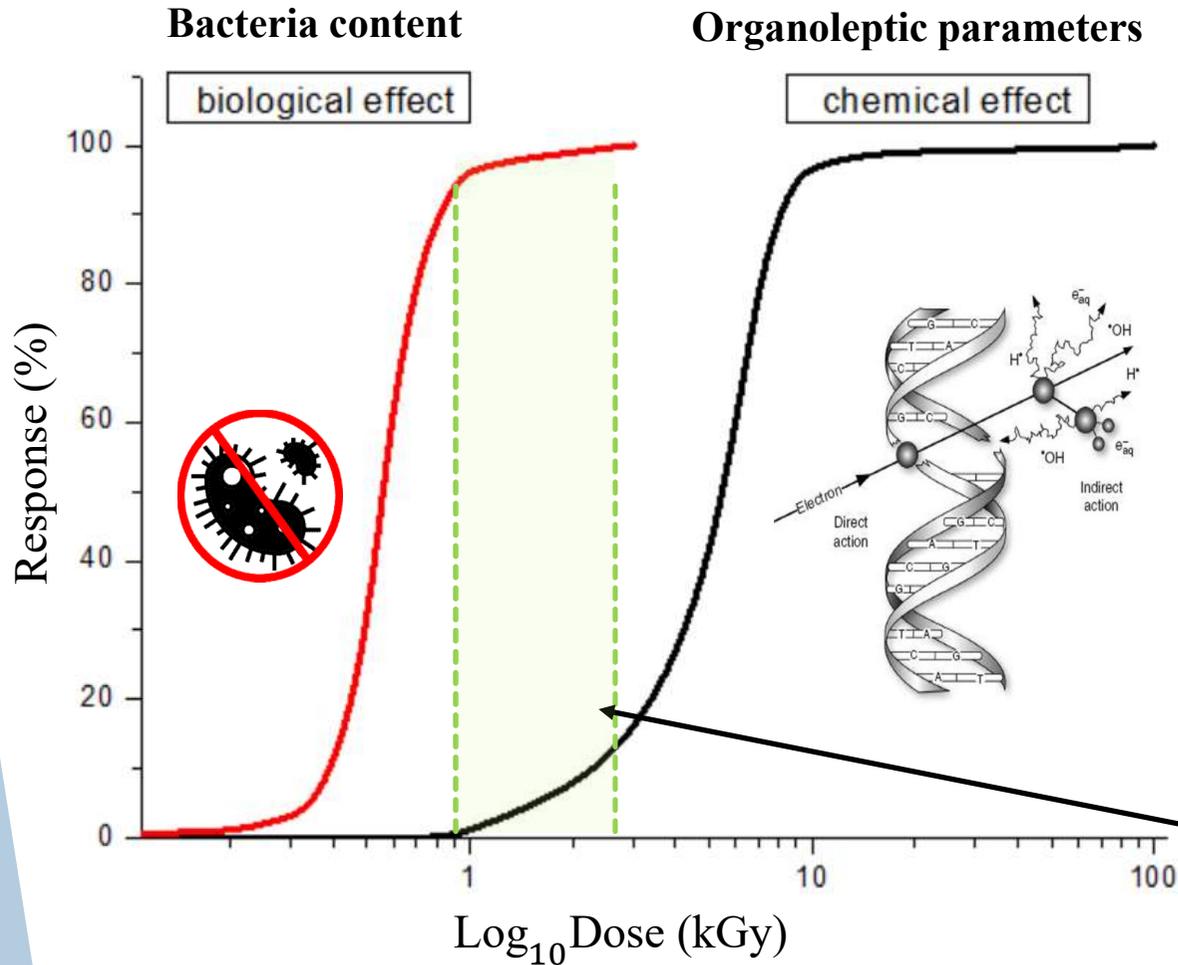
**Physics Department**

**Chair of Physics of Accelerators and Radiation Medicine**

**THE INFLUENCE OF ACCELERATED 1 MeV  
ELECTRON BEAM ON MICROBIOLOGICAL AND  
ORGANOLEPTIC PARAMETERS OF CHILLED  
RAINBOW TROUT**

Moscow  
2019

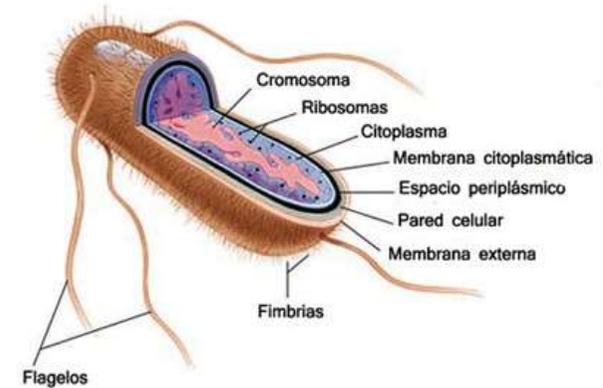
# Radiation Processing of Foods



**Radiation processing of foods** is a process in which products are exposed to ionizing radiation in order to prolong the shelf life, destroy biological microflora and preserve the structural integrity of the product, its organoleptic and physicochemical properties.

# The Bacterial Microflora of Fish

- Psychotrophic and Psychophilic Bacteria
- Gram-negative bacteria - Pseudomonas or Achromobacter
- Spore-forming bacteria (Clostridium)
- Various types of micrococcus, corynebacterium diphtheriae
- Conditionally pathogenic bacteria (Salmonella enteritidis and Escherichia Coli)



The quantity of microorganisms in chilled fish varies from  $10^2$  CFU / g and above.

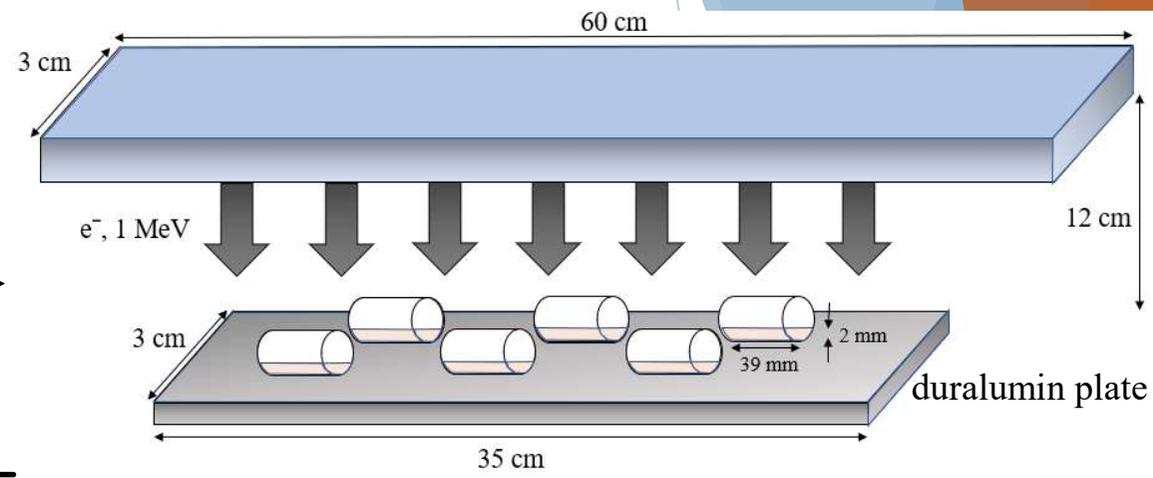
The maximum allowable quantity of microorganisms in chilled fish is **not more than  $10^5$  CFU / g.**

**The purpose of the study is to examine the microbiological and organoleptic parameters of chilled rainbow trout after treatment with 1 MeV electrons during extended period of storage.**

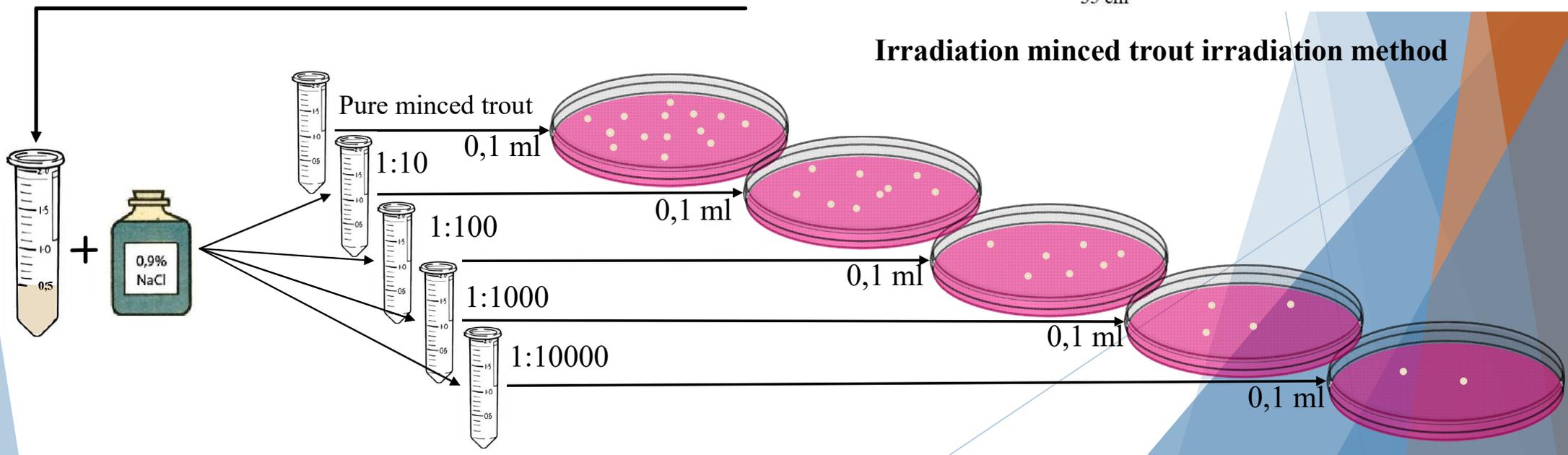
**Goals:**

1. Irradiating minced fish with 1 MeV accelerated electrons.
2. Monitoring microorganisms content of minced trout after irradiation in different doses during the whole period of storage.
3. Carrying out dosimetry measurements using ferrous sulfate (Fricke) dosimeter.
4. Monitoring E.coli content of minced trout after irradiation in different doses.
5. Analyzing the results.

# Experimental Techniques

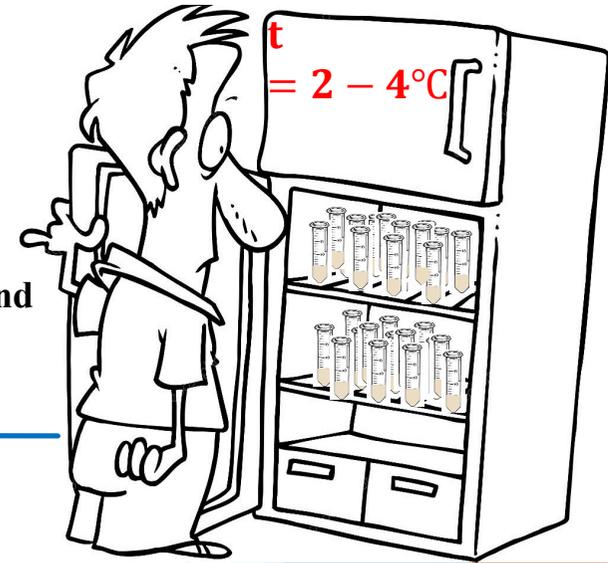
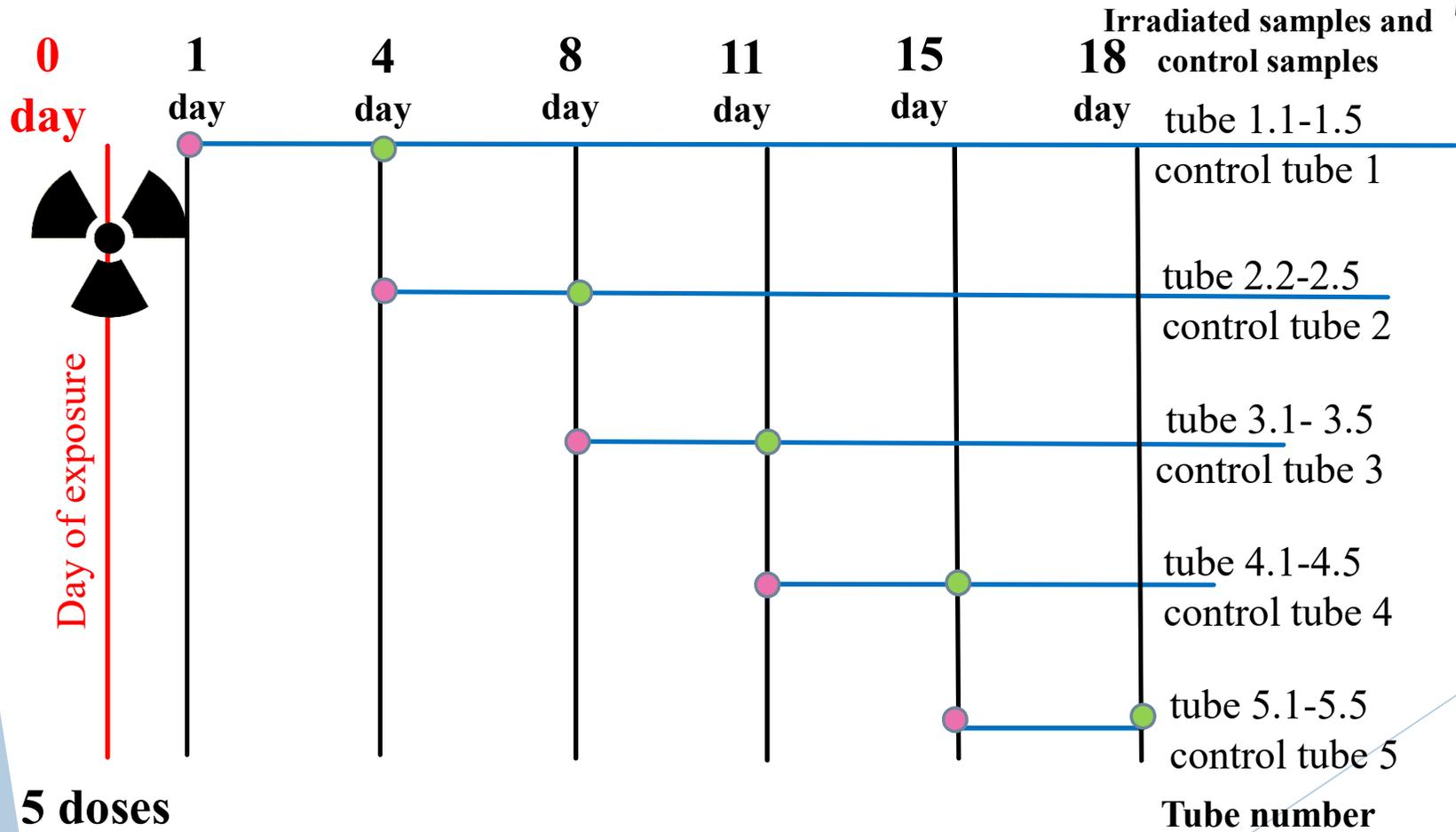


## Irradiation minced trout irradiation method

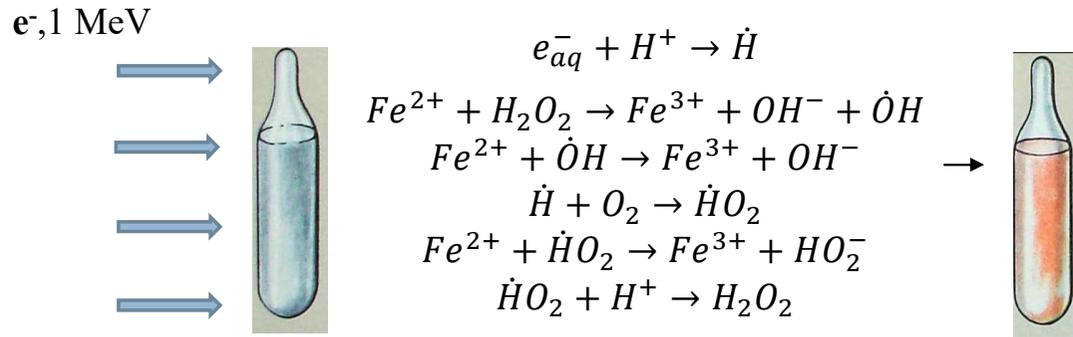


# Minced Trout Storage Simulation

- - seeding
- - measurement



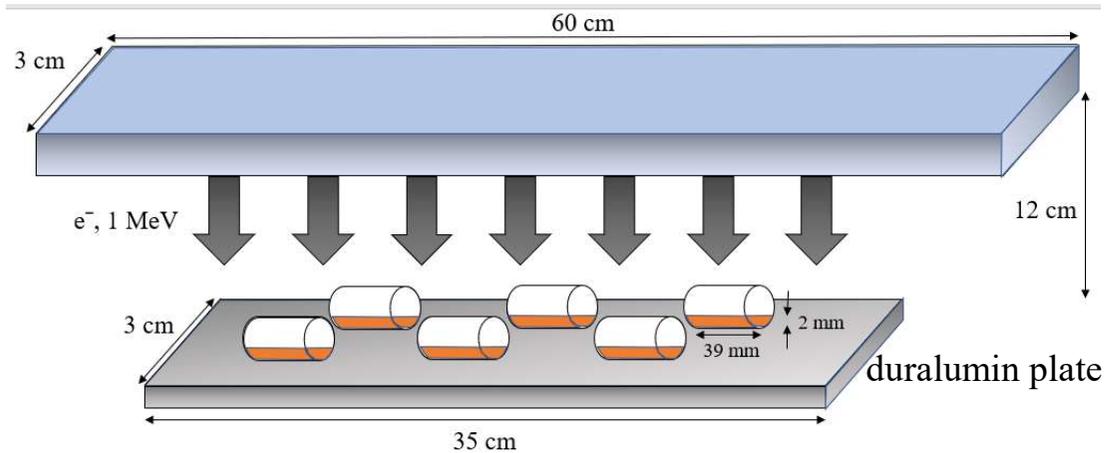
# The Ferrous Sulfate (Fricke) Dosimeter



Chemical reactions in Fricke dosimeter



Spectrophotometer UV-3600



Fricke dosimeter irradiation method

$$D_{Fricke} = (k\Delta S) / [\rho G(Fe^{3+})\epsilon l]$$

Minced trout density  $\rho = (0.994 \pm 0,04) \text{ g/cm}^3$   
 Fricke dosimeter density  $\rho_{Fricke} = 1.024 \text{ g/cm}^3$

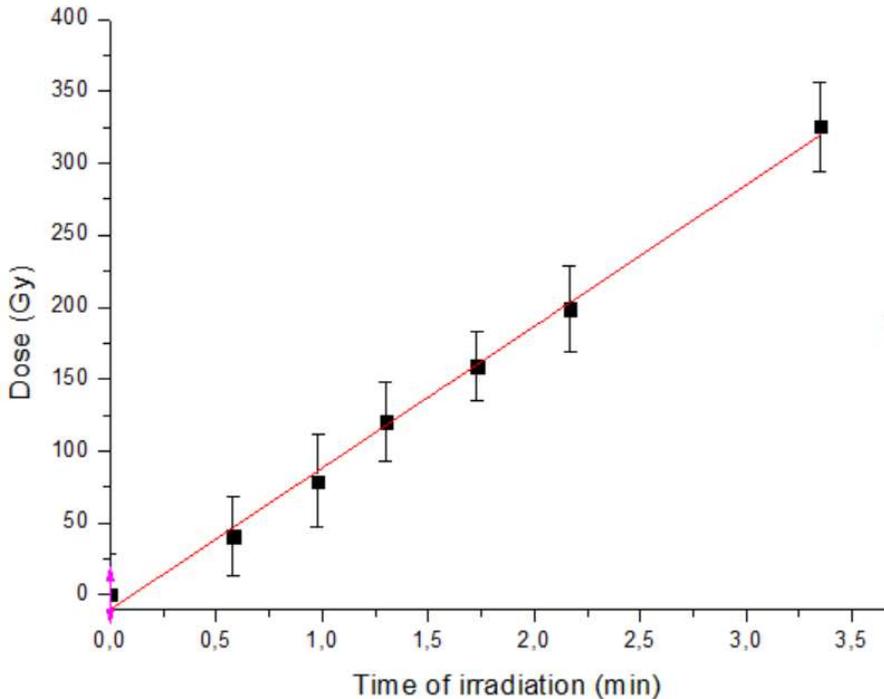
# Dosimetry Results

Fricke dosimeter parameters

#	Irradiation time (sec)	$Q^*$ (nC)	$\Delta S^{**}$ (RVUs)	Absorbed dose (Gy)
1	34,6	2390	0.146	40.8
2	58,5	4790	0.283	79.2
3	78	7380	0.43	120.3
4	104	9834	0.569	159.1
5	130	12410	0.71	198.6
6	201	20020	1.164	325.5

Minced trout irradiation parameters

#	Irradiation time (sec)	$Q^*$ (nC)	Absorbed dose (kGy)
1	10	12250	0.24
2	18	24780	0.48
3	33	50180	0.96
4	72	147500	2.8
5	130	294000	5.6

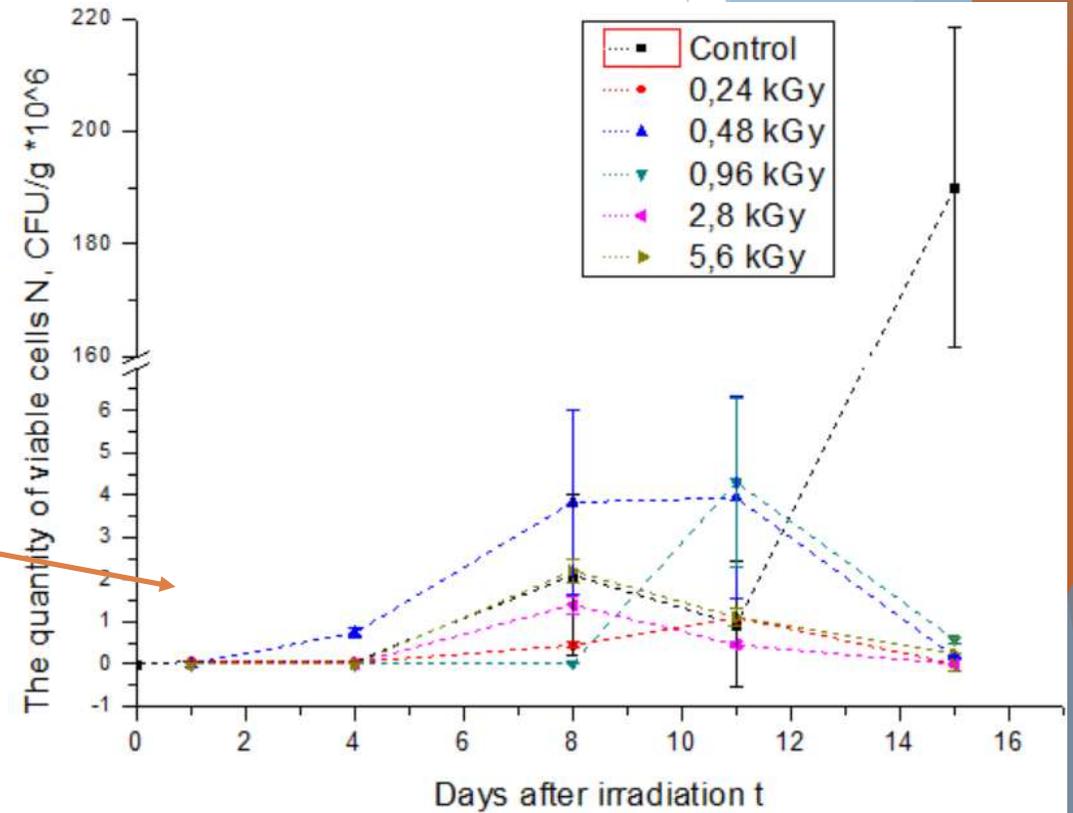
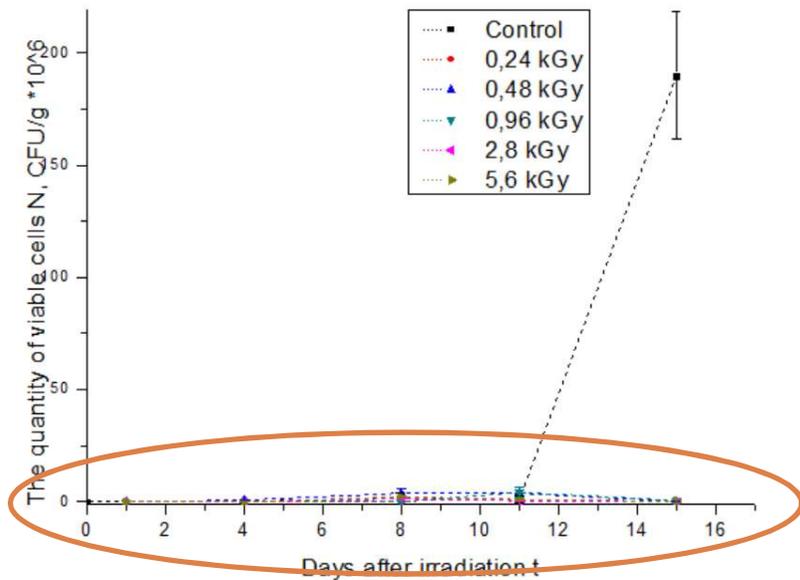


Dependence of the absorbed dose on irradiation time

**Dose Rate ( $1.7 \pm 0,04$ ) Gy/sec**

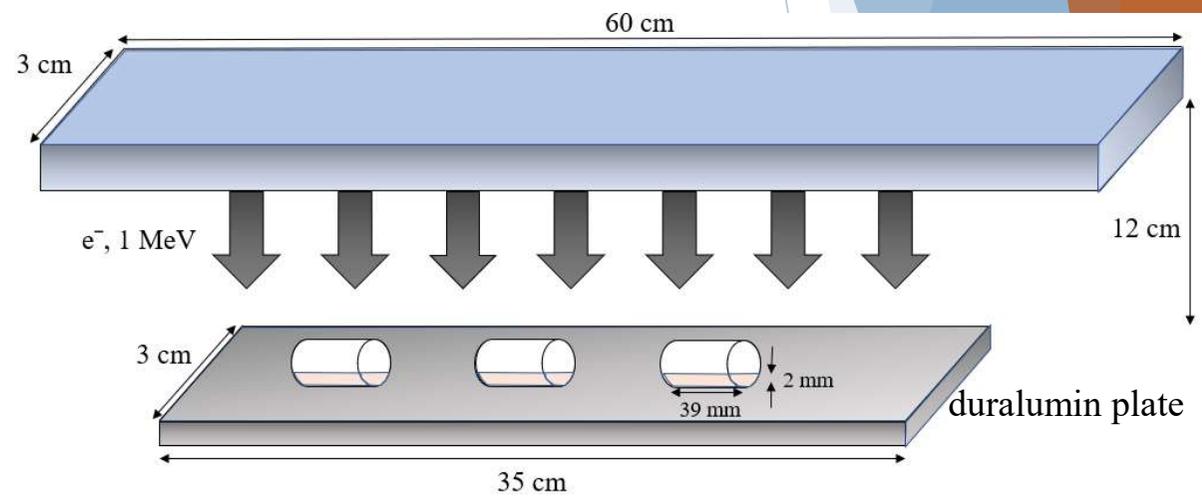
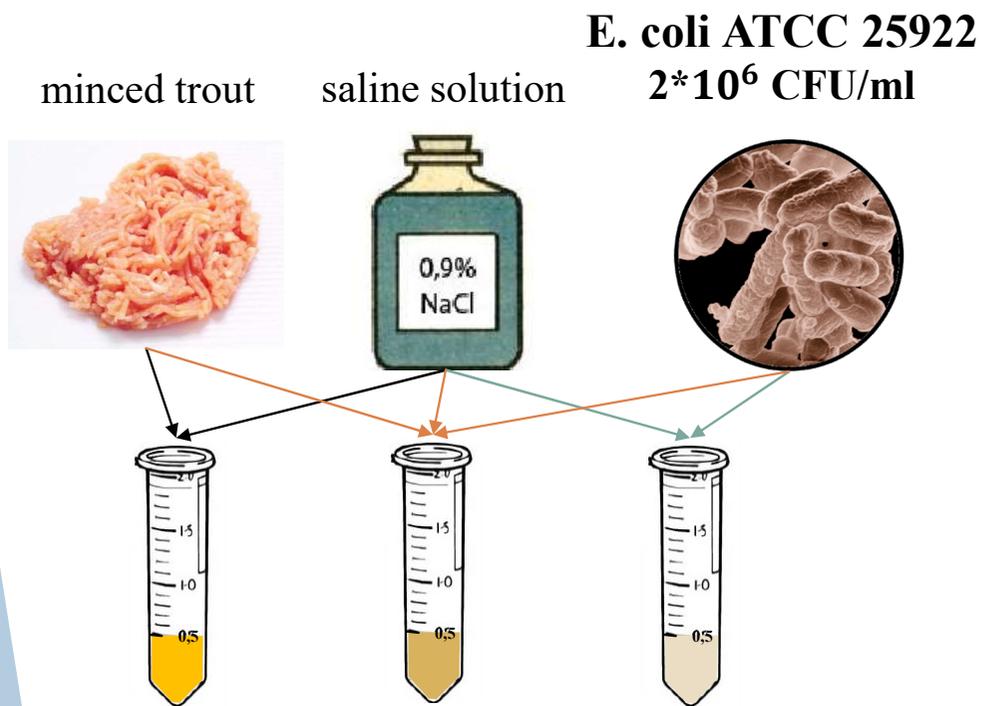
$Q^*$  means electric charge absorbed by duralumin plate with samples  
 $S^{**}$  means optical density variation of dosimetry solution

# Experimental Results of Storage



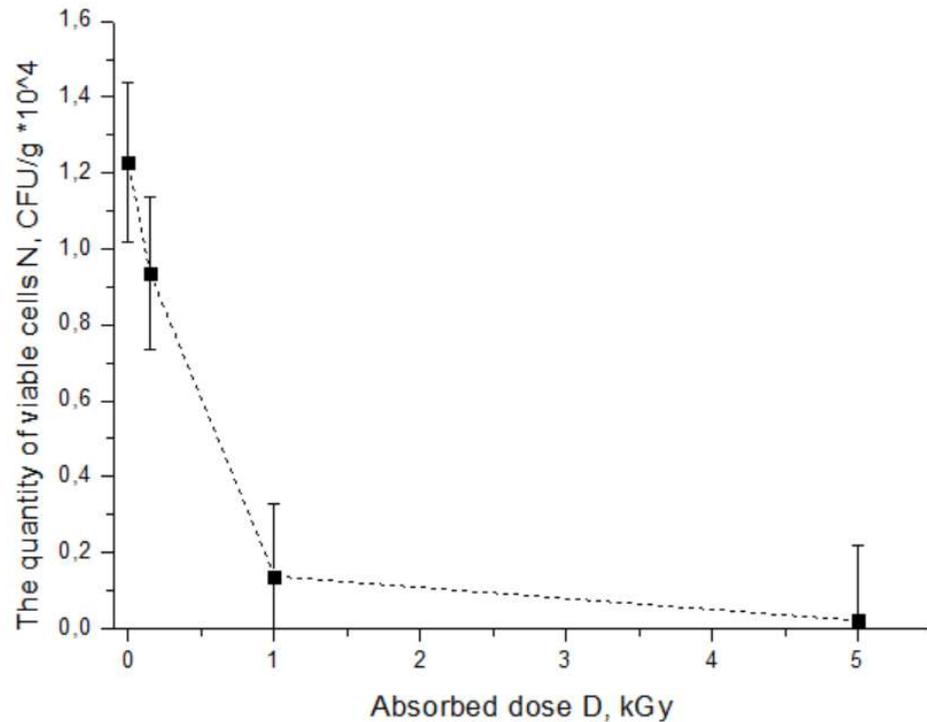
**Dependence of the quantity of viable cells in minced fish irradiated by various doses on the period of storage**

# Escherichia Coli Bacteria Survival Rate in Minced Trout

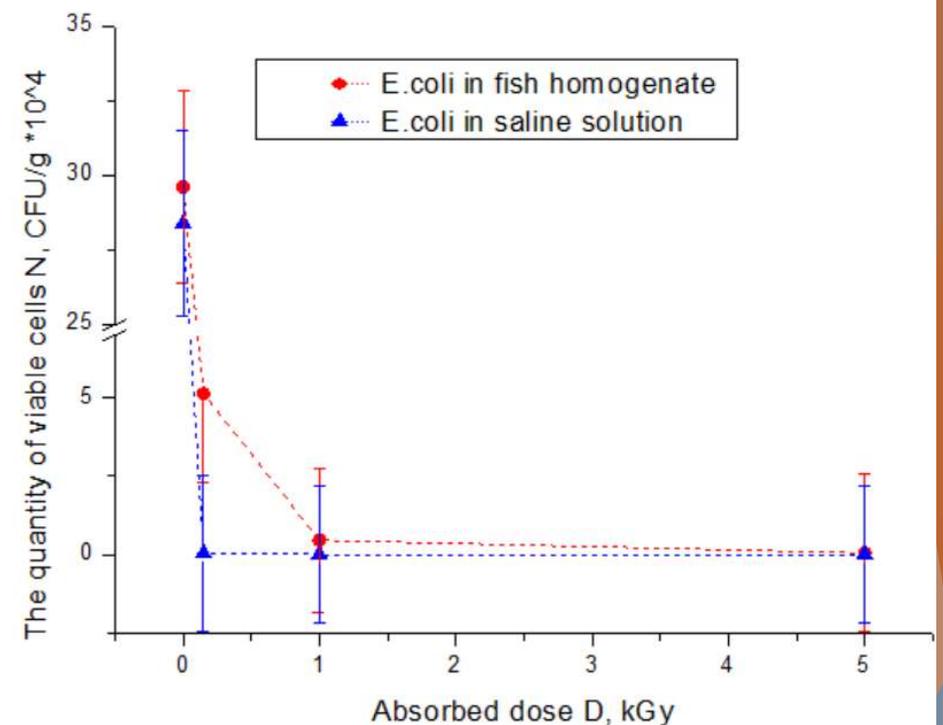


**Irradiation method**

# Escherichia Coli Survival Rate Bacteria in Various Environments



**Dependence of the quantity of viable cells in minced fish irradiated by various doses after irradiation**

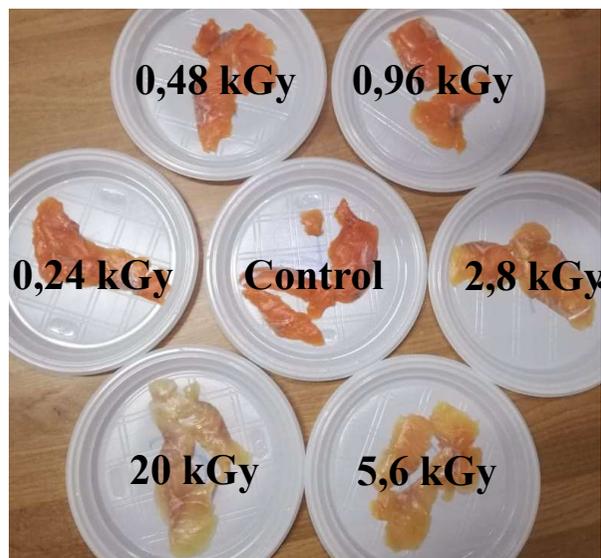


**Dependence of the quantity of viable cells in minced fish with E.coli and the E.coli in saline solution irradiated by various doses after irradiation**

# Organoleptic Parameters of Trout



Irradiation method



Trout samples

Dose, kGy	0 (control)	0,24	0,48	0,96	2,8	5,6	20
Radiochromic film							
The quantity of viable cells N, $1 \cdot 10^6$ CFU/g	0,053	0,051	0,0065	0,0016	0,0056	0,0002	-
Pieces trout after irradiation							
Colour	No change	No change	No change	A slight change	Change	A lot of change	A complete change
Smell	No change	A slight change	A slight change	Change	A lot of change	A complete change	A complete change
Taste	No change	No change	No change	Change	A lot of change	A complete change	A complete change

## Conclusion

1. It has been found that 1 MeV accelerated electron irradiation with the doses ranging from 0.24 kGy to 5.6 kGy reduces bacterial content in minced trout 100 times compared with non-irradiated samples after 15 days of storage.
2. Minced trout irradiated with 2.8 kGy and 5.6 kGy contains a lower number of viable cells within the hold period of storage to compare with non-irradiated samples. Total bacterial content under the given doses is within  $10^6$  CFU/g.
3. Samples irradiated with the doses ranging from 0.24 kGy to 0.96 kGy show fluctuations in total number of viable cells on the 8 to 11 days after irradiation. During day 8 to 11 the number of viable cells is higher than that in control samples.
4. Doses ranging from 0.96 kGy to 5.6 kGy change organoleptic parameters of chilled trout.
4. It has been found that *Escherichia Coli* survival rate in minced trout is higher than that in salt solution.

**THANK YOU FOR YOUR ATTENTION !**

