
Research Internship Proposal

Heat and mass transfer in 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: French annual meat consumption is 85 kg per person with ground beef representing approximately 15% of total beef consumption, which is an average annual ground beef consumption of around 13 kg per person. Minced meat consumption has several health benefits as minced beef is rich in high-quality protein, supporting muscle growth and maintenance. Minced beef is more rapidly digested and absorbed compared to beef steak, resulting in increased amino acid availability and greater postprandial protein retention.

Minced meat is cooked for several important reasons, the primary of which is food safety. Raw minced meat can contain harmful bacteria (like E. coli or Salmonella) that can cause foodborne illnesses. Cooking it thoroughly kills these bacteria, making the meat safe to eat. This is more significant in minced meat because the bacteria need to be eliminated throughout the entire product, unlike steaks, where only the surface needs to be addressed. Secondly, cooking minced meat enhances its flavor. The Maillard reaction, a chemical reaction between amino acids and reducing sugars, occurs when meat is cooked, giving it a rich, savory taste. Cooking helps break down the proteins and fats in minced meat, making it more tender and easier to digest.

The combined dynamics of heat and mass transfer, along with the changes in material properties during cooking, create a complex process. Precisely understanding these interactions allows process engineers and food scientists to develop efficient, reliable, and safe cooking methods. By developing a virtual model of the cooking process, operators can predict and optimize cooking parameters, minimizing the risks of undercooking, which can cause foodborne illnesses, or overcooking, which can compromise flavour and texture. Ultimately, this approach ensures safer, higher-quality food production. Accurately measuring and calibrating the process with instrumentation, along with processing the data, is undoubtedly a challenging task. However, it can serve as a powerful enabler in the age of digitalization and digital modelling.

Objectives of the internship:

- A) Perform literature search and obtain reported data to estimate the conditions of minced meat cooking in domestic and industrial scale applications.
- B) Design and optimization of the experimental setup to mimic the relevant conditions of cooking using numerical simulations, preferably in COMSOL or OpenFOAM.
- C) Create the experimental setup (informed by the simulations in objective-B) consisting of but not limited to a lab scale heating pan, thermal cameras, thermocouples, etc.
- D) Generate experimental data with the experimental setup and validate the setup.

PROFILE: Preferably a person with a taste for both experimentation and modelling. Basic capabilities in scripting languages such as Python, R or MATLAB, image analysis and exposure to simulation softwares such as COMSOL/OpenFOAM. Willingness to get their hands dirty with the experimentation data collection and analysis. B2 or higher level in English, competency in French appreciated.

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APPLICATION: *Curriculum Vitae*, transcript of grades for the last 3 years and motivation letter with around 250 words. To be submitted before 15-Feb-2025.