**From research to business: Technology transfer models in the field of Food Science**

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This PhD thesis project is aimed at the implementation of a model for the scale-up of food innovative solutions proposed by research, on a scale closer to the industrial one. Food prototypes developed at laboratory level (Technology Readiness Level, TRL 2-3), will be validated and designed at the industrial level (TRL 5-6). The project issues are in line with the mission 4 component 2 “M4C2” purpose of the National Recovery Plan and Resilience document, that provide to support investments in research and development, to promote innovations and their transfer to the food companies.

**Dalla ricerca all’impresa: Modelli di trasferimento tecnologico in ambito Food Science**

Questo progetto di tesi di dottorato mira alla realizzazione di un modello di scale-up industriale applicabile in ambito food science. In particolare, le soluzioni innovative proposte e sviluppate dalla ricerca, su scala laboratoriale (Technology Readiness Level, TRL 2-3), verranno convalidate in scala più vicina a quella industriale, (TRL 5-6), in linea con l’obiettivo M4C2 del documento Piano Nazionale Ripresa e Resilienza Italia. In quest’ultimo, infatti, la missione 4 e componente 2, prevedono di sostenere gli investimenti in ricerca e sviluppo, di promuovere l’innovazione e la diffusione delle tecnologie, di rafforzare le competenze, favorendo la transizione verso una economia basata sulla conoscenza.

1. **State-of-the-Art**

Food firms are one the most important manufacturing industries of the world. However, the food manufacturing and technology sector has typically been regarded as “low tech”, lacking in innovative capacity. Despite this aspect, food firms are increasingly open to innovation practices, driven mostly by the changes in consumers’ needs. Modern consumers, in fact, express different dietary needs, tastes and preferences compared to the past. In recent decades, consumers have shown greater attention to the environment, aware that human health cannot be separated from environmental health (Lusk et al., 2017). Moreover, there is also a greater focus on nutrition and its effect on consumer wellness (De Canio et al., 2021). As a result, consumers’ demand for food that is sustainably produced, healthy, free of chemical additives and with a longer shelf-life is increasing (Li et al., 2021). Often, new ideas are generated by universities, which are the engine of innovations. Outputs of innovation are represented by new processes, products, and markets, that are developed in a scale, the laboratory scale, often far from the real industrial scale. The technology transfer of the innovation, which is defined as the process of transforming research findings into viable outputs that can be commercialized, is the weak point of the process. Gachanja (2023) showed that technology transfer from universities to food firms is fundamental to achieve innovation. As a result, universities and food industries should cooperate, overcoming divergent attitudes between them and also, the SDGs mentioned technology transfer as a significant process to achieve sustainable development (Corsi et al., 2020).

In this context, the aim of this doctorate project, partially (50%) funded by the company Matarrese srl, sited in Alberobello (Bari, Apulia, Italy) will be the implementation of a model for the scale-up of food innovative solutions proposed by research, on a scale closer to the industrial one. Food prototypes developed at laboratory level (Technology Readiness Level, TRL 2-3), by the department of the Food science and technology Unit of the University of Bari Aldo Moro in collaboration with international research partners, will be validated and designed at the industrial level (TRL 5-6) in collaboration with Matarrese srl. The design and transfer model will be developed and applied both for meat-based products (low fat burgers with shelf-life extended) and vegetable-based ones (fresh pasta enhanced with free and microencapsulated olive pomace extracts and bakery products obtained by unconventional ingredients, such as legume flours and protein concentrate and acorn flours).

1. **PhD Thesis Objectives and Milestones**

Within the overall objective mentioned above this PhD thesis project can be subdivided into the following work packages and activities according to the Gantt diagram given in Table 1:

A0) **Bibliographic research**

**WP1: Development and scale-up of meat products with improved nutritional characteristics**

A1.1- Design of low-fat burgers with extended shelf-life and characterization

A1.2 - Industrial scale-up of production processes and consumers acceptability tests

**WP2: Development and scale-up for innovative vegetable products**

**A2.1 Scale-up of innovative formulations of gluten-free and gluten content flat bread:**

A2.1.1 Scale up of products already developed in laboratory scale

A2.1.2 Assessment of consumer acceptability of gluten free and gluten content flat bread

**A2.2: Scale-up of fresh pasta enhanced with vegetable by-products:**

A2.2.1: Scale up of fresh pasta (already developed in laboratory scale) enhanced with free and microencapsulated olive pomace extract.

**A2.3 - Valorization of acorn flour for food use- this activity will include:**

A2.3.1 - Sampling and characterization of acorn flours

A2.3.2 - Evaluation of primary and secondary shelf-life of acorn meal

A2.3.3 - Development of laboratory-scale prototypes of bakery products with acorn flours and characterizzation

A2.3.4 - Scale up of products and assessment of consumer acceptability

**A3-Writing and Editing** of the PhD thesis, scientific papers and oral and/or poster communications.

***Table 1***Gantt diagram for this PhD thesis project.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Activity Months | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** | **24** | |
| A0) | **Bibliographic research** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
| **WP1** | **Development and scale-up of meat products with improved nutritional characteristics** | | | | | | | | | | | | | | | | | | | | | | | | | |
|  | A1.1- Performance of laboratory tests and qualitative characterization of products |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
|  | A1.2-Industrial scale-up of production processes |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
| **WP2** | **Development and scale-up for innovative plant products** | | | | | | | | | | | | | | | | | | | | | | | | |  |
|  | **A2.1-Development and scale-up of innovative formulations of gluten-free and gluten content flat bread** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
|  | Scale up of products already developed in laboratory scale |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
|  | Assessment of consumer acceptability of gluten free and gluten content flat bread |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
|  | **A2.2 - Scale-up of fresh pasta enhanced with vegetable by-products** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
|  | Scale up of fresh pasta enhanced with free and microencapsulated olive pomace extract |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
|  | **A2.3 - Valorization of acorn flour for food use** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
|  | Sampling and characterization of acorn flours |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
|  | Evaluation of primary and secondary shelf-life of acorn meal |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
|  | Development of laboratory-scale prototypes of bakery products with acorn flours and characterizzation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
|  | Scale up of products and assessment of consumer acceptability |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
| **A3** | **Writing and Editing** of the PhD thesis, scientific papers and oral and/or poster communications. |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |

1. **Selected References**

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