**Development of a “foodomics” platform for monitoring the transformation process of aromatic plants for the food industry**

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Herbal plants find large use in the food industry for providing aroma to semi processed and processed food products. The aroma quality and quantity in the ingredient is function of multiple factors including the time of harvesting, the age of the plant and the condition of transformation. The present project aims at developing a multi-analytical model for characterizing at molecular level of herbal plants, using basil’s leaves as the model, at different steps from farm to consumer. The multi-omic approach will help identifying qualitative markers for maximizing the aromatic traits of herbal plants.

**Sviluppo di una piattaforma “foodomics” per il monitoraggio del processo di trasformazione alimentare delle erbe aromatiche**

Le piante erbacee trovano ampio impiego nell'industria alimentare per fornire aroma a prodotti alimentari semilavorati e lavorati. La qualità e la quantità dell'aroma nell'ingrediente è funzione di molteplici fattori, tra cui il momento della raccolta, l'età della pianta e lo stato di trasformazione. Il presente progetto mira a sviluppare un modello multi-analitico per la caratterizzazione a livello molecolare di piante erbacee, utilizzando le foglie di basilico come modello, in diverse fasi dall'azienda agricola al consumatore. L'approccio multi-omico aiuterà a identificare marcatori qualitativi per massimizzare i tratti aromatici delle piante erbacee.

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

Aromatic plants, known also as “herbs and spices”, find large application in the food industry as a source of uniquearoma and taste and in the production of functional foods, taking advantage of their bioactive compounds (bactericidal, anti-oxidative, fungicidal).

Plants belonging to the Lamiaceae family are particularly intriguing because of their natural ability to produce and accumulate "essential oils." Basil (*Ocimum basilicum* L.) plays a crucial role in Mediterranean cuisine because ofits distinctive aromas. It is also considered a notable herb, with researchers studying its genotypic characteristics and the effects of consecutive harvests on the phenolic acids and aromatic profile (Ciriello et al., 2021). Basil leaves are widely used in preparing pesto and as a seasoning for fresh or semi-prepared dishes. The basil essential oils are synthesized in specialized leaf epidermal outgrowths called glandular trichomes and include predominantly terpenes such as oxygenated monoterpenes, hydrocarbon sesquiterpenes, oxygenated sesquiterpenes, and phenylpropanoids. These compounds are well-known for their antioxidant properties, providing additional benefits beyond their aromatic qualities. The content of bioactive phytochemicals in basil depends also on various factors, including the variety, growing conditions, altitude, storage, location, and weather. Subsequent harvests can influence the qualitative characteristics, playing a pivotal role in defining the final sensory profile of the product. As regard basil, Terpenes (monoterpene: (*R*)- linalool and 1,8-cineole and sesquiterpene: germacrene D and α-bergamotene being sesquiterpenes) and phenylpropenes are the primary components of basil’s essential oils. The growing interest for medicinal properties as well as for economic im- portance in Lamiaceae species has led to the publication of several genomes in recent years (Vining et al., 2022; Bornowski et al., 2020; Hamilton et al., 2020; Jia et al., 2021; Zheng et al., 2021; Li et al., 2022), thus providing an opportunity to exploited available genomic resources for the assessment of food product quality and safety. Three basil genome assemblies were released (Table 1), the sweet basil variety ‘Perrie’ will be used in this study to develop a novel and advanced platform in food science and technologies.

***Table 1.*** *List all the available genomic resources of the Ocimum basilicum cultivars*

|  |  |  |  |
| --- | --- | --- | --- |
| **Cultivar name** | **Genome size (Gb)** | **Predicted gene set** | **References** |
| Perrie | 2.13 | - | Dudai *et al.,* 2018 |
| Perrie | 2.13 | 62,067 | Gonda *et al.,* 2020 |
| Genovese | 2.068 | 78,990 | Bornowski *et al.,* 2020 |

**2. PhD Thesis Objectives and Milestones**

The present project aims at creating a multi-analytical system to characterize aromatic plants and standardize and evaluate the process of transformation of their products. The approach will be based on genomic, transcriptomic, and proteomic data to assess how the genetic traits control and regulate the aromatic profile changes during the plant's development. This will be supported by metabolomic data to create "foodomic" markers to support the food business operators in choosing the best processing conditions. The multidimensional platform will have two main purposes: to create a signature for ingredient authentication and to monitor the evolution of molecular components during transformation processes. Additionally, the developed model can be applied to other plant varieties. The entire project will be carried out through an integrated and multidisciplinary exchange between different scientific areas.

The PhD thesis project can be subdivided into the following activities according to the Gantt diagram given in Table 2:
A1) **Development and optimization of sample preparation process** for each target analytical platform.

A2) **Generation of data** for each target platform.

A3) **Elaboration, interpretation, and visualization of multi-omic data** to understand the genetic traits that control and regulate the aromatic profiles change during the plant's development.

A4) **Manuscript preparation and submission of the scientific papers** and oral and/or poster communications.

A5) **Writing and Editing of the PhD thesis**.

***Table 2.*** *Gantt diagram for Ph.D. 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) | ***Sample preparation process*** |   |   |   |  |  |  |  |   |   |  |  |  |  |   |  |  |  |  |   |   |  |  |  |  |
| A2) | ***Generation of Data***  |   |   |   |  |  |  |  |   |   |  |  |  |  |   |   |   |  |   |   |   |  |  |  |  |
| A3) | ***Analyses of multi-omic data*** |   |  |   |   |   |   |  |   |   |   |   |   |  |   |  |  |  |  |   |   |   |   |   |  |
| A4) | ***Preparation of the scientific papers*** |   |  |   |  |  |   |   |   |   |  |  |   |   |   |  |  |  |  |   |   |  |  |   |   |
| A5) | ***Thesis Preparation*** |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |   |   |   |   |   |   |   |

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