ICoMST
60th International Congress of Meat Science and Technology
URUGUAY | 2014

EFFECTS OF GAMMA IRRADIATION ON TRIMMING DESTINED TO ELABORATE BEEF HAMBURGERS AIMING AT PROVOKING MINIMAL CHANGES IN QUALITY ATTRIBUTES : MICROBIOLOGICAL, PHYSICOCHEMICAL AND SENSORY ASPECTS.

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LATU LABORATORIO TECNOLOGICO DEL URUGUAY

INTRODUCTION

MAIN DRIVERS

- Intensification of meat production worldwide
- Increase of land value
- Food safety and security concerns
- Commercialization standards
- Non thermal processes as a tool to preserve meats

OBJECTIVES

GENERAL OBJECTIVE

The objective of the present work was to assess the use of moderate doses of gamma irradiation (2 to 5 kGy) in bovine trimmings in order to reduce the risk of pathogen presence without altering its quality attributes, or the quality attributes of the patties prepared with this trimmings.

OBJECTIVES

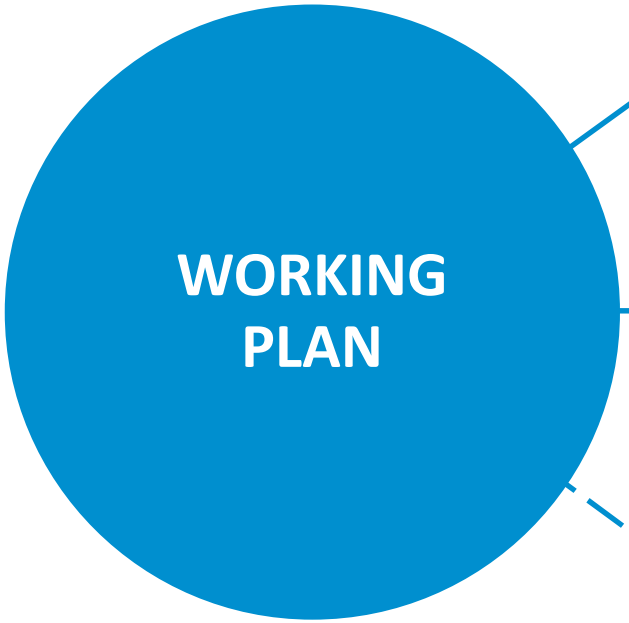
SPECIFIC OBJECTIVES

In particular moderate doses of irradiation (2 to 5 KGy) were used in order to:

- Evaluate irradiation as tool to mitigate the presence of pathogens using *Listeria monocytogenes* and *Escherichia coli* O157:H7 as markers inoculated into bovine trimmings samples.

- Reduce the microbial load without altering the quality attributes of bovine trimmings and of patties made of irradiated trimmings, including:
    - microbiological indicators during 30 days of storage (coliforms, *Pseudomonas* and mesophilic aerobics counts)
    - physicochemical indicators (pH, TBA and color) during a 180 day storage period at freezing temperatures.
    - sensory changes during a 180 day storage period at freezing temperatures.

MATERIALS AND METHODS



COLLECTION OF TRIMMINGS SAMPLES

Trimmings were otained at local packing plants. Trimmings samples were stored under refrigerating or freezing temperatures

MEAT QUALITY ATTRIBUTES

Study of quality attributes of irradiated trimmings

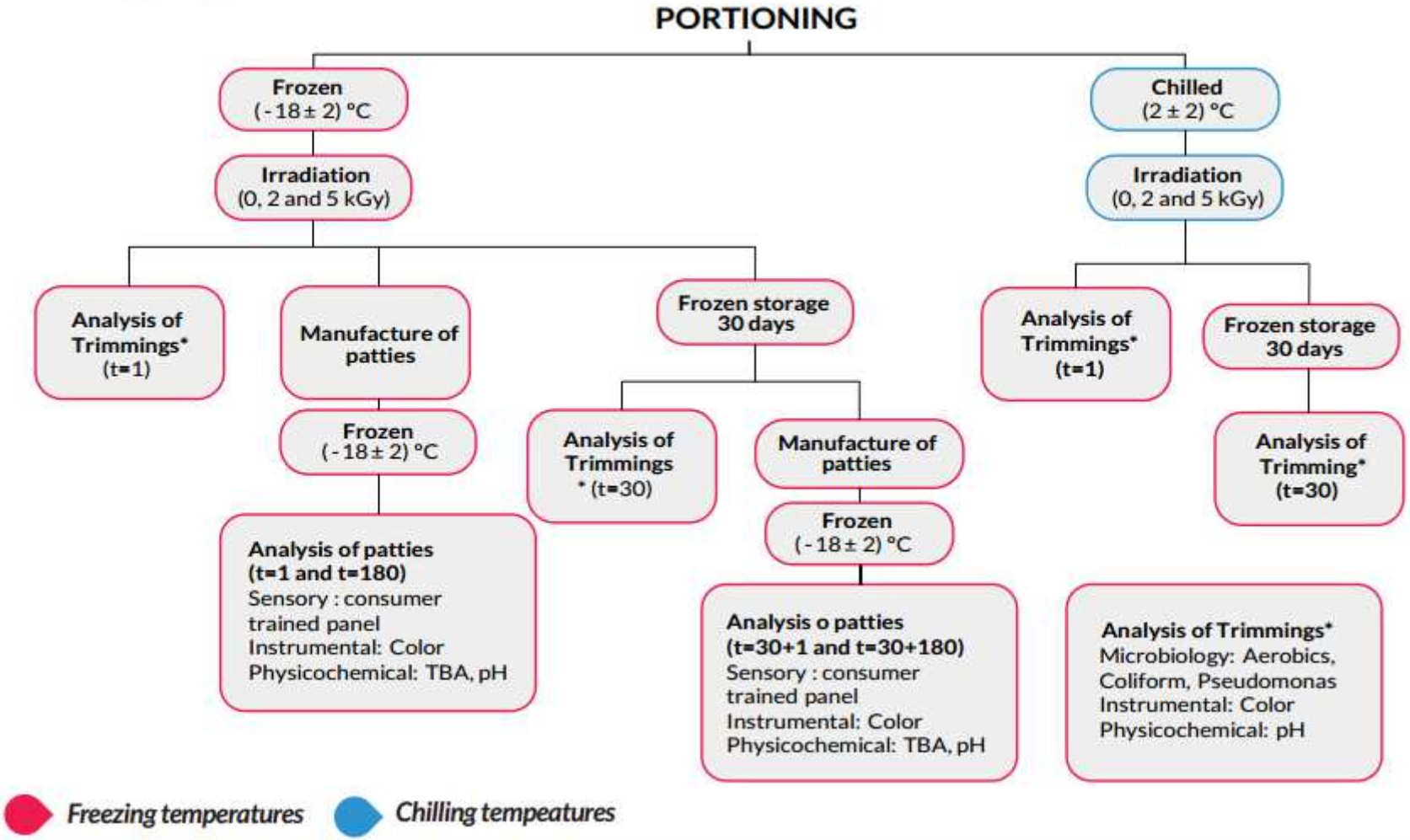
Study of quality attributes of patties made of fresh or aged irradiated trimmings and storage at freezing temperatures

PATHOGEN INACTIVATION

Study of inactivation of pathogenic cells inoculated into trimmings

MATERIALS AND METHODS

Meat Quality Attributes



MATERIALS AND METHODS



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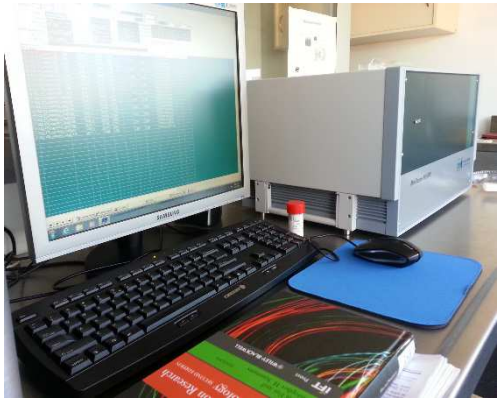
MATERIALS AND METHODS



LATU IRRADIATION PILOT PLANT:

- Modular Equipment EMI-9, dry shield, Buenos Aires, Argentina.
- Source: Cobalt-60; Mean dose rate: 20 kGy/h
- Measurement of absorbed irradiation: Alanine dose-meter EPR Spectrometer

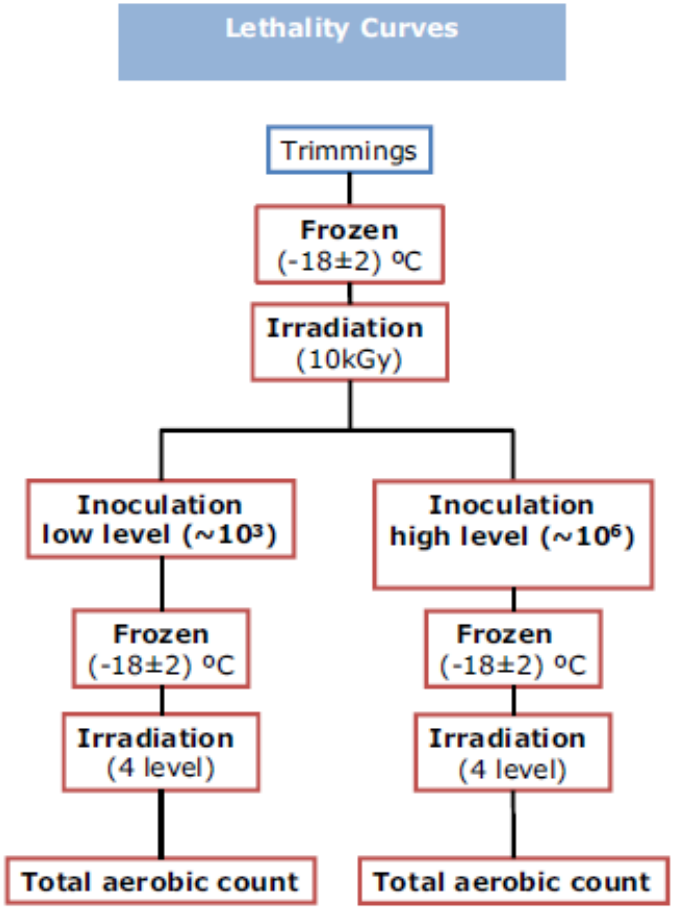
TARGET DOSE	2.5 kg bags	200 g bags
2 kGy (D1)	(2.2 – 3.1) kGy	(2.2-2.4) kGy
5 kGy (D2)	(4.6 – 5.5) kGy	(4.6-5.1) kGy

MATERIALS AND METHODS

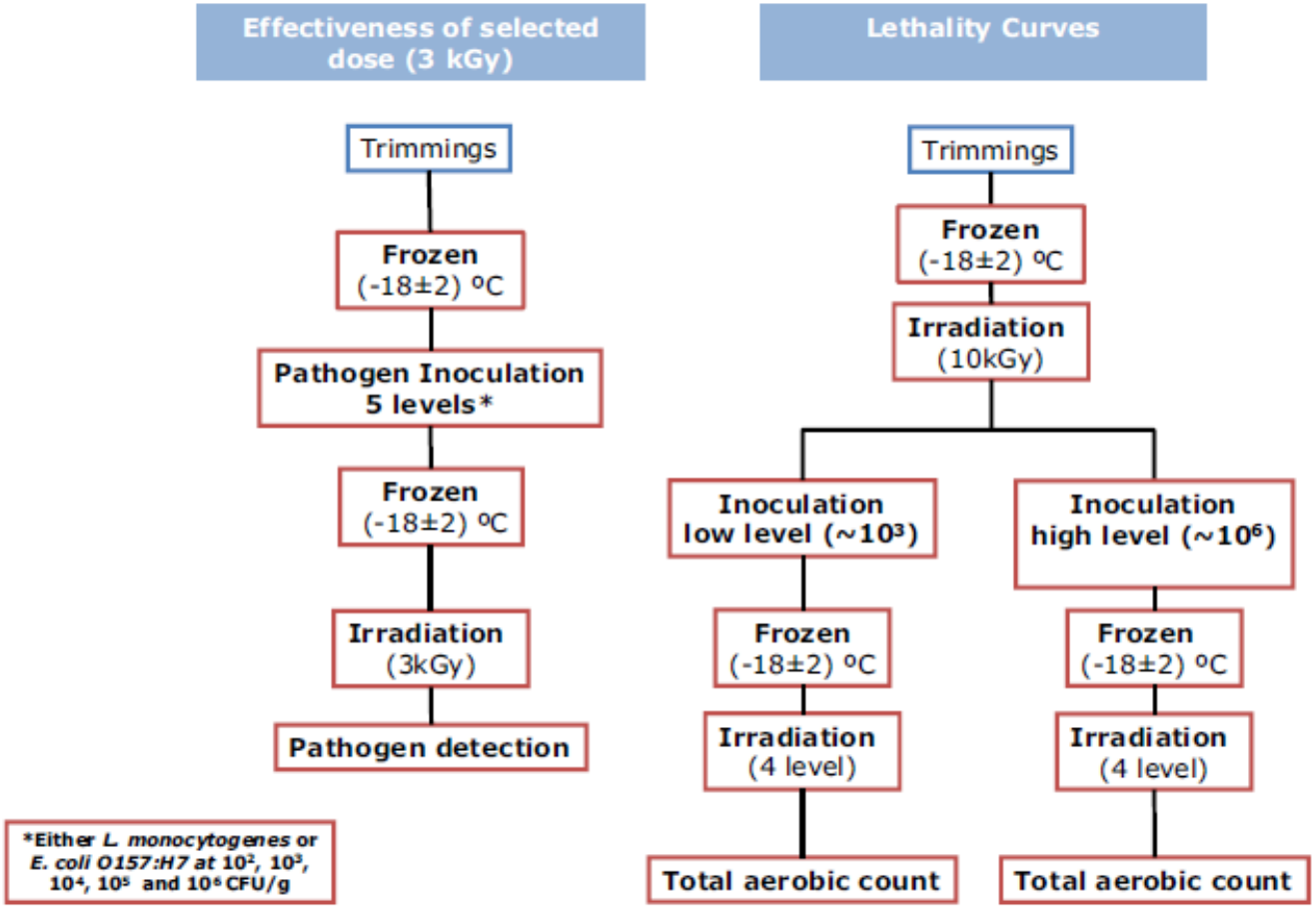
INOCULA:

- *Listeria monoctyogenes* ATCC19111
- *Escherichia coli* 0157:H7 NCTC12900

Inoculated samples were handled following Biosafety Class II protocols

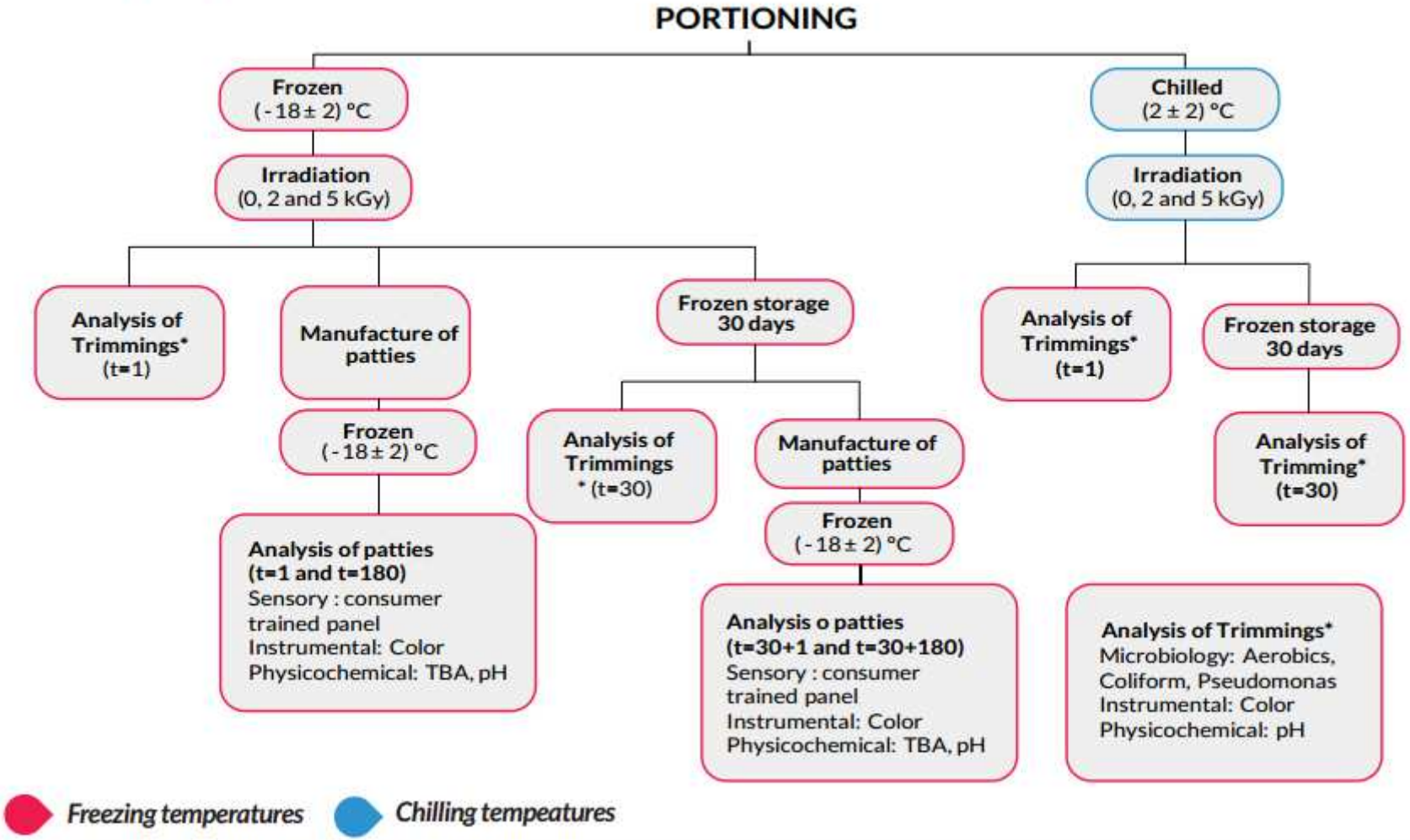


MATERIALS AND METHODS



RESULTS – MEAT QUALITY ATTRIBUTES

Meat Quality Attributes



RESULTS – MEAT QUALITY ATTRIBUTES

MICROBIOLOGICAL INDICATORS of TRIMMINGS:

	Ni (0kGy)				D1 (2kGy)				D2 (5kGy)			
	Chilled		Frozen		Chilled		Frozen		Chilled		Frozen	
	1d	30d	1d	30d	1d	30d	1d	30d	1d	30d	1d	30d
Total Aerobic log(cfu/g)	2,68[a]	2,54[a]	2,68[a]	2,72[a]	0.45[b]	<1	<1	<1	<1	<1	<1	<1
Pseudomonas log (cfu/g)	1,82[a]	1,18[b]	2,03[a]	1,11[b]	<1	<1	<1	<1	<1	<1	<1	<1
Coliforms (NMP/g)	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
E. coli (NMP/g)	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3

RESULTS – MEAT QUALITY ATTRIBUTES

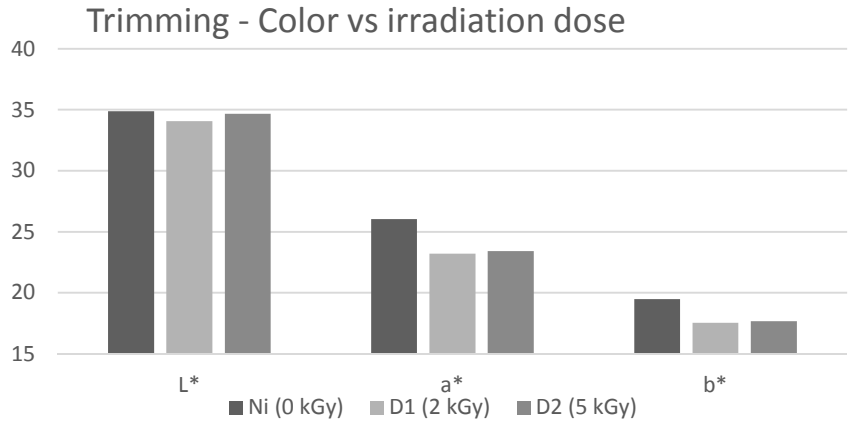
pH of TRIMMINGS

Irradiation Dose (kGy)			Storage time (days)		Irradiation temperature	
Ni	D1	D2	1	30	Chilled	Frozen
5,62[a]	5,61[a]	5,61[a]	5,60[a]	5,62[a]	5,63[a]	5,59[a]

pH mean values (n=5) on beef trimmings irradiated at Ni (0kGy), D1 (2 kGy) and D2 (5kGy) under chilling (2±2°C) or freezing (-18± 2°C) temperatures. Column mean values with the same superscript ([a]) do not differ (P >0.05).

RESULTS – MEAT QUALITY ATTRIBUTES

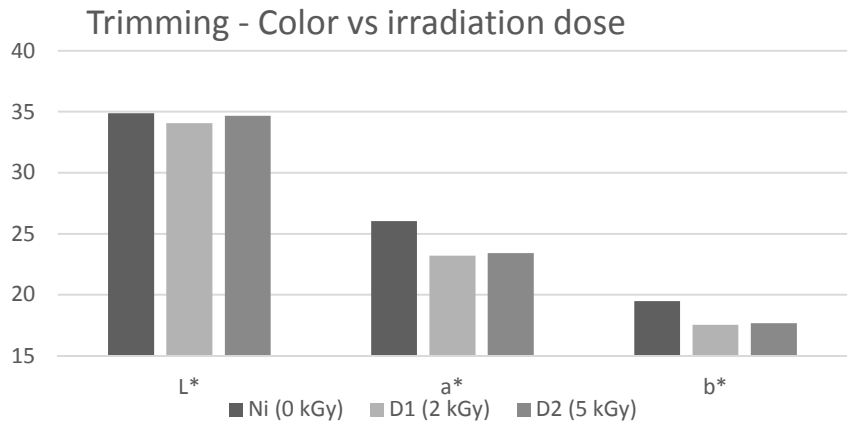
COLOR OF TRIMMINGS



	L*	a*	b*	Saturation index
Effect of irradiation dose				
(overall irradiation temperature and storage time)				
Ni (0 kGy)	34,89[a]	26,03[a]	19,47[a]	32,54[a]
D1 (2 kGy)	34,07[a]	23,20[b]	17,54[b]	29,12[b]
D2 (5 kGy)	34,66[a]	23,42[b]	17,66[b]	29,38[b]
Statistical significance	ns	***	***	***

RESULTS – MEAT QUALITY ATTRIBUTES

COLOR OF TRIMMINGS



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D2 (5 kGy)	34,66[a]	23,42[b]	17,66[b]	29,38[b]
Statistical significance	ns	***	***	***
Effect of storage time				
(overall irradiation dose and irradiation temperature)				
1 day storage	36,05[a]	24,66[a]	18,60[a]	30,92[a]
30 days storage	33,04[b]	23,77[a]	17,85[a]	29,77[b]
Statistical significance	***	*	ns	*

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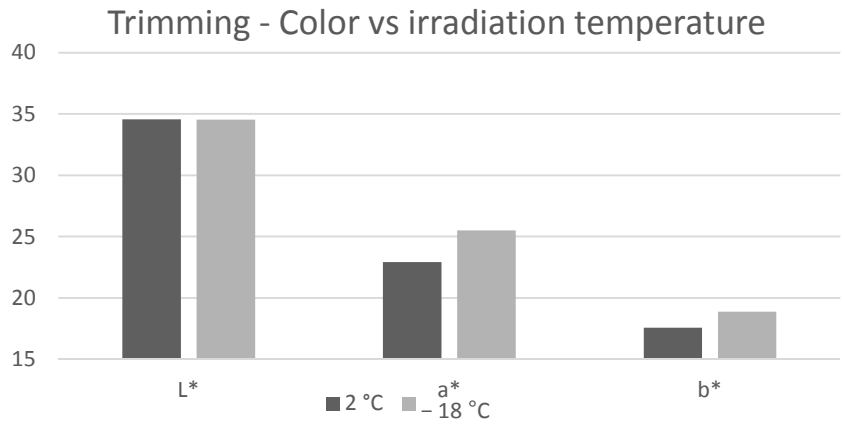
RESULTS – MEAT QUALITY ATTRIBUTES

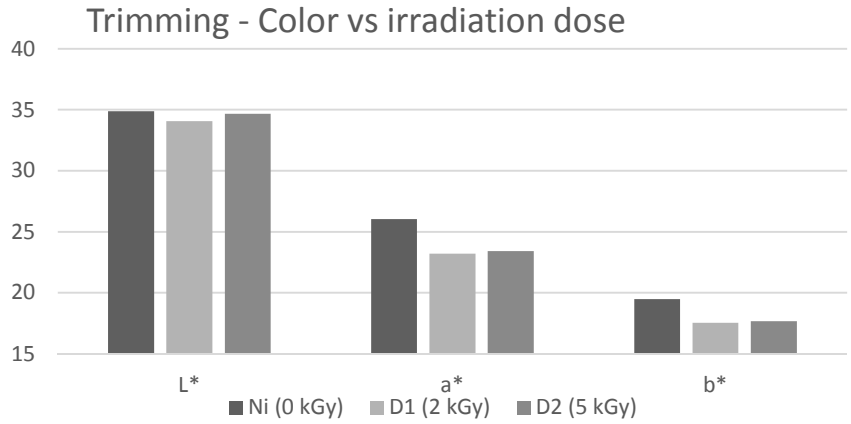
COLOR OF TRIMMINGS

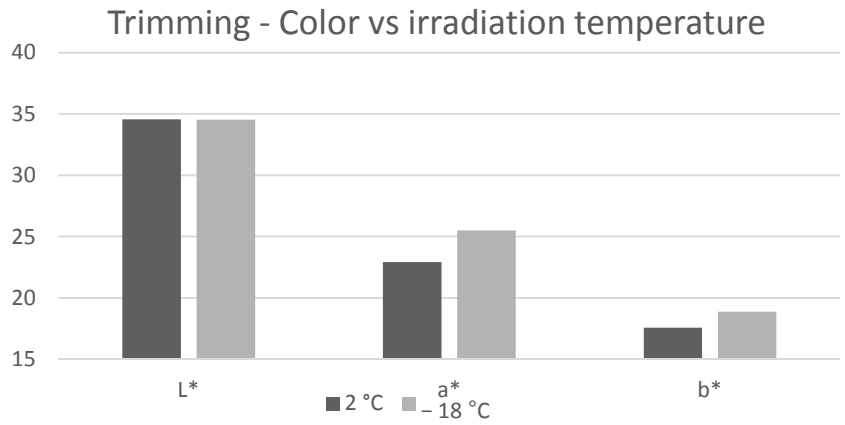


	L*	a*	b*	Saturation index
Effect of irradiation temperature				
(overall irradiation dose and storage time)				
2°C	34,56[a]	22,93[a]	17,56[a]	28,93[a]
-18°C	34,53[a]	25,50[b]	18,89[b]	31,76[b]
Statistical significance	ns	***	**	***

RESULTS – MEAT QUALITY ATTRIBUTES

COLOR OF TRIMMINGS





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Statistical significance	ns	***	**	***

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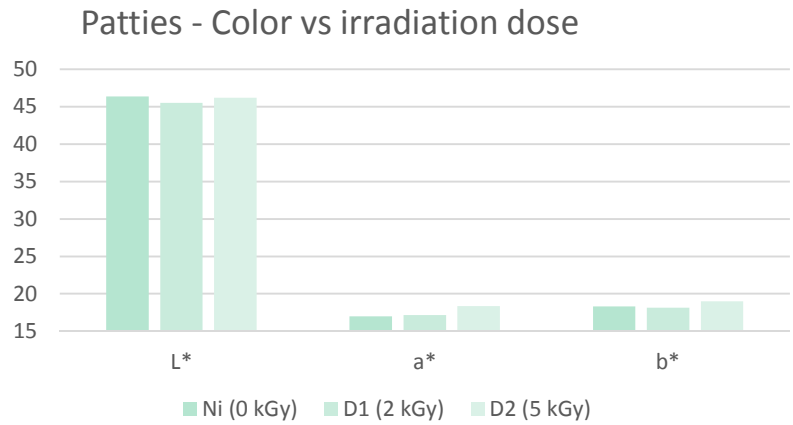
RESULTS – MEAT QUALITY ATTRIBUTES

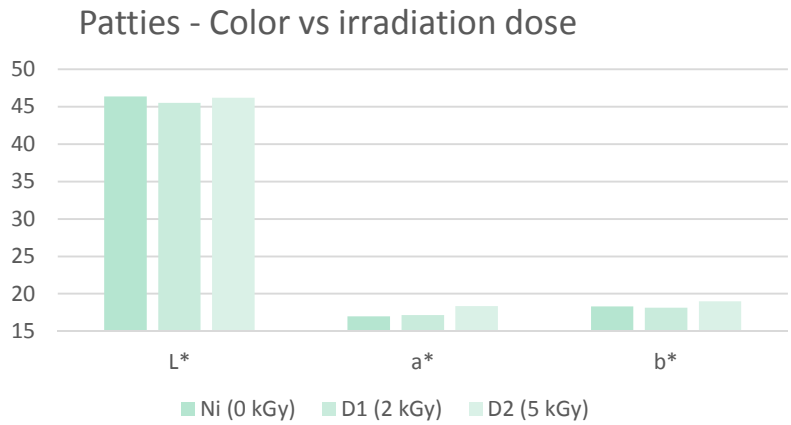
COLOR OF PATTIES



	L*	a*	b*	Saturation index
Effect of irradiation dose				
(overall trimmings age and storage time)				
Ni (0 kGy)	46,35[a]	17,00[a]	18,33[a]	25,05[a]
D1 (2 kGy)	45,49[a]	17,15[a]	18,14[a]	24,99[a]
D2 (5 kGy)	46,19[a]	18,36[a]	18,98[a]	26,44[a]
Statistical significance	ns	ns	ns	ns

RESULTS – MEAT QUALITY ATTRIBUTES

COLOR OF PATTIES



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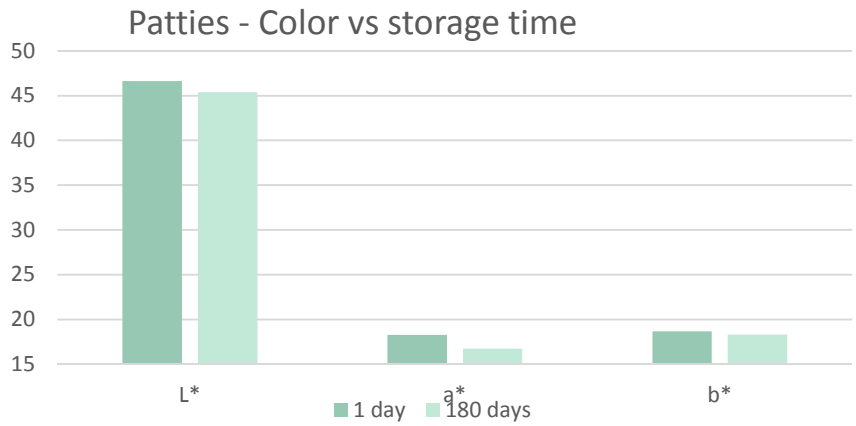
D2 (5 kGy)	46,19[a]	18,36[a]	18,98[a]	26,44[a]
Statistical significance	ns	ns	ns	ns
Effect of trimmings age before patty production				
(overall irradiation dose and storage time)				
1 day storage	44,86[a]	16,70[a]	18,07[a]	24,63[a]
30 days storage	47,15[b]	18,31[b]	18,90[b]	26,35[b]
Statistical significance	***	**	**	**

RESULTS – MEAT QUALITY ATTRIBUTES

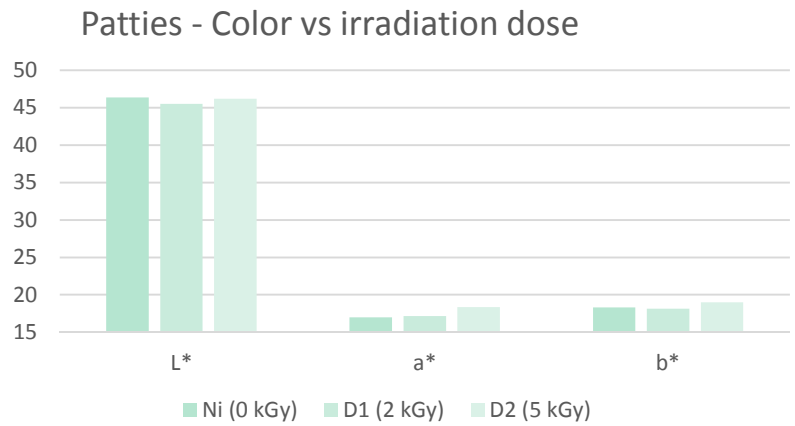
COLOR OF PATTIES

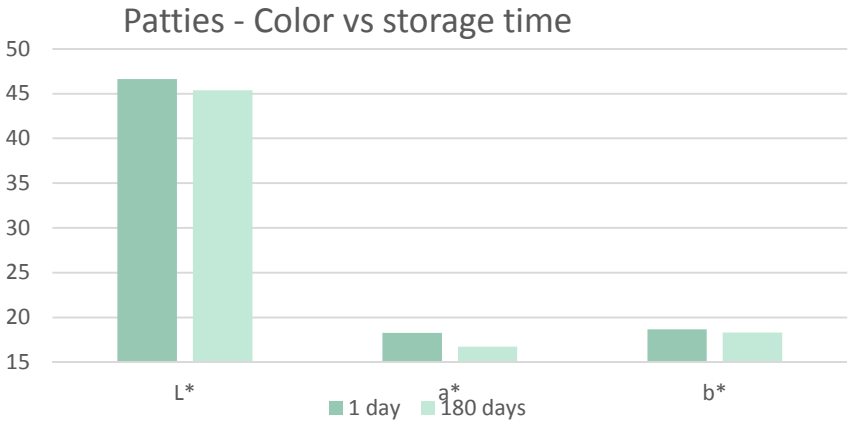


	L*	a*	b*	Saturation index
Effect of storage time				
(overall irradiation dose and trimmings age)				
1 day	46,64[a]	18,28[a]	18,65[a]	26,16[a]
180 days	45,37[b]	16,73[b]	18,31[a]	24,82[b]
Statistical significance	**	**	ns	*

RESULTS – MEAT QUALITY ATTRIBUTES

COLOR OF PATTIES





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Statistical significance	ns	ns	ns	ns
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Statistical significance	***	**	**	**
Effect of storage time				
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Statistical significance	**	**	ns	*

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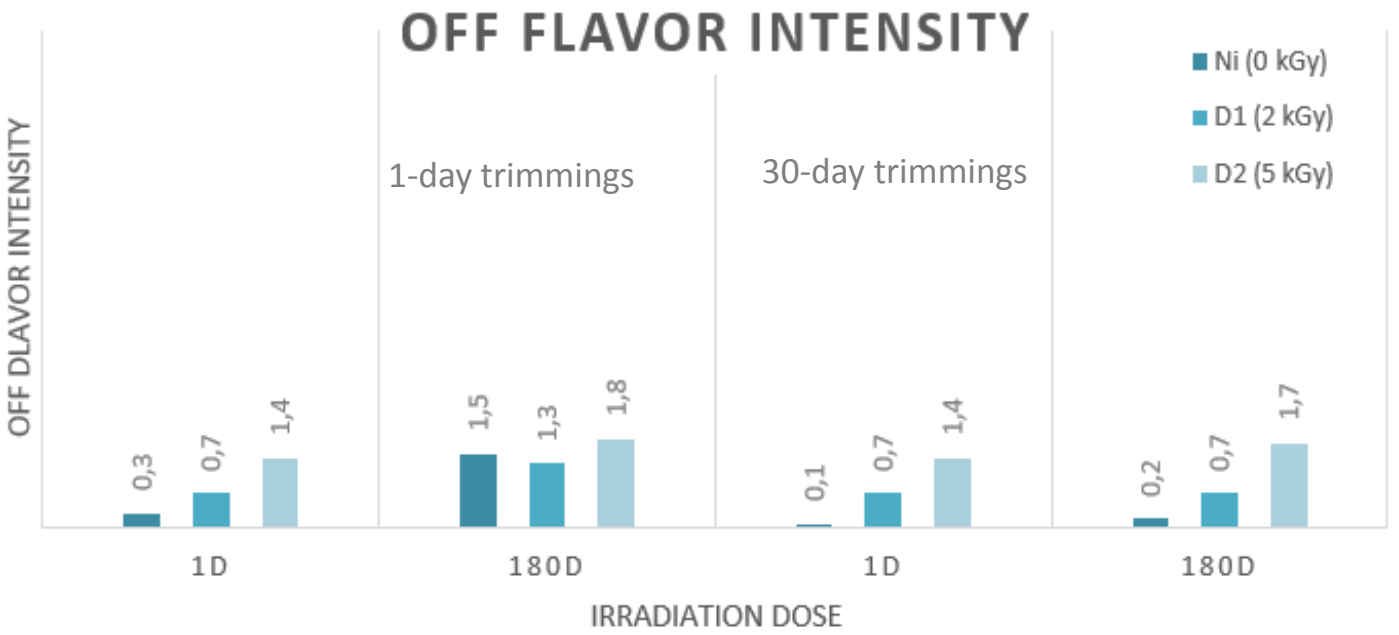
RESULTS – MEAT QUALITY ATTRIBUTES

TRAINED SENSORY PANNEL FOR PATTIES

SENSORY ATTRIBUTES	1 to 9 SCALE	SIGNIFICANCE
ODOR INTENSITY	5 – 6	ns
INITIAL TENDERNESS	0.3 – 1.4	ns
FINAL TENDERNESS	4.2 – 5.9	ns
INITIAL JUICINESS	4.7 – 5.8	ns
FINAL JUICINESS	4.2 – 5.7	ns
FLAVOR INTENSITY	5.0 – 6.2	ns

RESULTS – MEAT QUALITY ATTRIBUTES

TRAINED SENSORY PANNEL FOR PATTIES



Dose	1d	180d	1d	180d
Ni	0.3 ^{a,x}	1.5 ^{a,y}	0.1 ^{a,x}	0.2 ^{a,x}
D1	0.7 ^{a,b,x}	1.3 ^{a,x}	0.7 ^{a,b,x}	0.7 ^{a,b,x}
D2	1.4 ^{a,b,x}	1.8 ^{a,x}	1.4 ^{b,x}	1.7 ^{a,b,x}

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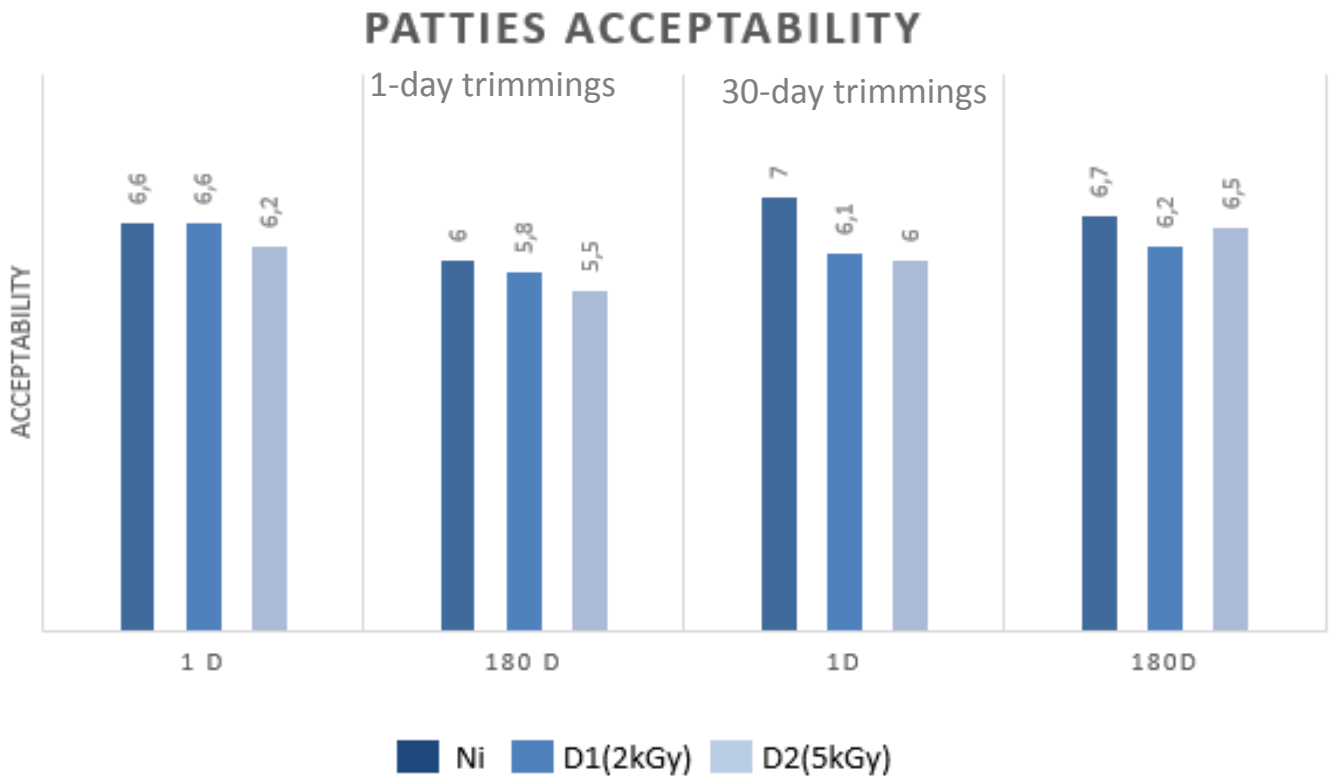
RESULTS – Meat quality attributes



	Acceptability			
	Fresh trimming		30 days aged trimming	
Dose	1 d	180 d	1d	180d
Ni	6.6 ^{a,x,y}	6.0 ^{a,y}	7.0 ^{a,x}	6.7 ^{a,x,y}
D1	6.6 ^{a,x}	5.8 ^{a,y}	6.1 ^{b,x,y}	6.2 ^{a,x,y}
D2	6.2 ^{a,x,y}	5.5 ^{a,y}	6.0 ^{b,x,y}	6.5 ^{a,x}

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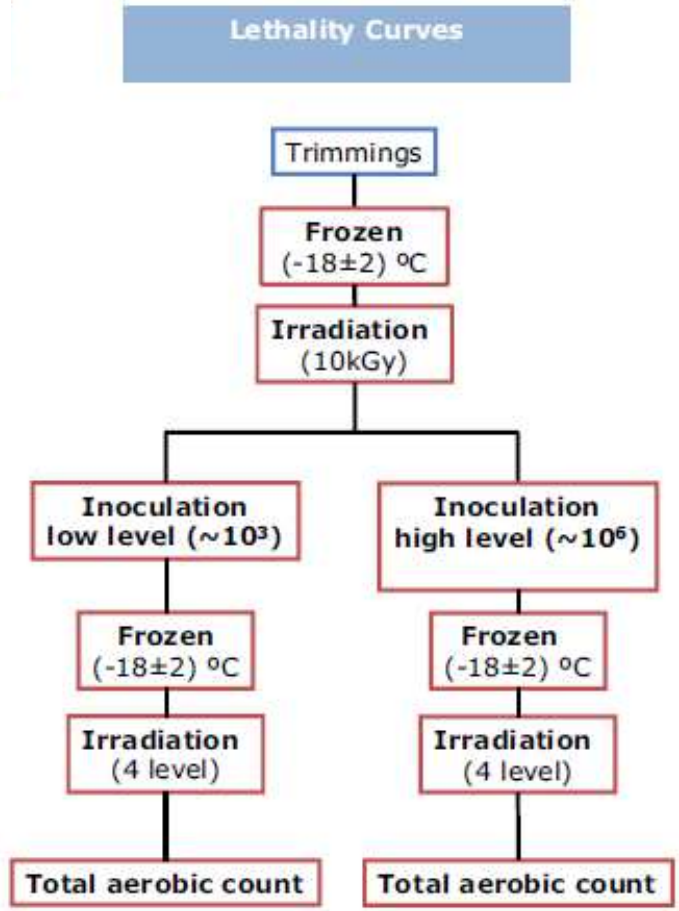
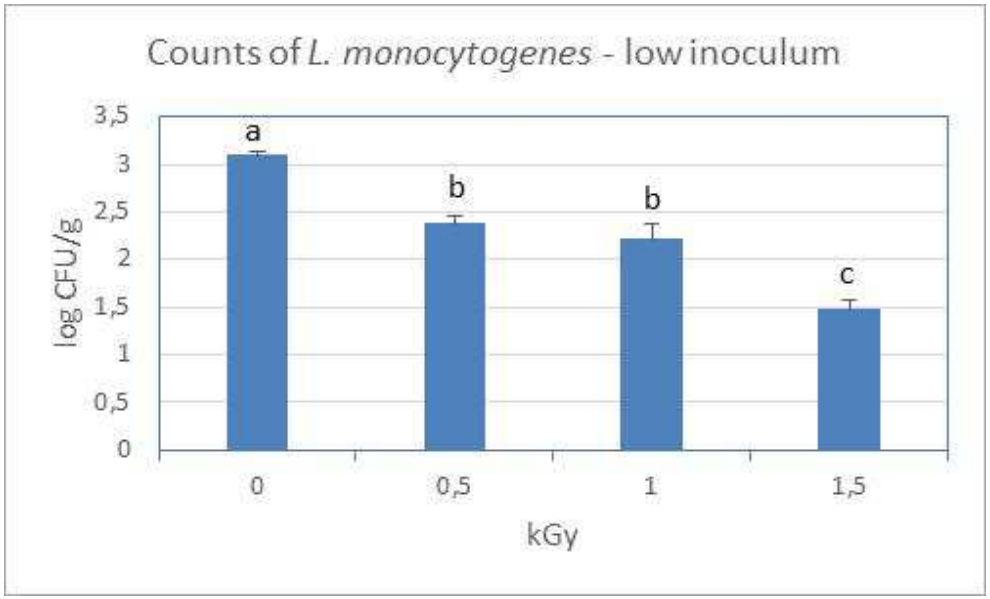
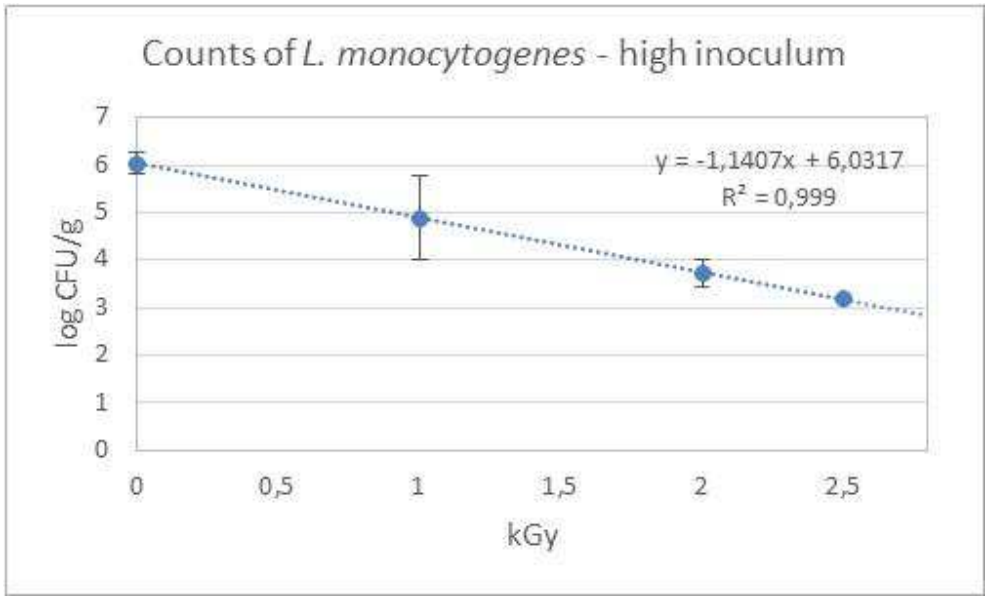
RESULTS - EFFECTS ON PATHOGENIC SURROGATES



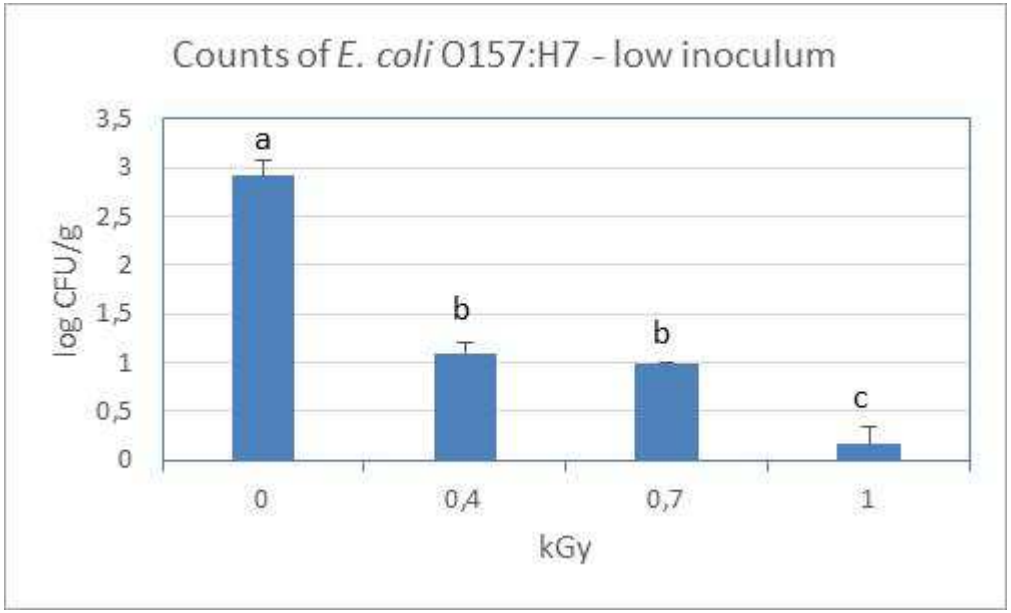
RESULTS - EFFECTS ON PATHOGENIC SURROGATES

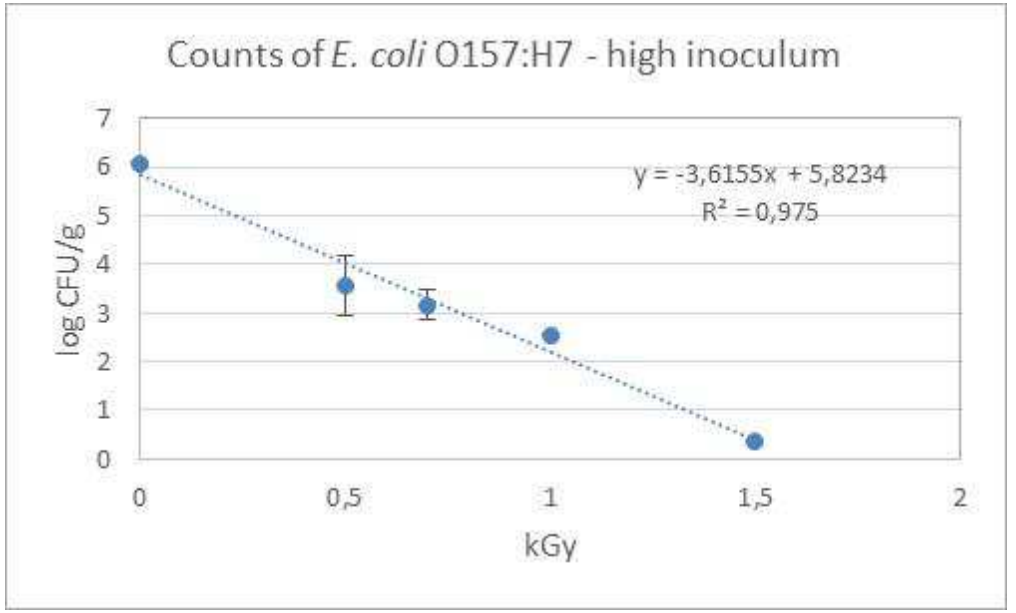




$D_{10} = 0.71$

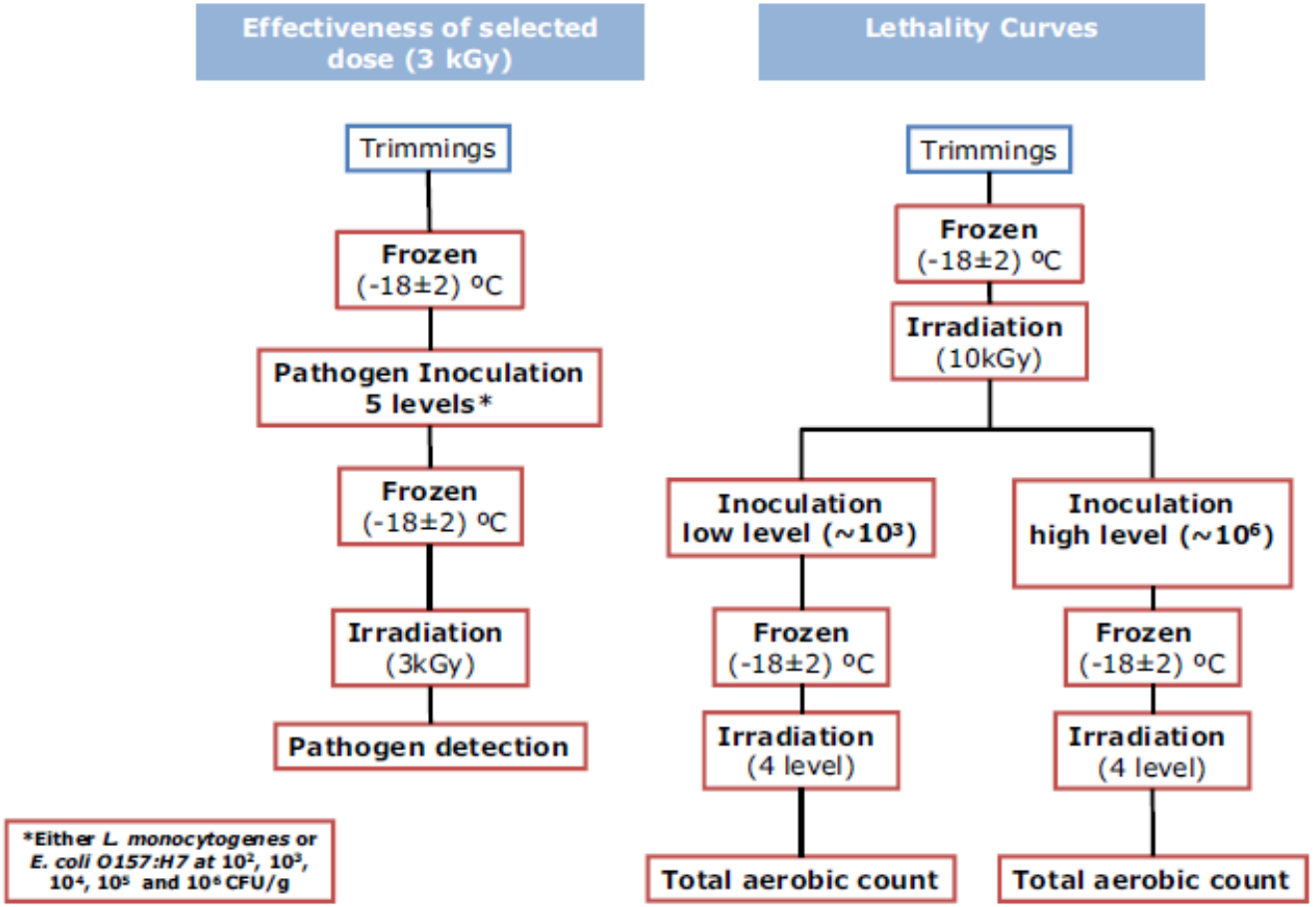
RESULTS - EFFECTS ON PATHOGENIC SURROGATES





D_{10} = 0.28

RESULTS - VALIDATION OF SELECTED DOSE



RESULTS - VALIDATION OF SELECTED DOSE

Dosis teórica de irradiación 3 kGY						
Listeria monocytogenes						
(UFC/g)	Replica 1	Curva	Replica 2	Curva	Replica 3	Curva
Blanco	-		-		-	
$3{,}3 \times 10^{1}$	-		-		+	
$3{,}3 \times 10^{2}$	-		+		+	
$3{,}3 \times 10^{3}$	+		+		+	
$3{,}3 \times 10^{4}$	+		+		+	
$3{,}3 \times 10^{5}$	+		+		+	

Dosis teórica de irradiación 3 kGY						
Escherichia Coli O157:H7						
(UFC/g)	Replica 1	Curva	Replica 2	Curva	Replica 3	Curva
Blanco	-		-		-	
$2{,}1 \times 10^{1}$	-		-		-	
$2{,}1 \times 10^{2}$	-		-		-	
$2{,}1 \times 10^{3}$	-		-		-	
$2{,}1 \times 10^{4}$	-		-		-	
$2{,}1 \times 10^{5}$	+		-		-	

Detection of *L. monocytogenes* and *E. coli* O157:H7 by PCR "BAX® System method after irradiation treatment (3 kGy): (−) not detectable (+) presence.

L. monocytogenes		*E. coli* O157:H7	
Inoculum (log cfu/g)	Presence	Inoculum (log cfu/g)	Presence
Control	-	Control	-
1.52	−	1.32	−
2.52	−	2.32	−
3.52	+	3.32	−
4.52	+	4.32	−
5.52	+	5.32	+

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CONCLUSIONS

- The results of meat quality attributes (pH, color, sensory analysis, *Pseudomonas* spp., coliforms and mesophilic counts) implies that irradiation may provide an alternative capable of decreasing the microbial load of meat products while slightly altering physicochemical and sensory properties of trimmings and patties.

- Provided that moderate gamma irradiation doses up to 2.5 KGy were used, at least reductions of 2 log cfu/g of *L.monocytogenes* and 5 log cfu/g of *E. coli* O157:H7 are achieved as deducted from lethality curves.

CONCLUSIONS

- It seems reasonable to suppose that irradiation can be successfully employed to achieve the safety of frozen trimmings when the initial load of pathogenic bacteria is not extremely high.

- This study has been carried out using beef trimmings, representing a huge share of the world trade market of meat destined to elaborate burgers or patties. The pathogenic reductions obtained in this work support the role of irradiation as a useful processing tool for increasing food safety and security of trimmings.

ACKNOWLEDGEMENTS

The authors want to thank the collaboration of the Irradiation Unit of LATU, through the National Committee of Irradiation (CNI) and the International Atomic Energy Agency (IAEA).

The authors also whish to to thank the contributions of Aníbal Abreu, Inés Martínez, Ronny Pelaggio, Jaqueline Cea and Rosana Reinares from LATU and of Pablo Formento and Nancy Denis from INAC.

PROJECT TEAM

THANK YOU!!

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