

28th Workshop on the Developments in the Italian Ph.D research
on Food Science, Technology and Biotechnology

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**Advancing in Process Analytical Technology:
e-sensing for food cold chain**

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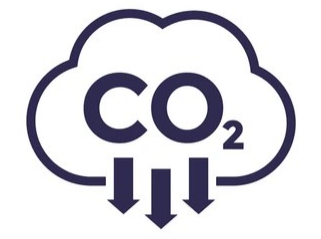
INTRODUCTION

The PhD research project focuses on **enhancing refrigeration technologies** within the food cold chain through the development of **Process Analytical Technology** approaches.

By targeting the optimization of **superchilling** in food processing and addressing **cold-induced damage** during storage, the project aims to improve the overall efficiency and effectiveness of food preservation methods. The study will involve analyzing physicochemical changes that occur during food transformation and conservation using both conventional targeted techniques and **untargeted techniques** combined with Chemometrics.

AIM OF THE PROJECT

Increase shelf life Reduce energy consumption and carbon footprint



Adopting innovative technologies in food processing for Industry 4.0



Retain high food quality Maintain food freshness

STATE OF THE ART

	PROBLEM	SOLUTION	POSSIBLE OUTCOMES
SUPER CHILLING [1]	Lack of online process monitoring	E-sensors	Multivariate control charts
CHILLING INJURY [3]	Lack of fast and non-destructive analysis	E-sensors	Suitable protocols to monitor and reduce injuries



Superchilling involves lowering the temperature of the foodstuff to 1-2 °C below its initial freezing point [6].

Chilling injury describe the physiological damage that occurs in many plants and plant products, because of their exposure to low temperatures [3].

PhD PROJECT DEVELOPMENT

LITERATURE SURVEY to overview of current knowledge, allowing you to identify relevant theories, methods, and gaps in the existing research.

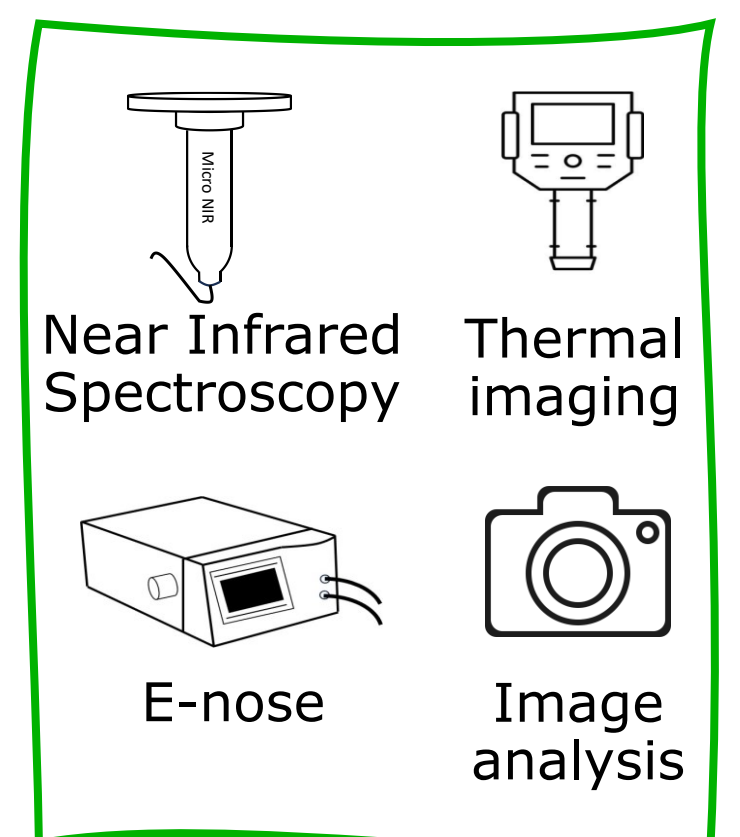
Activity	1st Year												2nd Year												3rd Year											
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
WP0) Literature survey	[Green cells indicating activity]																																			
1) Superchilling - meat	[Green cells indicating activity]																																			
2) Superchilling - potatoes	[Green cells indicating activity]																																			
3) Chilling injury - potatoes	[Green cells indicating activity]																																			
4) Chilling injury - kiwi	[Green cells indicating activity]																																			

SUPERCHILLING → Studying, by conventional approaches, of the main **process factors** affecting **product structure** and **enzymatic activity**. The fundamental knowledge will allow to develop and implement **statistical multivariate control charts**, based on untargeted approaches, to describe, monitor and optimise the process in real-time.

Activity	1st Year												2nd Year												3rd Year											
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
WP1) Superchilling - meat	[Green cells indicating activity]																																			
[4] 0) Trial test/DoE	[Green cells indicating activity]																																			
1) Meat processing	[Green cells indicating activity]																																			
2) Quality assessment	[Green cells indicating activity]																																			
3) Model development	[Green cells indicating activity]																																			
WP2) Superchilling - potatoes	[Green cells indicating activity]																																			
[7] 0) Trial test/DoE	[Green cells indicating activity]																																			
1) Potatoes processing	[Green cells indicating activity]																																			
2) Quality assessment	[Green cells indicating activity]																																			
3) Model development	[Green cells indicating activity]																																			

- Total Volatile Basic Nitrogen
- Lipid oxidation
- Drip loss
- Water holding capacity

- Total viable count
- Psychrophilic plate count



- Enzymatic activity

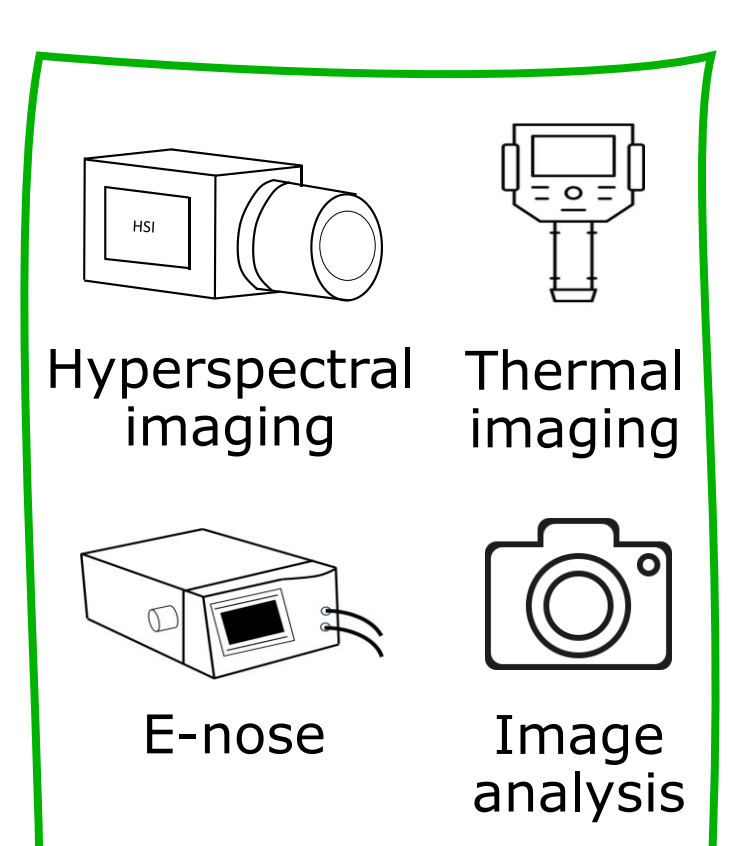
- Texture analyses

CHILLING INJURY → Development of protocols to monitor and reduce damage, and to study the process factors effecting cell structure, enzymatic activity, and oxidative stress by conventional and untargeted approaches, thus improving cold chain management and real-time quality control.

Activity	1st Year												2nd Year												3rd Year											
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
WP3) Chilling injury - potatoes	[Green cells indicating activity]																																			
[5] 0) Trial test/DoE	[Green cells indicating activity]																																			
1) Potatoes collection	[Green cells indicating activity]																																			
2) Chilling injury assessment	[Green cells indicating activity]																																			
3) Model development	[Green cells indicating activity]																																			
WP4) Chilling injury - kiwi	[Green cells indicating activity]																																			
[2] 0) Trial test/DoE	[Green cells indicating activity]																																			
1) Kiwi collection	[Green cells indicating activity]																																			
2) Chilling injury assessment	[Green cells indicating activity]																																			
3) Model development	[Green cells indicating activity]																																			

- Total acidity
- Total phenolic content
- DPPH
- Malondialdehyde
- Weight loss

- Total viable count
- Psychrophilic total plate count



- Stress-related enzyme activity

- Texture analyses

DISSEMINATION → Preparation of scientific manuscripts to be shared with the scientific community and presentation of the relevant results at national and international conferences.

Activity	1st Year												2nd Year												3rd Year											
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
WP5) Thesis and Paper Preparation	[Green cells indicating activity]																																			
1) Scientific manuscripts	[Green cells indicating activity]																																			
2) Conference attendance	[Green cells indicating activity]																																			
3) Thesis preparation	[Green cells indicating activity]																																			

SELECTED REFERENCES

[1] Banerjee, R., & Maheswarappa, N. B. (2019). *Critical reviews in food science and nutrition*, 59(8), 1256-1263; [2] Gao, M. et al. (2021). *Postharvest Biology and Technology*, 172, 111385; [3] Jackman, R. L. et al. (1988). *Journal of food quality*, 11(4), 253-278; [4] Lee, H. J. et al. (2023). *Meat Science*, 199, 109137; [5] López-Maestresalas, A. et al. (2016). *Food control*, 70, 229-241; [6] Magnussen, O. M. et al. (2008). *Trends in Food Science & Technology*, 19(8), 418-424; [7] Rady, A. M., & Guyer, D. E. (2015). *Computers and electronics in agriculture*, 117, 31-48.