PLAN P – sPectral tools and digitalisation for the development of sustAinable structured food with plaNt Proteins

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2019 cofunded Call
End-term Project Seminar
30th January 2024

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PLAN P
SPECTRAL TOOLS & DIGITALISATION

ADRIA FOOD EXPERTISE

Technological research organization with food expertise

ERA-NET COFUND ICT AGRI FOOD

Région BRETAGNE

955 k€

January 2021 – December 2023
Extension: **June 2024**

DIAFIR Innovative Diagnostic Solutions

Private company specialized in the development of innovative spectroscopic devices combining sensor and AI algorithms

Ministry of Food, Agriculture and Fisheries of Denmark
gudp

UNIVERSITY OF COPENHAGEN

Department of Food Science KU-FOOD
Spectroscopy and chemometrics section

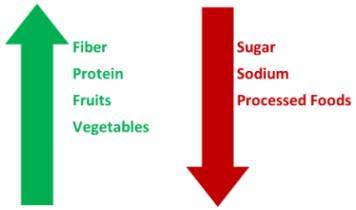
GSRI
GENERAL SECRETARIAT FOR RESEARCH AND INNOVATION

SCiO

Private company focused on big data analytics in food systems

Objective

Food choice by consumers:
+ natural, + rich in plants and + vegetarian meals



The increase in the supply of food products based on vegetable proteins stimulates their consumption.

No single way to develop value chains for protein-rich plants or seeds

Garnet et al., 2019. Proceeding of the National Academy of Sciences

Ultra-processed foods

Food emulsions & foams are ubiquitous in the food sector

Desired textural effects

Empirical approach

How to accelerate the design of new emulsion and foam-type products by diversifying the nature of proteins, while ensuring during production that the texture of the final product meets the requirements of the relevant product domain?

Hypothesis

The extraction of relevant information with sensors should facilitate:
- **The development of new products**
- **The changes of scale for production with optimization of processes**

Accelerate the plant-based food transition, through the evaluation of the acceptability of the texture of new products such as emulsions and foams by diversifying the nature of proteins (i.e. greater integration of plant proteins) based on spectral analysis

Research into the type of spectral technology appropriate for assessing production quality

Study how sensor data can be processed using multivariate analysis and machine learning

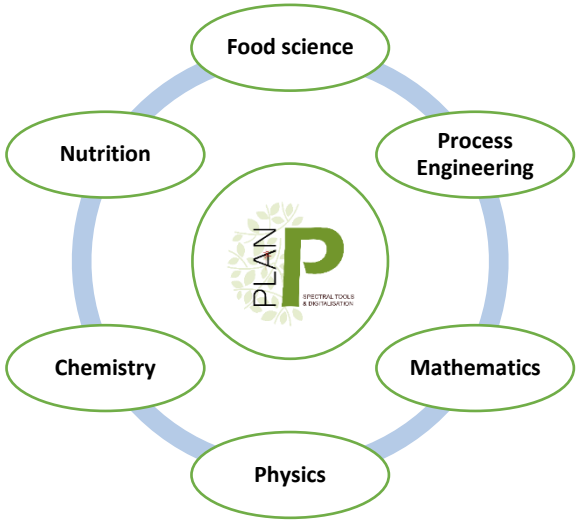
Identification of product quality markers

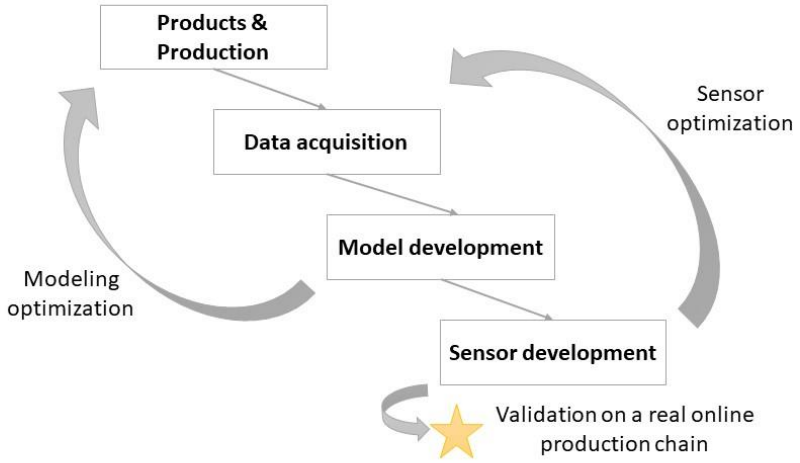
Development of online sensor prototypes

Develop a system to design sustainable foods and control quality during production

→ Facilitate protein transition using spectral methods and predictive models

Selected research approach, methodology





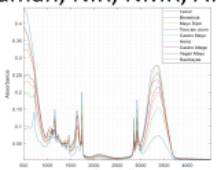
Screening of various **plant ingredients** and determination of their **functional** and **Physico-chemical** properties

Clustering of these plant ingredients based on their **foaming** or **emulsifying** capacities and their protein content → Selection of one ingredient per cluster

Production of matrices (emulsions and foams) with various textural properties by modifying process and formulation variables based on a **robust experimental design**

Physico-chemical characterization of the matrices (texture, viscosity, stability…)

Spectral characterization of the matrices (Raman, NIR, NMR, ATR)



ATR spectra of commercial mayonnaises

Data analysis for the **development of a predictive model** based on artificial intelligence

Elaboration of a sensor to analyze and predict the quality of plant ingredient-based food **during production**

2021

2022

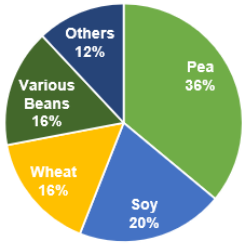
2023

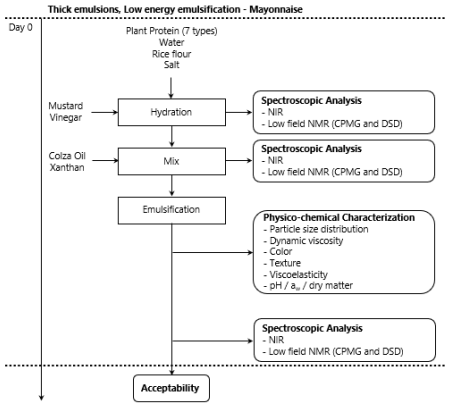
2024

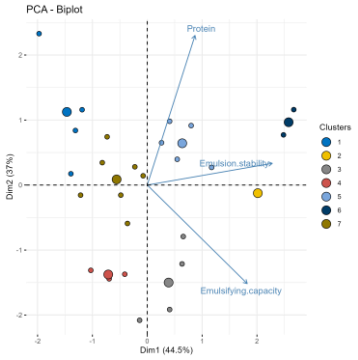
Major results: Highlight key accomplishments and challenges faced

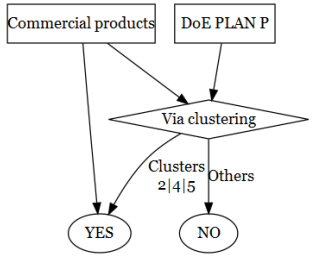
Instability of ingredients on the market	Objective definition of acceptability	Define sensor specification	Use spectal data to predict texture acceptability	Good models accurary for all matrices	Scale up validation test

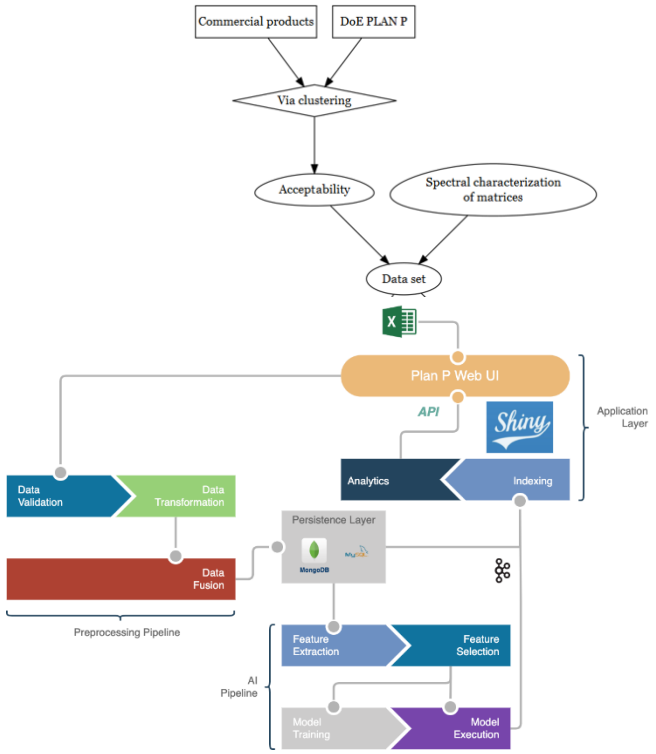
26 ingredients identified
(from 13 different suppliers)

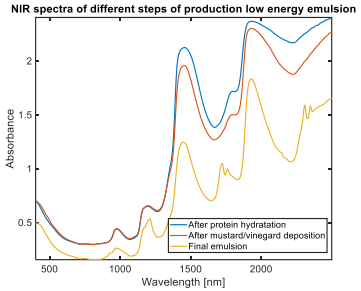


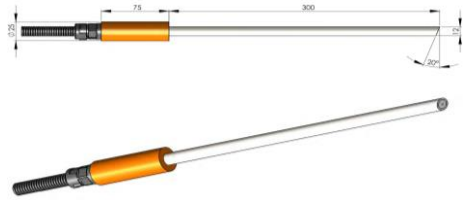












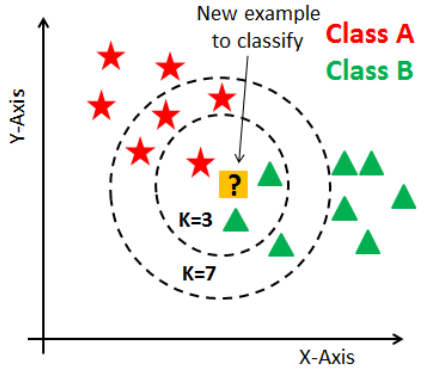
Partitioned clustering of the techno-functional characterization dataset	FrF2mix: A R package to combine process and mixture factors in the same design	A process for automatically building neural architectures	Predictive model of texture acceptability from spectral data (classification) Accuracy: 80,17% (on mayonnaise)	A NIR probe (800 nm to 2500 nm)

Opportunities and next steps for innovation

An **innovative component** of development achieved so far could be the **partitioned clustering of the techno-functional characterization dataset of plant protein ingredients** to **facilitate the screening of new ingredients**.

→ The new data could be **classified using the k-nearest neighbors (KNN) algorithm**

→ **New product or service offering**



Screening tool

Marketing departments of ingredient manufacturers

Presentation of the product offer or to Respond more specifically to customer requests

Until the end of June :

- **finalized the predictive models for all matrix**
- **complete the validation phase with scale-up production**
- **communication & dissemination of results:**
  - CFIA 2024 (Rennes, France): Oral presentation in a major event in the the food-processing sector: “Texture 2.0: Discover the results of AI in predicting the acceptability of the texture of emulsified or foam products based on vegetable proteins at the process stage
  - Thematic day on plant proteins (consumer expectations, economy, regulations, health safety, process (PLAN P results))
  - Draft of a scientific article

Summary and Conclusion takeaways and lessons learned

The **first period** of the project was devoted to the **sourcing of ingredients**, the beginning of their **characterization**, the implementation of **different methodologies** and the **experimental data acquisition**.

The **second period** was **lead to the development and then the testing of a platform of adapted sensors coupled to predictive models**.

Until the end of June :

- **finalized the predictive models for all matrix**
- **complete the validation phase with scale-up production**
- **communication & dissemination of results**

Acquiring training data was very time-consuming

Development of matrix dependent predictive models

Low return from the custumer needs survey

Sustainable products but an unstable ingredient market

International Collaboration

Project Management (project with few partners)

Adaptability

Communication and Dissemination

Networking

Collaborations established during the project can create future opportunities

→ **Reflection to merge and analyze ingredient databases (characterized by techno-functionality methods and spectral analyzes)**

LET'S KEEP IN TOUCH!

Please feel always free to reach out to us.

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Thank you for your attention!