**Technological treatments to obtain high-quality food production**

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This PhD thesis project aims to evaluate different technological treatments, useful for the reduction of the degradative phenomena that occur as a result of food processing. In particular, vegetable products will be subjected to chemical (e.g.natural antioxidants) and physical pretreatments (impregnation assisted by different systems) and then subjected to stabilization treatments. The efficacy of different operations will be evaluated through physicochemical, microbiological and antioxidant analysis in order to establish the best one to obtain a final product with excellent characteristics in terms of quality and shelf life.

Trattamenti tecnologici per ottenere una produzione alimentare di alta qualità

Questo progetto di tesi di dottorato ha lo scopo di valutare differenti trattamenti tecnologi, utili alla riduzione dei fenomeni degradativi che avvengono in seguito alla trasformazione degli alimenti. Nello specifico, alimenti di origine vegetale verranno sottoposti a pretrattamenti di natura chimica (es. antiossidanti naturali) e fisica (impregnazione coadiuvata da differenti sistemi) e successivamente sottoposti a trattamenti di stabilizzazione. L’efficacia dei diversi trattamenti verrà valutata attraverso analisi chimico-fisiche, microbiologiche ed antiossidanti al fine di stabilire il miglior trattamento che consenta di ottenere un prodotto finale con ottime caratteristiche dal punto di vista qualitativo e di durata di conservazione.

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

The food processing and preservation concept has changed during the time, indeed, the initial aim was to obtain food products with a long shelf-life and innocuous for the human health, while today are required foods safety and characterized by a high content of nutrients and antioxidants. Particularly, the modern consumers are increasingly focused to purchase minimally processed fruits and vegetables, characterized by some aspects such as: health properties, convenience of use, high nutrition properties, extended maintenance of freshness. This has led to an intensification of research investment relatively to the development of alternative technique to extend the shelf life of this products and to maintain the nutritional properties.

One of the most important problems for this category of food products is represented by the more rapidly deteriorate than unprocessed raw materials, mainly because of damage caused by minimal processing methods. This implies that the shelf life of fresh cut fruits and vegetables has a decay and a series of typical symptoms, such as softening of the tissues, surface burnishing of the cut, decrease in nutritional value, presence of off taste and microbiological deterioration during storage ([Ma](https://www.sciencedirect.com/science/article/pii/S0924224421001321?casa_token=WR06Ak5glrgAAAAA:YxualoL-bk34hoag4J6qt8wgf08_0mIaVgTf3wmmOgEejURKIBv1hO97UUjvubJrrqP9tl8zCw" \l "bib61) *[et al](https://www.sciencedirect.com/science/article/pii/S0924224421001321?casa_token=WR06Ak5glrgAAAAA:YxualoL-bk34hoag4J6qt8wgf08_0mIaVgTf3wmmOgEejURKIBv1hO97UUjvubJrrqP9tl8zCw" \l "bib61)*[., 2017](https://www.sciencedirect.com/science/article/pii/S0924224421001321?casa_token=WR06Ak5glrgAAAAA:YxualoL-bk34hoag4J6qt8wgf08_0mIaVgTf3wmmOgEejURKIBv1hO97UUjvubJrrqP9tl8zCw" \l "bib61)). The application of technological treatments may be useful in overcoming this problem. Among the various emerging technologies used for treatments on food products in order to obtain safe products and with a higher quality we can mention the non-thermal treatments (NTT) the use of these treatments, in particular, has increased in recent decades (Morales-de la Peña *et al*., 2019); advantages over conventional heat treatments are as many as short processing times, greater process efficiency and better product quality, preventing colour, flavour and nutritional value alterations of vegetable products (Osae *et al*., 2020).

In addition, another very important aspect useful also to meet the needs of the consumer, is the use of natural preservatives, to replace the most critical synthetic additives that are used in the food system to extend food storage. These natural antioxidants can be obtained also by waste and/or by-products produced by agrifood companies. Wastes represent a resource of bioactive compounds such as polyphenols, essential oils, pigments, organic acids and functional additives, that after their recovery may be re-entered in the food system. These combined with technological treatments can greatly extend the shelf life of food and increase quality parameters. For example, with vacuum impregnation it is possible to obtain a product enriched from the nutritional point of view (Panayampadan *et al*., 2022). Different compounds (eg. nutritional and functional compounds, antimicrobial and antioxidant substances, organic acids and so on) can be introduced into the food and on the basis of type of compound chosen for impregnation, the final product will be characterized by better quality and greater shelf life (Tappi *et al*., 2016).

The following project will consider vegetable products in order to preserve and improve nutritional quality and extend shelf life. The addition of biomolecules inside food matrices, or their use for the realization of minimally processed fortified products, could bring improvements in the food industry, both as regards research through the extension of the shelf-life and to develop alternative techniques to minimise product quality losses after heat treatments.

Today is growing social attention to environmental issues that affect the excessive production of waste by agri-food industries. Therefore, food enrichment with bioactive compounds recovered from by-products and the possible related increased shelf-life could reduce this environmental impact.

# **2. PhD Thesis Objectives and Milestones**

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

A1) **Application of pre-treatments:** evaluation of different pre-treatments (eg. vacuum impregnation with natural antioxidants, dipping in different solutions) (A1.1) application of pre-treatments on vegetable products and evaluation of physicochemical parameters (A1.2).

A2) **Stabilization/transformation treatments:** different types of cooking (eg. vacuum drying, semi drying, frying) (A2.1) evaluation of different conditions (time, temperature) and physicochemical parameters (A2.2).

A3) **Evaluation of shelf life**: evaluation of shelf life by physicochemical, microbiological analysis, sensorial and structural evaluation (A3.1).

A4) **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** |
| A1) | ***Application of pre-treatments*** |   |   |   |  |  |  |  |   |   |  |  |  |  |   |  |  |  |  |   |   |  |  |  |  |
|  | 1) Evaluation ofdifferent pre-treatments  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 2) Application of pre-treatments on vegetable products |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| A2) | ***Application of stabilization/transformation treatments***  |   |   |   |  |  |  |  |   |   |  |  |  |  |   |   |   |  |   |   |   |  |  |  |  |
|  | 1) Different types of cooking |   |   |   |  |  |  |  |   |   |  |  |  |  |   |   |  |  |  |   |   |  |  |  |  |
|  | 2) Different conditions |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| A3) | ***Evaluation of shelf life*** |   |  |   |  |  |   |   |   |   |  |  |   |   |   |  |  |  |  |   |   |  |  |   |   |
|  | 1) Analysis during storage |   |  |   |  |  |   |   |   |   |  |  |   |   |   |  |  |  |  |   |   |  |  |   |   |
| A4) | ***Thesis and Paper Preparation*** |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |   |   |   |   |   |   |   |

# **3. Selected References**

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