Research Internship Proposal

DESIGN OF AN INSTRUMENTED CONTACT HEATING DEVICE FOR ANALYZING HEAT AND MASS TRANSFER DURING MINCED MEAT COOKING

LEVEL: Master 2 / Engineering 5th year.

DURATION: March to August 2025 (around 6 months).

PLACE: UMR SayFood(Campus Agro Paris-Saclay, Palaiseau)

SUBJECT: Raw minced meat can contain harmful bacteria, such as E. coli or Salmonella, which cause foodborne illnesses. Eliminating these bacteria is particularly important in minced meat, as they can be present throughout the entire product, unlike steaks, where bacteria are usually confined to the surface and can be more easily addressed.

The interaction of heat and mass transfer, combined with the changes in material properties during cooking, makes it a complex process. While some cooking techniques, such as hot-air oven cooking, have been extensively studied, this is not the case for contact heating (consisting of putting raw meat into contact with a hot surface), despite its widespread use in homes, catering, and industrial settings (e.g., pan-frying, single or double-sided grilling). The lack of research in this area may stem from the challenges associated with measuring properties like thermal flux exchanged between the product and the heating surface during cooking, which are influenced by material properties that evolve rapidly during cooking.

One potential solution to this challenge is the development of an inverse method, which uses temperature measurements at fixed locations within the heating plate to calculate the heat flux exchanged between the heating plate and the product as a function of time. However, applying the inverse method to such a complex phenomenon is not straightforward.

This internship project aims to design a setup that replicates both domestic and commercial cooking applications while strategically capturing data at specific locations with sufficient resolution to apply the inverse method. The project presents several design challenges, such as selecting materials, determining device geometry, managing system thermal inertia, choosing sensor types, and positioning them effectively. The final version of the experimental setup will also need to consider factors like durability, portability.

The project aims to generate data at different process conditions. Ultimately, this approach is a step towards ensuring the production of safer, higher-quality foods.

Objectives of the internship:

A) Make design choices such as material for equipment setup, geometry, sensors types and placement.
B) Manufacture and test experimental prototypes which may include thermal cameras, thermocouples, etc.
C) Validate the experimental setup and generate experimental data.

PROFILE: The ideal candidate should have a background in engineering science (ideally in thermal sciences) and an interest in experimentation. Basic understanding of instrumentation, such as using thermocouples and thermal cameras, is appreciated.

CONTACT:

Arnesh PALANISAMY, arnesh.palanisamy@agroparistech.fr
Emmanuel BERNUAU, emmanuel.bernuau@agroparistech.fr
Bertrand BROYART, bertrand.broyart@agroparistech.fr

APPLICATION: *Curriculum Vitae*, transcript of grades for the last 3 years and motivation letter with around 250 words.